EOTA®

EUROPEAN ASSESSMENT DOCUMENT

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METAL WEB BEAMS AND COLUMNS

This European Assessment Document (EAD) has been developed taking into account up-to-date technical and scientific knowledge at the time of issue and is published in accordance with the relevant provisions of Regulation (EU) No 305/2011 as a basis for the preparation and issuing of European Technical Assessments (ETA).

Contents

1 SCOPE OF THE EAD

1.1 Description of the Construction Product

Metal-web beams and columns are shallow parallel-chord trusses in which timber flanges are connected to each other by a system of triangulation provided by steel webs. A web is a thin gauge steel member that is fixed to the flanges of the beam or column by the pressed insertion of integral nail-plates. A metal web beam or column always has webs on both of the wider faces of the beam or column, although the arrangement of the webs on one face may not be the symmetrical opposite of the other face. A typical beam is shown in elevation in Figure 1 and in cross-section in Figure 2. This EAD covers beams or columns of any depth.

The flange must provide sufficient material for insertion of all the teeth of the nail-plates without overlap between opposing nail-plates. For any particular type and size of integral nail-plate, the minimum section depth and width dimensions of the flange shall be specified in the ETA, with a minimum cross-section area of 2000 mm².

The flanges may be of strength graded solid timber or of structural glued laminated timber. Where necessary the flanges may be end-jointed using punched metal plate fasteners (known as splice plates) pressed into the top and bottom faces of the flanges (Figure 3).

The webs are typically produced in end-joined pairs, called V-webs. On elevation the V-webs have integral nailplates at each end and at the root of the V-web as shown in Figure 4. These nailplates are pressed into the sides of the flanges to form triangulated frameworks of the type shown in Figure 1. For beams and columns or parts of beams and columns under high load, double webs may be used whereby two webs are placed adjacent and parallel to each other on each side of the flanges as shown in Figure 5. Figure 5 also shows that half V-webs are used to make up a double web at the end of a joist, whilst in the middle of a joist double webs are generally achieved by up-turning alternate V-webs. Beams and columns with spans that are not multiples of the nominal horizontal module of the V-web must have sufficient strength and stiffness along their entire length.

The example methods below of achieving any length of metal-web beams may be followed:

1. A Vierendeel bay is formed in the joist by fixing two short timber verticals between the flanges as shown in Figure 6 where the distance between the timber verticals does not exceed the horizontal module of the steel V-web.
2. The metal-web triangulation is discontinued locally such that the final webs on opposite sides of the non-triangulated zone are parallel to each other as shown in Figure 7. The maximum extent of the non-triangulated zone along either flange is half the horizontal module of the steel V-web.
3. The metal-web triangulation is discontinued locally with a vertical timber post fixed equidistant from the nearest metal webs as shown in Figure 8. The maximum distance along either flange from the centre of the post to the nearest integral nailplate is half the horizontal module of the steel V-web.

If other methods or models for achieving alternative lengths of metal-web members are developed, these shall be verified by calculation to EN 1995-1-1.

This EAD provides for the flanges of the metal-web beams and columns to be made of preservative or fire retardant treated timber. It does not include within its scope fire retardant coatings that may be applied post-fabrication.

1.1.1 Typical Metal Web Beam Designs

Figure 1: Elevation on a Metal Web Beam

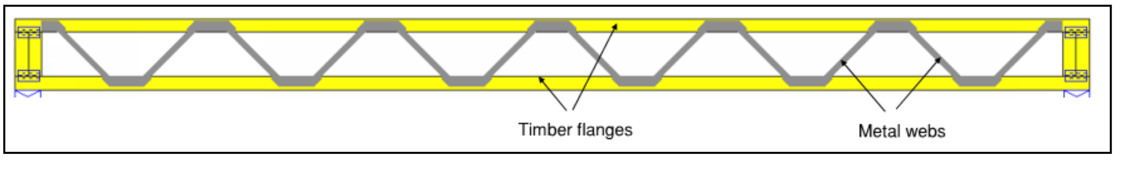


Figure 2: Cross section through Metal Web Beam

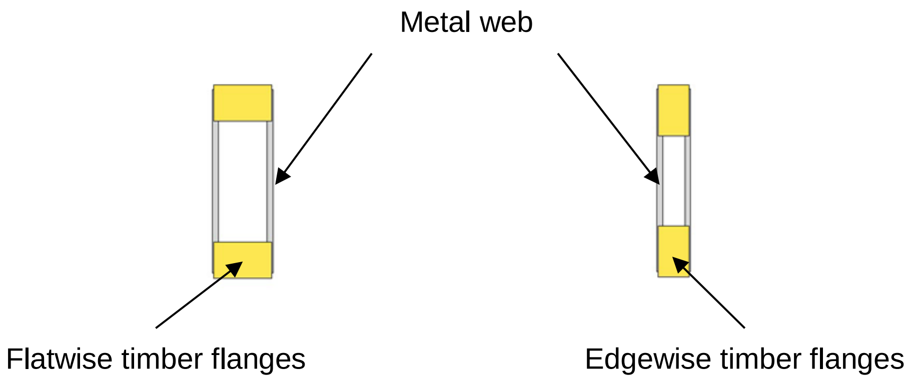


Figure 3: Location of Splice Plates on Flanges

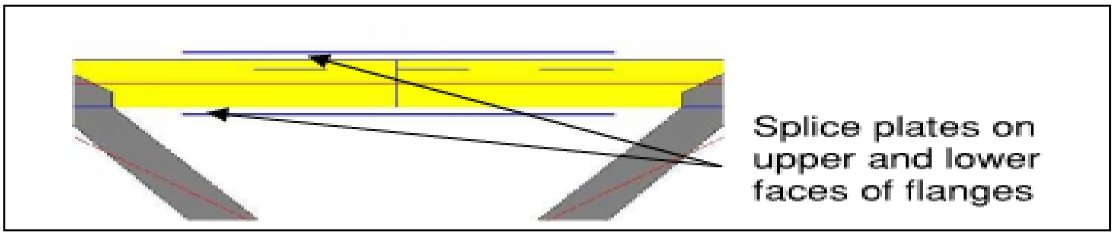


Figure 4: Elevation on a Single Metal V-web

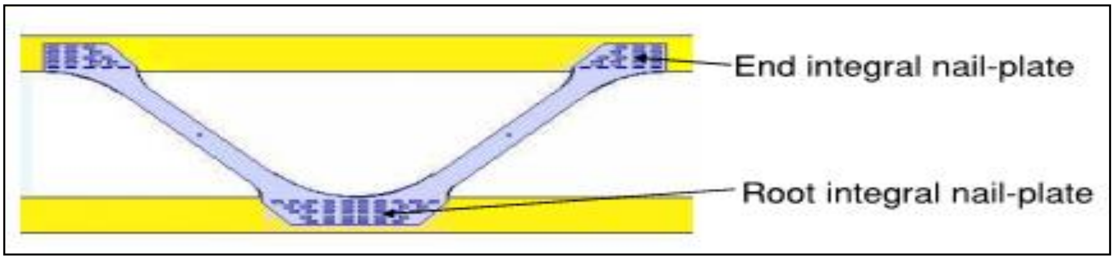
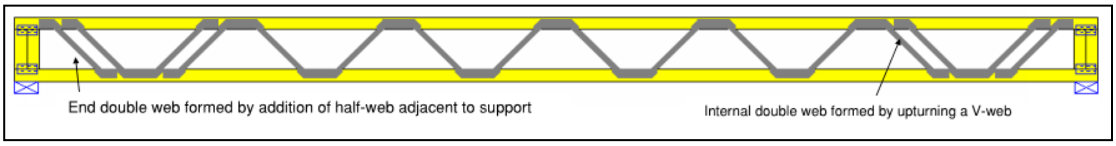


Figure 5: Metal Web Beam with Double Webs



1.1.2 Example methods to achieve any length of metal web beam or column

Figure 6: Joist length achieved using a Vierendeel bay

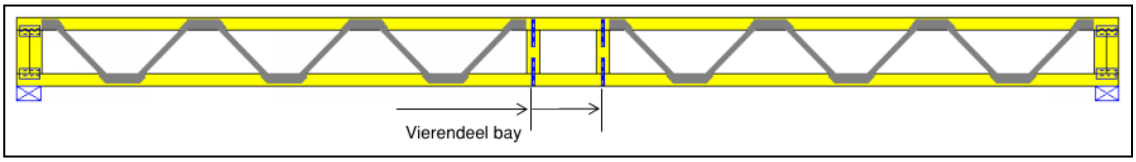


Figure 7: Joist Length Achieved by Locally Discontinuing the Metal Web Triangulation

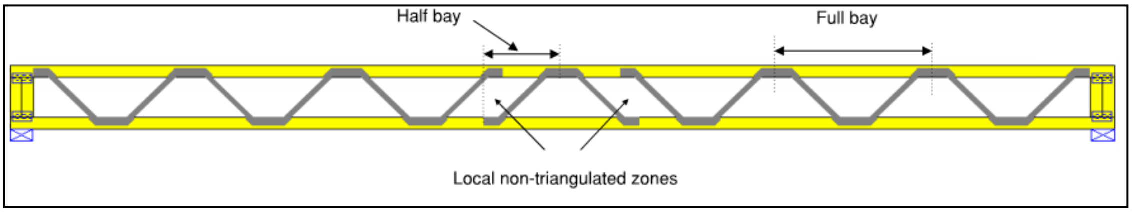
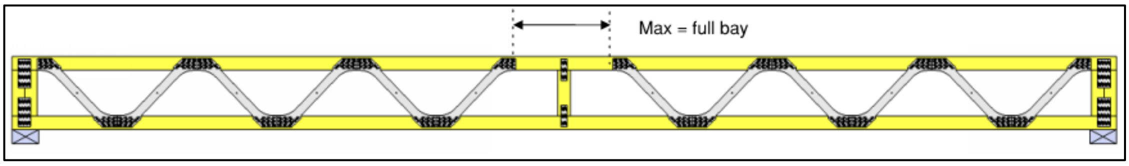


Figure 8: Joist Length Achieved by Using One Central Column



The product is not covered by a harmonised European standard (hEN).

Concerning product packaging, transport, storage, maintenance, replacement and repair it is the responsibility of the manufacturer to undertake the appropriate measures and to advise his clients on the transport, storage, maintenance, replacement and repair of the product as he considers necessary.

It is assumed that the product will be installed in accordance with the manufacturer's instructions.

Relevant manufacturer's stipulations having influence on the performance of the product covered by this European Assessment Document shall be considered for the determination of the performance and detailed in the ETA.

1.2 Information on the Intended Use(s) of the Construction Product

1.2.1 Intended Use(s)

Metal-web beams and columns are intended for use in buildings as loadbearing components in elements such as walls, roofs, floors or trusses. They are for use in Service Classes 1 and 2 as defined in EN 1995-1-1 and in Use Classes 1 and 2 as defined in EN 335 Parts 1 and 2.

1.2.2 Working Life/Durability

The assessment methods included or referred to in this EAD have been written based on the manufacturer's request to take into account a working life of the Metal Web Beams for the intended use of 60 years when installed in the works provided that the Metal Web Beam is subject to appropriate installation. These provisions are based upon the current state of the art and the available knowledge and experience.

When assessing the product, the intended use as foreseen by the manufacturer shall be taken into account. The real working life may be, in normal use conditions, considerably longer without major degradation affecting the basic requirements for works[1].

The indications given as to the working life of the construction product cannot be interpreted as a guarantee neither given by the product manufacturer or his representative nor by EOTA when drafting this EAD nor by the Technical Assessment Body issuing an ETA based on this EAD, but regarded only as a means for expressing the expected economically reasonable working life of the product.

1.3 Specific Terms in this EAD (if necessary in addition to the definitions in CPR, Art 2)

In this EAD, the depth of a beam or column is the larger overall cross section dimension, irrespective of the loading direction.

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1 The real working life of a product incorporated in a specific works depends on the environmental conditions to which that works is subject, as well as on the particular conditions of the design, execution, use and maintenance of that works. Therefore, it cannot be excluded that in certain cases the real working life of the product may also be shorter than referred to above.

2 ESSENTIAL CHARACTERISTICS AND RELEVANT ASSESSMENT METHODS AND CRITERIA

2.1 Essential Characteristics of the Product

Table 1 shows how the performance of Metal Web Beams and Columns is assessed in relation to the essential characteristics.

Table 1: Essential Characteristics of the Product and Methods and Criteria for Assessing the Performance of the Product in relation to those Essential Characteristics

No.	Essential Characteristic	Assessment Method	Type of Expression of Product Performance (*level, class, description*)
Basic Works Requirement 1: Mechanical Resistance and Stability			
Strengths of Webs			
1	Single web characteristic anchorage strength in tension at end support	2.2.1.2	Level - $F_{SW,anch,ES,t,k}$
2	Single web characteristic anchorage strength in tension at internal node	2.2.1.3	Level - $F_{SW,anch,int,t,k}$
3	Single web characteristic anchorage strength in compression	2.2.1.4	Level - $F_{SW,anch,c,k}$
4	Double web characteristic anchorage strength in tension	2.2.1.5	Level - $F_{DW,anch,t,k}$
5	Double web characteristic anchorage strength in compression	2.2.1.6	Level - $F_{DW,anch,c,k}$
6	Single web characteristic compression buckling strength	2.2.1.7	Level - $F_{SW,buck,k}$
7	Double web characteristic compression buckling strength	2.2.1.8	Level - $F_{DW,buck,k}$
Strength of Flanges			
8	Flanges – bending strength	2.2.1.9	Level - $f_{m,k}$ or class
9	Flanges – tension strength parallel to grain	2.2.1.10	Level - $f_{t,0,k}$ or class
10	Flanges – compression strength parallel to grain	2.2.1.11	Level - $f_{c,0,k}$ or class
11	Flanges – compression strength perpendicular to grain	2.2.1.12	Level - $f_{c,90,k}$ or class
12	Flanges – shear strength parallel to grain	2.2.1.13	Level – $f_{v,k}$ or class
13	Flanges – characteristic density	2.2.1.14	Level – ρ_k or class

No.	Essential Characteristic	Assessment Method	Type of Expression of Product Performance (*level, class, description*)
14	Flanges – mean density	2.2.1.15	Level - ρ_{mean} or class
Member Stiffnesses			
15	Flange - modulus of elasticity in bending	2.2.1.16	Level - E_m or class
Joint stiffnesses			
16	Web-flange joint slip modulus: single web	2.2.1.18	Level - $k_{ser,SW}$
17	Web-flange joint slip modulus: double web	2.2.1.19	Level - $k_{ser,DW}$
Other			
18	Creep	2.2.1.20.1	Level - k_{mod}
19	Duration of Load	2.2.1.20.2	Level - k_{def}
20	Dimensional Stability	2.2.1.21	Description
Basic Works Requirement 2: Safety in Case of Fire			
21	Reaction to Fire	2.2.2.1	Class
Basic Works Requirement 6: Energy Economy and Heat Retention			
22	Thermal Resistance	2.2.3.1	Description
Durability			
23	Durability of timber components	2.2.4.1	Description
24	Durability of metal components	2.2.4.2	Description

2.2 Methods and Criteria for Assessing the Performance of the Product in Relation to Essential Characteristics of the Product

2.2.1 Mechanical Resistance and Stability

Strength property and slip modulus values for a single web or a double web are determined for a pair of webs or two pairs of webs respectively, fixed in symmetry on the two opposing faces of a metal web beam or column. For an individual web or double web on one face that does not have a symmetrical twin on the opposing face (e.g. in a staggered web arrangement), the values should be reduced appropriately.

2.2.1.1 General Requirements for Testing and Assessing Web Strengths

2.2.1.1.1 Number of Tests

The minimum number of tests for each strength characteristic varies depending on the number of beam or column depths within the assessment.

Table 2: Minimum Number of Tests per Beam or Column Depth for each Strength Characteristic Assessed by Test

Number of depths in assessment	Minimum number of tests per depth[2]	Minimum total number of tests[3]
1	30	30
2	15	30
3	10	30
4	10	40
5	10	50

A sample of strength results for analysis is a set of valid results for a particular strength characteristic, a single depth and a consistent mode of failure. The minimum sample size for analysis is the same as the minimum number of tests per depth.

2.2.1.1.2 Test Material

The properties of the steel coil used for the fabrication of the metal webs used in the tests shall be contained in the test report, specifically the coil thickness, the yield stress and the ultimate tensile strength. The Mill Test Certificate to EN 10204 is a suitable means of reporting these properties.

The mechanical properties of the flange material for tests shall be contained in the test report by reference to a Strength Class as established in accordance with EN 14081-1 (for solid timber) or EN 14080 (for glued laminated timber i.e. glulam), such as the Strength Classes listed in EN 338. The nominal cross section size of the flange material shall be 47 × 72 mm. The flange material shall not contain any type of spliced joint.

Selection of individual pieces shall be made for density according to EN ISO 8970 whereby ρ_m shall be taken as the mean density of the strength class.

The moisture content of the flange material shall be measured at the point of fabrication of the metal web beams for testing with a resistance moisture meter and recorded. Solid timber shall have a moisture content between 14% and 20%; glulam shall have a moisture content of between 9% and 15%.

The selection of test material shall be under the control of the Certification Body, but may be conducted at the premises of the fabricator or the material supplier.

2.2.1.1.3 Specimen Fabrication, Storage and Conditioning

The specimens shall be fabricated under normal manufacturing conditions with the flanges in a flatwise orientation.

The test beams and columns shall be conditioned at 20°C / 65% RH until they reach a constant mass[4].

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2 The minimum number of tests for a web strength parameter at a given beam or column depth (10) is twice the minimum number of tests (5) stipulated by EN 14545 for either steel or anchorage nailplate parameters.

3 The minimum total number of anchorage tests permitted by EN 14545 is as few as 30 tests to characterise the full range of nailplate sizes and orientations with regard to angles of load to grain and fastener length. This EAD stipulates the same minimum number of tests (30) for anchorage parameters within a narrow band of near-uniform nailplate sizes between different joist depths and angles of load to grain/fastener length ranging only between 30° and 40°.

4 Constant mass is considered to be attained when the results of two successive weighings, carried out at an interval of 6 hours, do not differ by more than 0.1% of the mass of the timber in the test specimen.

2.2.1.1.4 Test Procedure

Loading arrangements are given in Annex B. Where the load is distributed over more than one node, the method of application should ensure that loads at each node do not differ by more than 2% of the maximum combined load. The load shall be applied via spreader plates of sufficient size to prevent local flange failure.

It may be necessary to provide lateral restraints to restrain the specimen from torsional buckling under load. Such restraints should not provide any resistance to edgewise loading of the specimen.

The test specimens shall be tested using the loading procedure from EN 26891, including the initial loading and unloading stages.

The test shall be continued to failure as defined for the characteristic under test. The load shall be applied under load control to $0.7F_{est}$, as described in EN 26891. Above $0.7F_{est}$ the load may be applied in load control or displacement control to failure, whereby the gradient of the load-displacement curve shall not exceed that of the previous loading stage. The maximum load applied to the specimen and the mode of failure shall be recorded.

2.2.1.1.5 Determination of Moisture Content and Density

A section of timber at least 30 mm long shall be cut from one of the flanges near to the failure point for the determination of density and moisture content at test. The moisture content shall be determined in accordance with the method in EN 13183-1.

2.2.1.1.6 Determination of Axial Forces in Web Members

For each of the test arrangements in Annex B, the following method shall be used to determine the axial strength at failure of the web under consideration (F_{web}):

1. The test arrangement should be recreated using a static frame model following the principles shown in Fig. A-1 for single webs or Fig. A-2 for double webs. A unit point load (1 kN) should be applied to the static frame model, at each loading position shown in the test arrangement, with the number of unit point loads applied to the test arrangement being N_{PL}.
2. The axial force (F_{PL}) calculated by the static frame model for the web under consideration in the test arrangement should be recorded.
3. The axial strength of the web (F_{web}) should be calculated as follows;

$$F_{\mathrm{web}} = F_{\mathrm{PL}} \times \frac{P}{N_{\mathrm{PL}}}$$

Where;

N_{PL} Number of unit point loads applied to static frame model in test arrangement;

F_{PL} Axial force calculated by static frame model for web member under consideration in test arrangement;

F_{web} Axial strength of web, either F_{SW} for single webs, or F_{DW} for double webs;

P Total load at failure.

2.2.1.1.7 Determination of Characteristic Strength Values

For a single sample, characteristic values for strength parameters determined by test are calculated as 5-percentiles in accordance with the equation in EN 14358 for logarithmically normally distributed values;

$$m_{\mathrm{k}} = \exp\left(\bar{y} - k_{\mathrm{s}}(n) s_y\right)$$

Where:

m_k	Characteristic value of m
$\bar{y}$	Mean value of y, where $y_i = \ln(m_i)$
s_y	Sample standard deviation of y, where $y_i = \ln(m_i)$
n	Number of results in the sample
$k_s(n)$	A factor for the number of results in a sample, given as $(6{,}5n + 6)/(3{,}7n - 3)$

For multiple samples, where products are available in more than one depth, or where more than one valid sample is available at a particular depth, a global coefficient of variation is assumed[5]. When applied to the calculation of the characteristic value for each depth $n = \sum n_{\text{depth}}$ and $s_y = s_{y,\text{global}}$ in the equation above, whereby:

$$s_{y,\text{global}} = \max\left[\sqrt{\frac{\sum\left(\left(n_{\text{depth}} - 1\right)\left(s_{y,\text{depth}}\right)^2\right)}{\sum n_{\text{depth}} - J}};\, 0{,}05\right]$$

Where:

$s_{y,\text{depth}}$	Value of s_y for each valid sample at each depth
n_{depth}	Number of results in each valid sample at each depth
J	Total number of valid samples across all depths per web strength parameter

The individual ultimate compression buckling web strengths shall be modified for steel quality as per EN 1075.

2.2.1.2 Single Web Characteristic Anchorage Strength in Tension at End Support, $F_{SW,anch,ES,t,k}$

$F_{SW,anch,ES,t,k}$ is determined by test with the minimum number of test specimens for each depth being determined in accordance with Table 2.

The flanges and webs are selected in accordance with 2.2.1.1.2 and test specimens with the web configuration shown in Fig. B-1 are fabricated in accordance with 2.2.1.1.3.

Tests are conducted in accordance with 2.2.1.1.4 with valid tests being those with anchorage failure in one or more of the end tension webs.

For each valid test the axial tension force in the end web is determined in accordance with 2.2.1.1.6 with the characteristic value of $F_{SW,anch,ES,t,k}$ then being determined in accordance with 2.2.1.1.7.

2.2.1.3 Single Web Characteristic Anchorage Strength in Tension at Internal Node, $F_{SW,anch,int,t,k}$

$F_{SW,anch,int,t,k}$ is determined by test with the minimum number of test specimens for each depth being determined in accordance with Table 2.

The flanges and webs are selected in accordance with 2.2.1.1.2 and test specimens with the web configuration shown in Fig. B-2 are fabricated in accordance with 2.2.1.1.3.

Tests are conducted in accordance with 2.2.1.1.4 with valid tests being those with anchorage failure in one or more of the internal tension webs.

For each valid test the axial tension force in the internal web is determined in accordance with 2.2.1.1.6 with the characteristic value of $F_{SW,anch,int,t,k}$ then being determined in accordance with 2.2.1.1.7.

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5 The equation is adopted from EN 14545

2.2.1.4 Single Web Characteristic Anchorage Strength in Compression, $F_{SW,anch,c,k,}$

$F_{SW,anch,c,k}$ is determined by test with the minimum number of test specimens for each depth being determined in accordance with Table 2[6].

The flanges and webs are selected in accordance with 2.2.1.1.2 and test specimens with the web configuration shown in Fig. B-3 are fabricated in accordance with 2.2.1.1.3.

Tests are conducted in accordance with 2.2.1.1.4 with valid tests being those with anchorage failure in one or more of the end compression webs. Tests that fail in web buckling shall be repeated.

If 50% or more of the specimens in a sample fail in web buckling, additional specimens shall be tested with the webs laterally restrained to promote anchorage failure. A method of restraint is shown in Fig. B-6, whereby the restraint shall not provide any reinforcement to the anchorage. Sufficient specimens shall be tested to provide a valid sample. In this case, further testing shall carried out to determine $F_{SW,buck,k}$ (2.2.1.7).

For each valid test the axial compression force in the end web is determined in accordance with 2.2.1.1.6 with the characteristic value of $F_{SW,anch,c,k}$ then being determined in accordance with 2.2.1.1.7.

2.2.1.5 Double Web Characteristic Anchorage Strength in Tension, $F_{DW,anch,t,k}$

$F_{DW,anch,t,k}$ is determined by test with the minimum number of test specimens for each depth being determined in accordance with Table 2.

The flanges and webs are selected in accordance with 2.2.1.1.2 and test specimens with the web configuration shown in Fig. B-4a (which is the same as Fig. B-4b) are fabricated in accordance with 2.2.1.1.3.

Tests are conducted in accordance with 2.2.1.1.4 with valid tests being those with anchorage failure in one or more of the double tension webs. The test configuration in Fig. B-4a is preferred for simplicity, but if initial tests in this configuration do not fail in tension anchorage, testing should be continued with the test configuration in Fig. B-4b. Sufficient specimens shall be tested to provide a valid sample.

Note that for the test arrangement Fig. B-4b two load points are applied to the bottom chord, whereby the spreader plates shall not interfere with the steel webs.

For each valid test the double web anchorage strength in tension is determined in accordance with 2.2.1.1.6 with the characteristic value of $F_{DW,anch,t,k}$ being determined in accordance with 2.2.1.1.7.

2.2.1.6 Double Web Characteristic Anchorage Strength in Compression, $F_{DW,anch,c,k}$

$F_{DW,anch,c,k}$ is determined by test with the minimum number of test specimens for each depth being determined in accordance with Table 2.

The flanges and webs are selected in accordance with 2.2.1.1.2 and test specimens with the web configuration shown in Fig. B-5 are fabricated in accordance with 2.2.1.1.3.

Tests are conducted in accordance with 2.2.1.1.4 with valid tests being those with anchorage failure in one or more of the double compression webs. Tests that fail in web buckling shall be repeated.

If 50% or more of the specimens in a sample fail in web buckling, additional specimens shall be tested with the webs laterally restrained to promote anchorage failure. The method of restraint for single webs in Fig. B-6 may be adapted for double webs, whereby the restraint shall not provide

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6 Note that anchorage failure implies a failure of the timber while buckling failure implies a failure of the metal. When design values are calculated from timber failures, characteristic values are reduced by a greater amount than when they are calculated from metal failures. Hence if compression failure occurs in anchorage it is always governing, but if it occurs in buckling both buckling and anchorage values must be determined.

any reinforcement to the anchorage. Sufficient specimens shall be tested to provide a valid sample. In this case, further testing shall carried out to determine $F_{DW,buck,k}$ (2.2.1.8).

For each valid test the double web anchorage strength in compression is determined in accordance with 2.2.1.1.6 with the characteristic value of $F_{DW,anch,c,k}$ being determined in accordance with 2.2.1.1.7.

2.2.1.7 Single Web Characteristic Compression Buckling Strength, $F_{SW,buck,k}$

If $F_{SW,anch,k}$ (2.2.1.4) is determined without buckling restraint then $F_{SW,buck,k}$ = $F_{SW,anch,k}$. Otherwise $F_{SW,buck,k}$ is determined by test, with the minimum number of test specimens for each depth being determined in accordance with Table 2.

The flanges and webs are selected in accordance with 2.2.1.1.2 and test specimens with the web configuration shown in Fig. B-3 are fabricated in accordance with 2.2.1.1.3.

Tests are conducted in accordance with 2.2.1.1.4 with valid tests being those with web buckling failure in one or more of the end compression webs. Tests that fail in anchorage shall be repeated to obtain the minimum sample size in web buckling failure.

For each valid test the compression buckling strength in the end web is determined in accordance with 2.2.1.1.6 with the characteristic value of $F_{SW,buck,c,k}$ then being determined in accordance with 2.2.1.1.7.

2.2.1.8 Double Web Characteristic Compression Buckling Strength, $F_{DW,buck,k}$

If $F_{DW,anch,k}$ (2.2.1.5) is determined without buckling restraint then $F_{DW,buck,k}$ = $F_{DW,anch,k}$. Otherwise $F_{DW,buck,k}$ is determined by test, with the minimum number of test specimens for each depth being determined in accordance with Table 2.

The flanges and webs are selected in accordance with 2.2.1.1.2 and test specimens with the web configuration shown in Fig. B-5 are fabricated in accordance with 2.2.1.1.3.

Tests are conducted in accordance with 2.2.1.1.4 with valid tests being those with web buckling failure in one or more of the end compression webs. Tests that fail in anchorage shall be repeated to obtain the minimum sample size in web buckling failure.

For each valid test the double web buckling strength in compression is determined in accordance with 2.2.1.1.6 with the characteristic value of $F_{DW,buck,c,k}$ being determined in accordance with 2.2.1.1.7.

2.2.1.9 Flanges – Bending Strength $f_{m,k}$

The characteristic bending strength of the flanges $f_{m,k}$ shall be stated as the value for the strength class, such as by reference to those listed in EN 338, in accordance with EN14081-1 (for solid timber), or by reference to EN 14080 (for glulam).

2.2.1.10 Flanges – Tension Strength Parallel to Grain $f_{t,0,k}$

The characteristic tension strength parallel to grain of the flanges $f_{t,0,k}$ shall be stated as the value for the strength class as above.

2.2.1.11 Flanges – Compression Strength Parallel to Grain $f_{c,0,k}$

The characteristic compression strength parallel to grain of the flanges $f_{c,0,k}$ shall be stated as the value for the strength class as above.

2.2.1.12 Flanges – Compression Strength Perpendicular to Grain $f_{c,90,k}$

The characteristic compression strength perpendicular to grain of the flanges $f_{c,90,k}$ shall be stated as the value for the strength class as above.

2.2.1.13 Flanges – Shear Strength Parallel to Grain $f_{v,k}$

The characteristic shear strength parallel to grain of the flanges $f_{v,k}$ shall be stated as the value for the strength class as above.

2.2.1.14 Flanges – Characteristic Density ρ_k

The characteristic density of the flanges ρ_k shall be stated as the value for the strength class as above.

2.2.1.15 Flanges – Mean Density ρ_{mean}

The mean density of the flanges ρ_{mean} shall be stated as the value for the strength class as above.

2.2.1.16 Flange – Modulus of Elasticity in Bending, E_m

The mean modulus of elasticity E_m shall be stated as the value for the strength class as above.

2.2.1.17 Web-flange Joint Slip Modulus

2.2.1.17.1 Number of Tests

A minimum of 5 tests shall be conducted for each characteristic assessed by test. Each beam depth shall be assessed.

2.2.1.17.2 Test Material

See 2.2.1.1.2 for test material requirements, except the moisture content of solid timber flanges shall be between 12% and 16%.

The stiffness of the flange material shall be established prior to fabrication. The measurements shall be made in flatwise bending using a calibrated dead weight and deflection gauge at the centre of the flange specimen. The supports shall be as close to the ends of the specimen as possible, typically with an end distance equivalent to the thickness of the flange. The Modulus of Elasticity E_{flange} from these tests shall be calculated as:

$$E_{\text{flange}} = \frac{P}{\Delta} \times \frac{L^3}{4bd^3}$$

Where:

- P the force exerted by the dead weight in Newtons
- Δ the displacement caused by the dead weight in mm
- L the distance between the supports in mm
- b breadth (or width) of the flange in mm
- d depth (or thickness) of the flange in mm.

The value of E_{flange} shall be recorded for each piece of flange material intended for use in stiffness tests. Each piece of flange material selected shall have an E_{flange} value within 1000 N/mm² of the mean value E_m for its strength class.

The selection of test material and any determination of stiffness shall be under the control of the Certification Body, but may be conducted at the premises of the fabricator or the material supplier.

2.2.1.17.3 Specimen Fabrication, Storage and Conditioning

The specimens shall be fabricated under normal manufacturing conditions with the flanges in a flatwise orientation, and be delivered to the test laboratory within 24 hours of fabrication. Test specimens shall be tested within 48 hours of arrival at the test laboratory.

2.2.1.17.4 Test Procedure

Loading arrangements are given in Annex C. Where the load is distributed over several nodes, the method of application should ensure that the load at any one node does not differ from the load at any other node by more than 2% of the total combined load. This requirement applies when the combined load is greater than 15% of the estimated maximum load.

It may be necessary to provide lateral restraints to restrain the specimen from torsional buckling under load. Such restraints should not provide any resistance to edgewise loading of the specimen.

The deflection of the lower flange relative to the supports shall be recorded midway between the supports.

The test specimens shall be tested using the loading procedure from EN 26891, including the initial loading and unloading stages.

The test shall be continued to at least $0.6F_{est}$. The load shall be applied under load control as described in EN 26891. The complete load deflection cycle shall be continuously recorded.

2.2.1.17.5 Determination of Moisture Content and Density

A section of timber at least 30 mm long shall be cut from one of the flanges near mid-span for the determination of density and moisture content at time of test. The moisture content shall be determined in accordance with the method in EN 13183-1.

2.2.1.17.6 Determination of Joint Slip Modulus

For each of the test arrangements in Annex C, the following method should be used to determine the mean joint slip modulus ($k_{ser,SW}$ for a single web, $k_{ser,DW}$ for a double web):

The mean joint slip modulus for a given test arrangement should be taken as the mean of the joint slip moduli from the individual tests. The joint slip modulus for each test should be determined as follows:

1. The test arrangement should be recreated using a static frame model following the principles shown in Fig. A-1 for single webs or Fig. A-2 for double webs. A point load of magnitude, $1/N_{PL}$, where N_{PL} is the number of point loads in the test arrangement, should be applied to the static frame model at each loading position shown in the test arrangement. Using the measured dimensions and moduli of elasticity for the flanges, together with the representative cross-sectional area and modulus of elasticity of the webs, the mid-span deflection calculated by the static frame model under the presumption of no joint slip (δ_{member}) should be recorded.
2. The mid-span deflection attributable to joint slip (δ_{joint}) can then be calculated by deducting δ_{member} from the inverse of the measured load-deflection gradient (in kN/mm) of the 2nd load cycle.
3. Using the static frame model the magnitude of the joint slip modulus at each end of a web member causing the mid-span deflection attributable to joint slip (δ_{joint}) should be determined.

2.2.1.18 Web-flange Joint Slip Modulus: Single Web, $k_{ser,SW}$

$k_{ser,SW}$ is determined by test with the minimum number of test specimens for each beam depth and web configuration being determined in accordance with 2.2.1.17.1.

The flanges and webs are selected in accordance with 2.2.1.17.2 and test specimens with the web configurations shown in Fig. C-1 and Fig. C-2 are fabricated in accordance with 2.2.1.17.3.

Tests are conducted in accordance with 2.2.1.17.4.

For each test the single web joint slip modulus is determined in accordance with 2.2.1.17.6. A single mean value of $k_{ser,SW}$ is calculated from the joint slip moduli of individual tests with the web configurations shown in Fig. C-1 and Fig. C-2.

2.2.1.19 Web-flange Joint Slip Modulus: Double Web, $k_{ser,DW}$

$k_{ser,DW}$ is determined by test with the minimum number of test specimens for each beam depth being determined in accordance with 2.2.1.17.1.

The flanges and webs are selected in accordance with 2.2.1.17.2 and test specimens with the web configurations shown in Fig. C-3 are fabricated in accordance with 2.2.1.17.3.

Tests are conducted in accordance with 2.2.1.17.4.

For each test the double web joint slip modulus is determined in accordance with 2.2.1.17.6. A single mean value of $k_{ser,DW}$ is calculated from the joint slip moduli of individual tests with the web configurations shown in Fig. C-3.

2.2.1.20 Creep and Duration of Load

Whilst the steel webs are not susceptible to creep or duration of load phenomena, the creep and duration of load behaviour of the timber flanges and the timber anchorage joints shall be taken into account.

2.2.1.20.1 Creep k_{def}

A numeric value for the factor k_{def} shall be stated for the relevant service classes and duration of load classes defined in section 3.1 of Eurocode 5 (EN 1995-1-1).

2.2.1.20.2 Duration of Load k_{mod}

A numeric value for the factor k_{mod} shall be stated for the relevant service classes and duration of load classes defined in section 3.1 of Eurocode 5 (EN 1995-1-1).

2.2.1.21 Dimensional Stability

2.2.1.21.1 Tolerances of Dimensions

Numeric values of the nominal dimensions and the permissible deviations, e.g. on length, width and depth, shall be stated.

2.2.1.21.2 Stability of Dimensions

An assessment shall be made of the effect on the joist dimensions of variations in moisture content between installation and service as well as during the joist's service life.

The highest moisture condition for the intended use of the product shall be specified by reference to the appropriate service class in EN1995-1-1.

2.2.2 Safety in Case of Fire

2.2.2.1 Reaction to Fire

The reaction to fire of Metal Web Beams and Columns shall be determined and classified in accordance with Commission Delegated Regulation (EU) 2016/364.

2.2.3 Energy Economy and Heat Retention

2.2.3.1 Thermal Resistance

For the purpose of heat loss calculations, one or more of the following methods shall determine the thermal properties of the component materials of the beam or column:

- Design values specified in EN 12524.
- Other values are determined according to EN ISO 10456

2.2.4 Durability

The durability of the product shall be evaluated taking into account the intended use of the product and the relevant environmental conditions. The Service Classes and load duration classes according to EN 1995-1-1 and the Use Classes of EN 335 can generally describe the environmental conditions.

2.2.4.1 Durability of Timber Components

The natural durability of the timber flanges shall be stated in accordance with EN 350. A preservative treatment may be applied, selected in accordance with EN 351.

If the timber is preservative treated the effect on its strength may need to be evaluated according to EN 15228. Strength and stiffness shall be assumed not to be affected in the following cases:

- Treatments and preservatives listed in Annex A of EN 15228,
- Treatments with a penetration class not exceeding class NP2 according to EN 351.

Any preservative / fire retardant used shall be compatible with the metal components of the metal-web beam or column and shall not result in their corrosion.

2.2.4.2 Durability of Metal Components

For metal webs that are manufactured from hot-dip zinc coated sheet, the thickness of the coating shall be determined in accordance with EN 10346. The minimum corrosion protection or materials specification for different service classes shall be in accordance with EN 1995-1-1. Alternative materials shall have equivalent properties/performance.

The corrosion protection shall be determined in conjunction with the intended service conditions according to EN 1995-1-1 and the intended corrosivity category according to EN ISO 12944-2.

Contact between different materials, used in the manufacture of the metal fasteners and other structural connectors shall not result in corrosion occurring in the service classes being considered. The same rationale shall be applied in relation to the metal fasteners and other structural connectors and the timber species, proposed for use in the manufacture of the metal-web beams and columns.

3 ASSESSMENT AND VERIFICATION OF CONSTANCY OF PERFORMANCE

3.1 System of Assessment and Verification of Constancy of Performance to be Applied

For the products covered by this EAD the applicable European legal act is: Decision 1999/92/EC

The System is: 1

3.2 Tasks of the Manufacturer

The cornerstones of the actions to be undertaken by the manufacturer of the product in the process of assessment and verification of constancy of performance are laid down in Table 3.

Table 3: Control Plan for the Manufacturer; Cornerstones

No.	Subject/Type of Control (product, raw/constituent material, component - indicating characteristic concerned)	Test or Control Method	Criteria, if any	Minimum Number of Samples	Minimum Frequency of Control
Factory Production Control (FPC) [including testing of samples taken at the factory in accordance with a prescribed test plan]*					
1	Flange material - strength	Check supplier documentation and marking	Graded for structural use to EN 14081-1 or EN 14080	NA	Each delivery
2	Moisture content of flange material at fabrication	Check with moisture meter	Solid timber – max 22% Glulam – max 15%	5	Each shift
3	Flange material	Check geometry	Match specification	1	Each batch and each shift
4	Metal webs	Check supplier documentation and marking	Match specification	NA	Each batch
5	Positioning and fixing of metal webs to flanges	Visual check	N/A	All beams	NA
6	Geometry of beam	Dimensional check	Within declared tolerance	5	Each batch
7	Marking	Visual check	Match specification	1	Each batch

3.3 Tasks of the Notified Body

The cornerstones of the actions to be undertaken by the notified body in the process of assessment and verification of constancy of performance for Metal Web Beams and Columns are laid down in Table 4.

Table 4: Control Plan for the Notified Body; Cornerstones

No.	Subject/Type of Control (product, raw/constituent material, component - indicating characteristic concerned)	Test or Control Method	Criteria, if any	Minimum Number of Samples	Minimum Frequency of Control
Initial Inspection of the Manufacturing Plant and of Factory Production Control *(for systems 1+, 1 and 2+ only)*					
1.	The Notified Body shall ascertain that the Factory and Factory Production Control System is suitable in ensuring consistent manufacture of the product in accordance with the prescribed Test plan.	-	-	-	Before Certification
Continuous Surveillance, Assessment and Evaluation of Factory Production Control *(for systems 1+, 1 and 2+ only)*					
1.	The Notified Body shall carry out Continuing Surveillance of the Factory and Factory Production Control, taking into account the prescribed Test Plan, to ensure consistent manufacture of the product	-	-	-	1/Year

Whenever a change occurs in materials or production process which would significantly change the above characteristics, the tests or assessments shall be repeated for the appropriate characteristics.

4 REFERENCE DOCUMENTS

As far as no edition date is given in the list of standards thereafter, the standard in its current version at the time of issuing the European Technical Assessment, is of relevance.

EN 1995-1-1	Eurocode 5: Design of timber structures. Part 1-1: General – Common rules and rules for buildings
EN 338	Structural timber – Strength classes
EN 350	Durability of wood and wood-based products. Testing and classification of the durability to biological agents of wood and wood-based materials
EN351	Durability of wood and wood-based products. Preservative-treated solid wood. Guidance on sampling for the analysis of preservative-treated wood
EN 1075	Timber structures – Test methods – Joints made with punched metal plate fasteners
EN 13183-1	Moisture content of a piece of sawn timber - Part 1: Determination by oven dry method
EN 10204	Metallic products. Types of inspection documents
EN 14081-1	Timber structures. Strength graded structural timber with rectangular cross section - Part 1: General requirements
EN 14358	Timber structures – Calculation and verification of characteristic values
EN 14545	Timber structures – Connectors – Requirements
EN 15228	Structural timber. Structural timber preservative treated against biological attack
EN ISO 8970	Timber Structures – Testing of Joints made with Mechanical Fasteners – Requirements for Wood Density.
EN 26891	Timber structures – Joints made with mechanical fasteners. General principles for the determination of strength and deformation characteristics
ETAG 011	Guideline for European Technical Approval of Light composite wood-based beams and columns
EN ISO 12944-2	Paints and varnishes. Corrosion protection of steel structures by protective paint systems. Classification of environments
EN 13501-2	Fire classification of construction products and building elements – Part 2 Classification using data from fire resistance tests.
EN 1365-1	Fire resistance tests for loadbearing elements. Walls
EN 1365-2	Fire resistance tests for loadbearing elements. Floors and roofs
EN 1365-3	Fire Resistance for loadbearing elements. Beams
EN 1365-4	Fire resistance tests for loadbearing elements. Columns

EN 335	Durability of wood and wood-based products. Use classes: definitions, application to solid wood and wood-based products
EN 460	Durability of wood and wood-based products - Natural durability of solid wood - Guide to the durability requirements for wood to be used in hazard classes
EN 599-1	Durability of wood and wood-based products — Efficacy of preventive wood preservatives as determined by biological tests Part 1: Specification according to use class
EN 10346	Continuously hot-dip coated steel flat products. Technical delivery conditions
EN 12524	Building materials and products. Hygrothermal properties. Tabulated design values
EN ISO 10456	Building materials and products. Hygrothermal properties. Tabulated design values and procedures for determining declared and design thermal values
EN ISO 9001	Quality systems – Model for quality assurance in design, development, production, installation and servicing.

ANNEX A STRUCTURAL MODEL FOR METAL WEB BEAMS AND COLUMNS

As shown in Fig. A-1 and Fig. A-2 the web system lines coincide at a pinned node (the web node). For the flange dimensions of the test material it is assumed that the web node falls on the system line of the flange and is pinned to it.

For the design of metal web beams with flanges of a greater depth than the test specimens this assumption may not be valid. In this case an additional node should be placed on the system line adjacent to each web node and pinned to it by a short fictive line.

Fig. A-1: Structural model for metal-web joists with single webs **[NOT TO SCALE]**

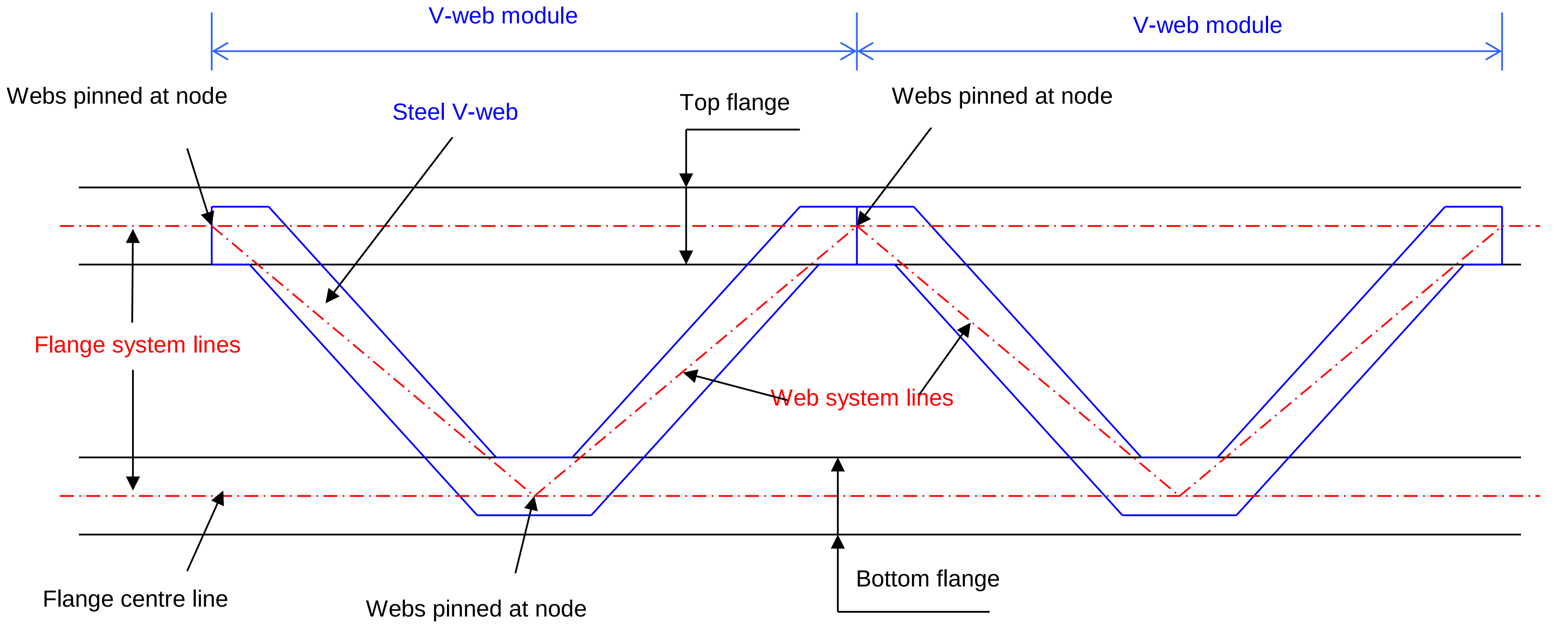
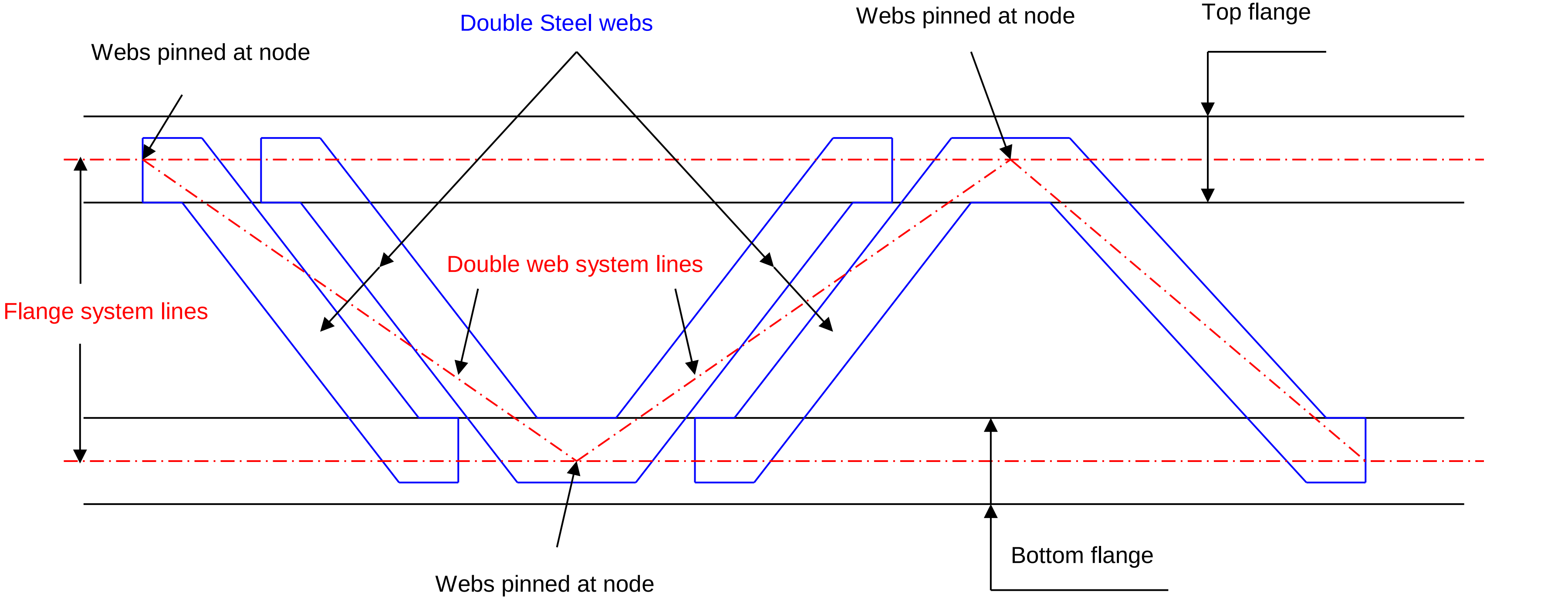


Fig. A-2: Structural model for metal-web joists with double webs **[NOT TO SCALE]**



ANNEX B TEST ARRANGEMENTS FOR DETERMINATION OF STRENGTHS OF WEBS

In the following figures, individual webs and V-webs are distinguished by the red and blue colours. *P* is the total applied load.

Fig. B-1: Tension anchorage strength of single webs at supports

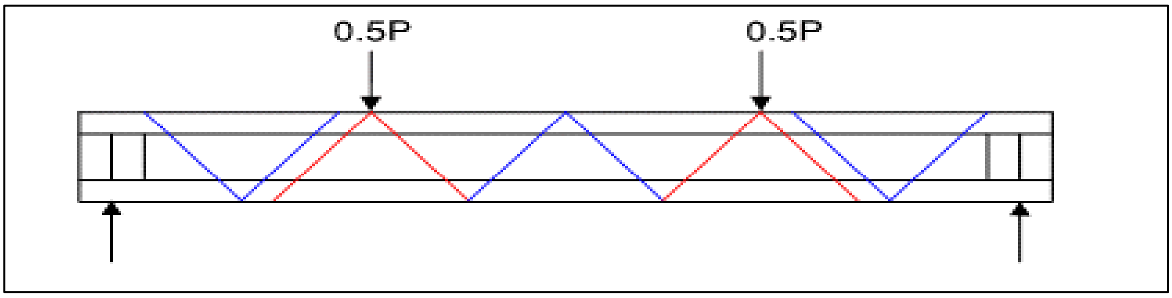


Fig. B-2: Tension anchorage strength of single webs at internal nodes

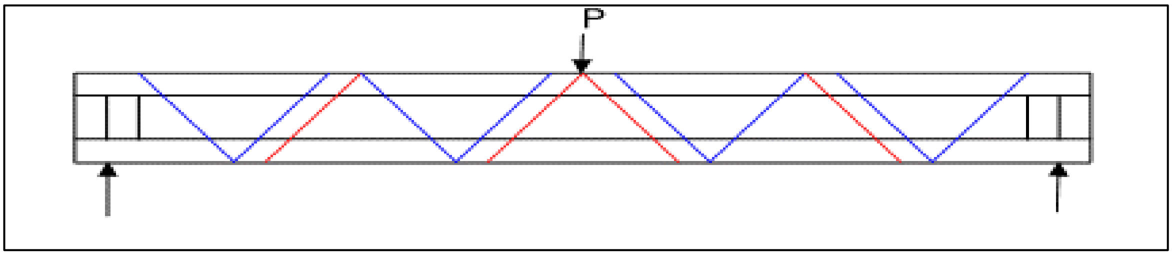


Fig. B-3: Compression strength of single webs

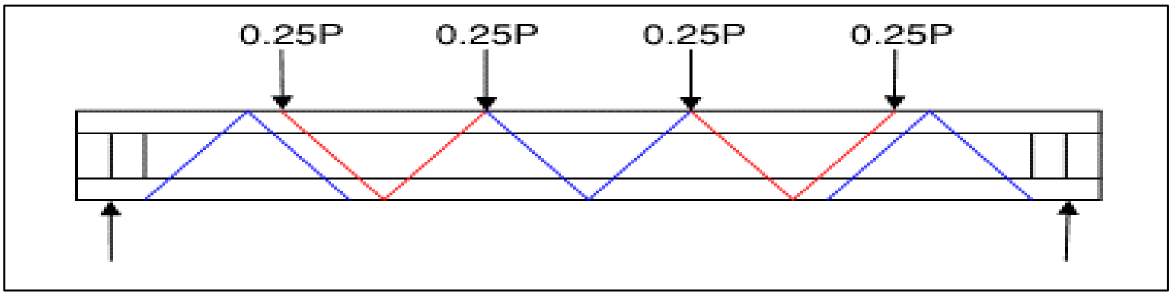


Fig. B-4a: Tension strength of double webs for web types for which it is known that compressive strength is greater than tension strength

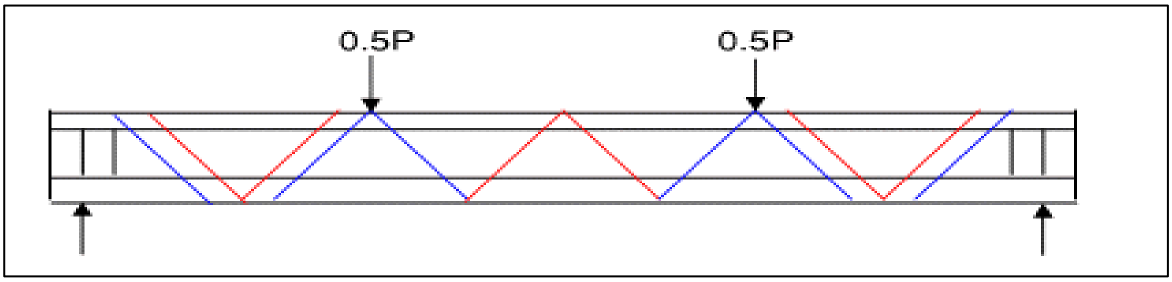
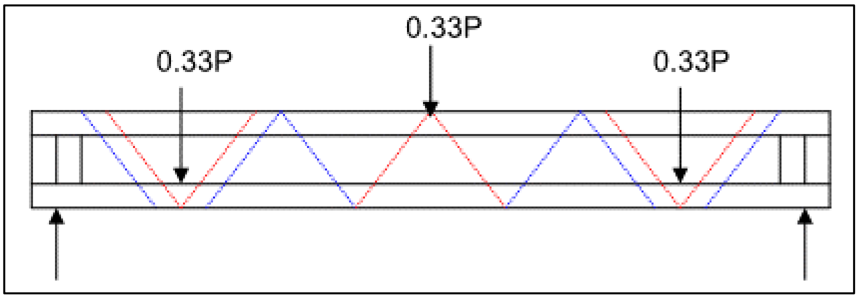


Fig. B-4b: Tension strength of double webs for web types for which it is known that compressive strength is less than tension strength



In Fig. B-4b, note that the load is applied to bottom chord nodes as a tensile force reacting off the test frame below the beam. The load may be applied directly to the top face of the bottom chord by means of a “saddle” resting on a thick steel plate at least 30 mm narrower than the chord width, thereby avoiding any interference with the steel webs.

Fig. B-5: Compression strength of double webs

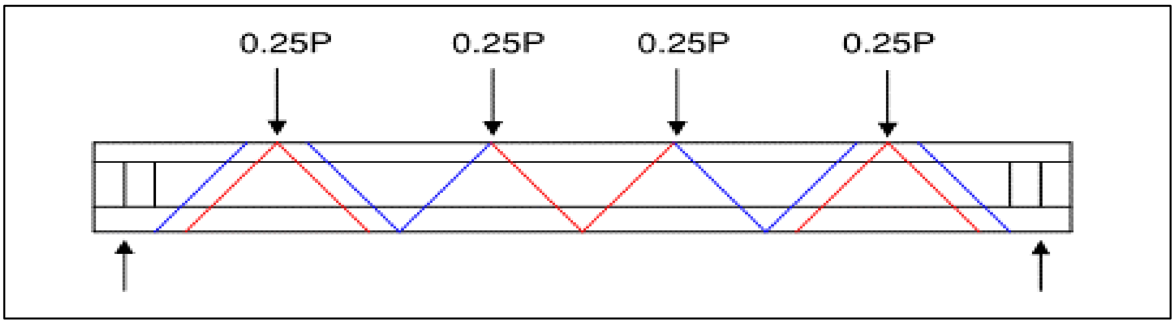
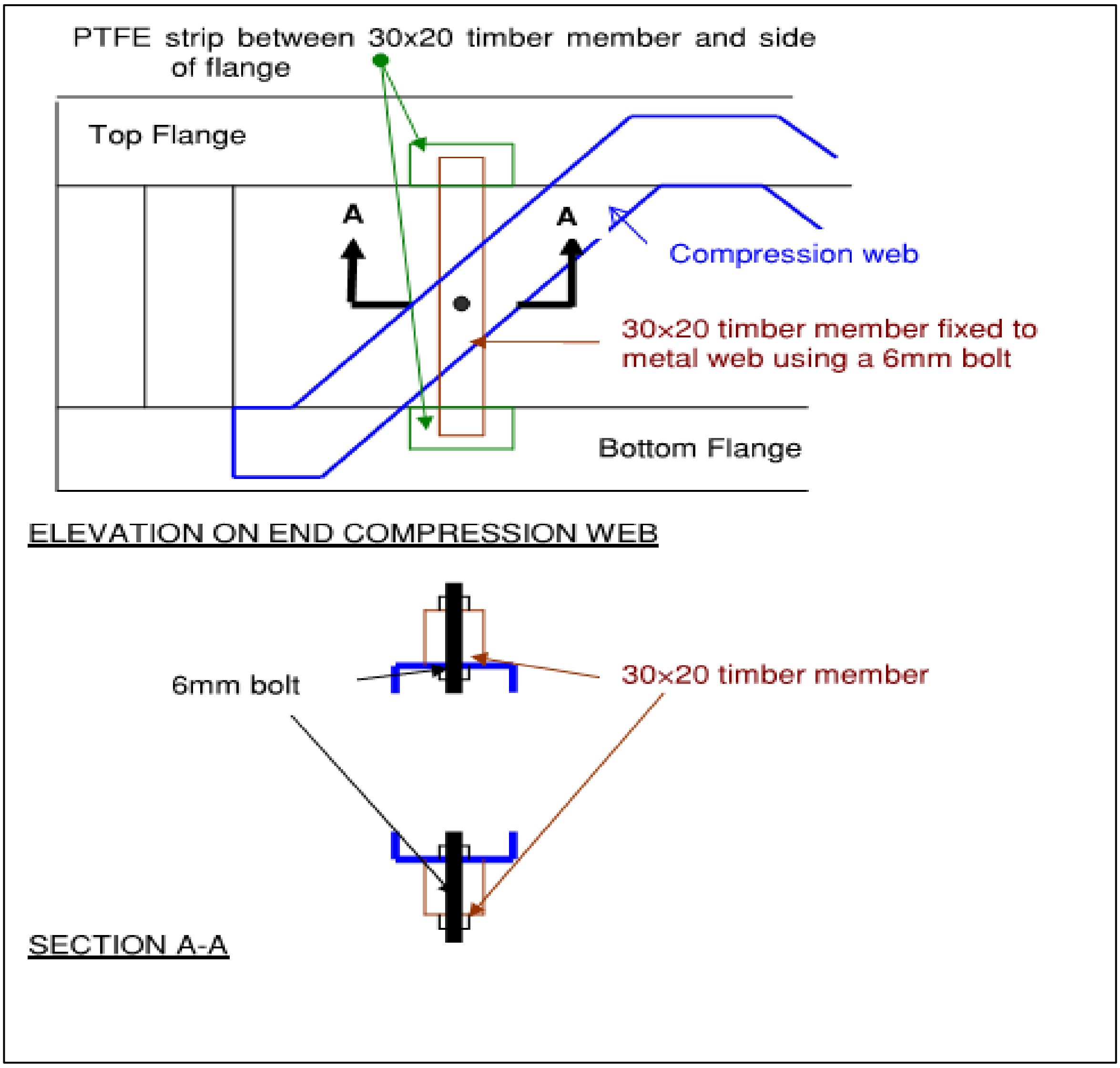


Fig. B-6: Possible method of providing lateral restraint to end compression webs of Fig. B-3 to facilitate compression anchorage failure



ANNEX C TEST ARRANGEMENTS FOR DETERMINATION OF WEB JOINT SLIP MODULI

In the following figures, individual webs and V-webs are distinguished by the red and blue colours. *P* is the total applied load.

Fig. C-1: Slip modulus test arrangement – single web, five loading points

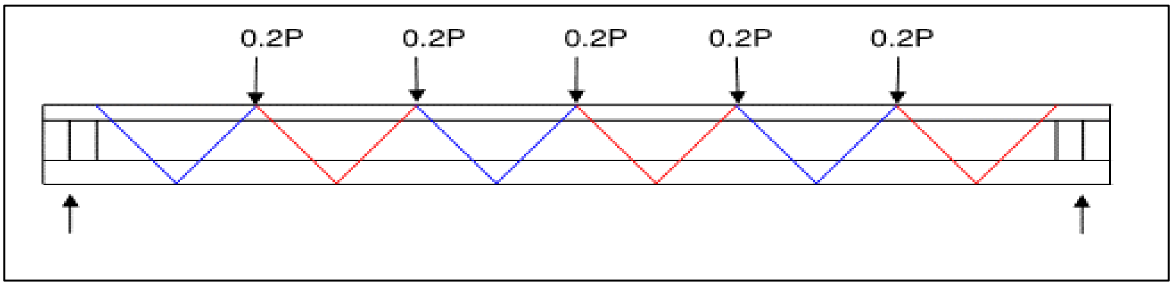


Fig. C-2: Slip modulus test arrangement – single web, seven loading points

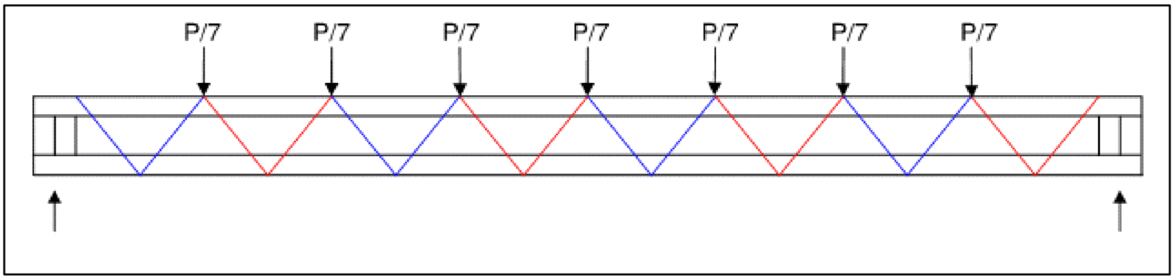


Fig. C-3: Slip modulus test arrangement – double web, five loading points