EUROPEAN ASSESSMENT DOCUMENT

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LIGHT WEIGHT STEEL/WOOD LOAD BEARING ROOF ELEMENTS

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Contents

1 SCOPE OF THE EAD

1.1 Description of the construction product

Light weight steel/wood load bearing roof elements, based on structural interaction between two parallel U-shaped steel profiles, wood flanges and a plywood board in top of the elements. The elements are filled with thermal insulation, and have a water vapour control layer on the underside and a roof waterproofing sheet on top. An insulated steel ceiling is normally added to the underside.

The general element design and section build-up is shown in fig. 1. The material and component specifications are shown in table °1.

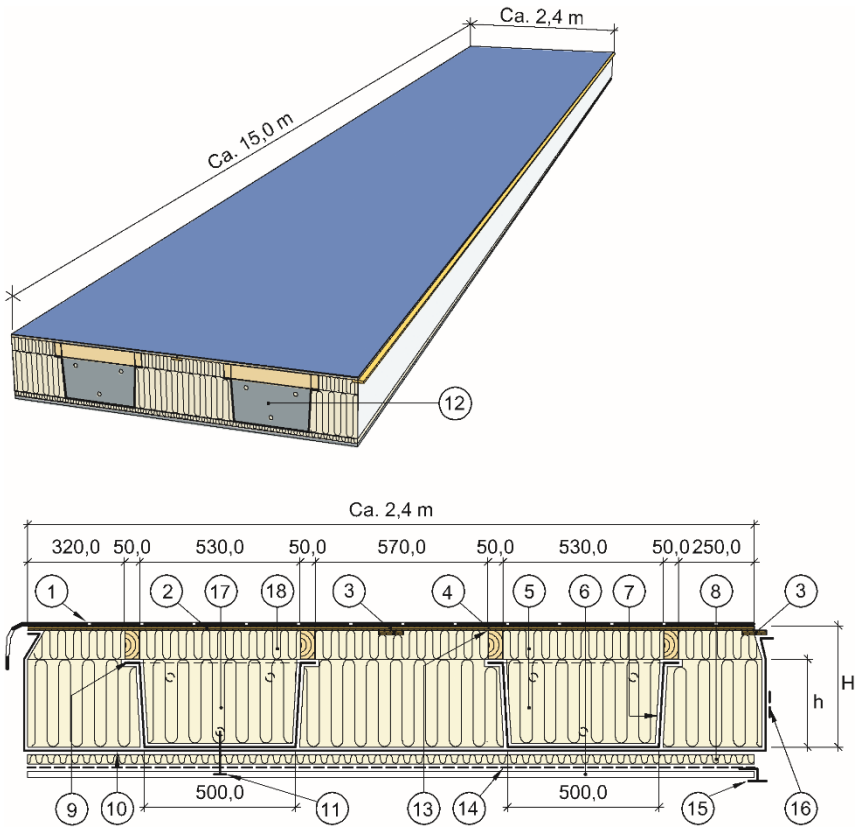

Fig. 1
General element design.

Table 1 Specifications of element materials and components shown in fig. 1

1	Bitumen roof waterproofing sheet according to EN 13707 or PVC waterproofing sheet according to EN 13956. Euroclass $B_{roof}(t2)$
2	15 – 19 mm structural spruce plywood type Exterior according to EN 13986. Thickness and material properties according to the individual structural element design, Euroclass D-s2,d0
3	15 mm structural spruce plywood strip type Exterior according to EN 13986 Euroclass D-s2,d0
4	48 mm x 71, 96 or 121 mm structural timber C 24 or C 30 according to EN 14081-1 and EN 338, as specified in the individual structural element design. Euroclass D-s2,d0
5	Mineral wool according to EN 13162, with maximum λ_D = 0,037 W/mK, Euroclass A1

6	TRP 20 steel corrugated ceiling sheet (alternatively perforated). Euroclass A1
7	0,9 – 2,0 mm thick galvanized steel profiles S350GD +Z275MA according to EN 10027. Steel thickness as specified in the individual structural element design. Euroclass A1
8	30 mm to 120 mm rockwool according to EN 13162, with λ_D = 0,034 W/mK , density 90 kg/m^3. Euroclass A1
9	Joint between steel and timber with Gunnebo 32 x 2,5 galvanized steel nails spaced c/c 30 mm, or with nails spaced c/c 60 mm plus SikaForce Base 7736 structural polyurethane glue with hardener 7050. Euroclass F
10	0,20 mm polyethylene water vapour control layer type A according to EN 13984 with $s_d \geq 50$ m. Euroclass F
11	4,8 x 70 mm steel screw for ceiling installation. Euroclass A1
12	Galvanized steel end plate similar to pos. 7
13	Joint between plywood and timber with MUF structural glue, approved and certified according to EN 301, and 11,1 x 22 – 44 mm galvanized staples spaced 50 mm. Euroclass F
14	Air barrier layer when specified Euroclass F
15	Steel T-profile for ceiling edge. Euroclass A1
16	Two-sided tape for connecting water vapour control layers. Euroclass F

The steel profiles and the wood flanges are assembled with nails, or with nails and glue. Glue is used to improve the bending stiffness of the element. Joints with glue is designed with enough nails to prevent element collapse at ultimate limit state if the glue line fails.

The plywood board and the wood flanges are assembled with nails and glue. The wood flanges and the plywood board are working as the compressive flange of the element.

In the longitudinal joint the water vapour control layers are continues from one side of the plywood to the other and the mineral wool are a few centimetres oversized. There is a two-sided tape placed on one side of the element. When to elements are placed next to each other the tape and the oversize of the insulation inside the vapour barrier are squeezed together.

In the transversal joints the water vapour control layers has a loose end. Water vapour control layers from connecting element are placed upon each other and thermal insulation is pressed down over the vapour barrier joint.

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 according to the manufacturer's instructions or (in absence of such instructions) according to the usual practice of the building professionals.

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)

The intended use of Light weight steel/wood bearing roof elements are in buildings with normal to dry indoor climate and flat or sloped roofs with internal drainage. When supplemented with a ventilated roofing the roof elements may also be used in sloped roofs with external drainage.

The roof elements shall not be used in buildings with high air humidity like swimming pools, printing works etc. The roof elements shall not be used in buildings with positive air pressure ventilation systems.

The production of the elements are performed indoor under climate controlled conditions, and the finished elements are stored indoor until being transported to the building site. During transportation the elements are covered with a tarpaulin.

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 Light weight steel/wood bearing roof elements for the intended use of 50 years (The assumed working for the roofing is minimum 25 years) when installed in the works. 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 are regarded only as a means for expressing the expected economically reasonable working life of the product.

2 ESSENTIAL CHARACTERISTICS AND RELEVANT ASSESSMENT METHODS AND CRITERIA

2.1 Essential characteristics of the product

Table °2 shows how the performance of Light weight steel/wood load bearing elements is established in relation to the essential characteristics.

Table 2 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			
1	Load bearing capacity and rigidity	See clause 2.2.1	Load bearing capacity calculated according to the specific structural design for each delivery.

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.

No	Essential characteristic	Assessment method	Type of expression of product performance *(level, class, description)*
Basic Works Requirement 2: Safety in case of fire			
2	Reaction to fire	See clause 2.2.2	Reaction to fire classification of materials and components according to EN 13501-1 and EN 13501-5
3	Resistance to fire	See clause 2.2.3	Fire resistance classification according to EN 13501-2
Basic Works Requirement 3: Hygiene, health and the environment			
4	Water vapour tightness and moisture resistance	See clause 2.2.5	Watertightness according to EN 13707 for bitumen sheets and EN 13956 for plastic sheets. Water vapour resistance according to EN 13984
Basic Works Requirement 5: Protection against noise			
5	Airborne sound insulation	See clause 2.2.5	Sound insulation performance according to EN ISO 717-1 when required.
Basic Works Requirement 6: Energy economy and heat retention			
6	Thermal resistance	See clause 2.2.6	U-value calculated according to EN 6946
7	Airtightness of element joints	See clause 2.2.7	Air flow value in m^3/h m at 50 Pa pressure difference
Durability aspects			
8	Durability of structural components	See clause 2.2.8	Material specifications for steel corrosion protection and plywood use class
9	Resistance to UV-radiation and heat	See clause 2.2.9	Performance by reference to CE-marking of the roofing material and water vapour control layer.

2.2 Methods and criteria for the performance of the product in relation to essential characteristics of the product

Materials and components which are covered by a harmonised European product standard, and used in the manufacturing of the elements, shall be CE-marked according to the relevant product standard.

2.2.1 Load bearing capacity and rigidity of the elements

For each individual project and element the load bearing capacity and rigidity shall be determined by structural calculations according to the European structural standards EN 1990, EN 1991, EN 1993 and EN 1995. The detailed structural design method shall be assessed by the technical assessment body.

The load/slip performance of nailed joints between steel and wood applied for the structural design shall be verified by reference to the provisions in EN 1995-1-1. For structural glued joints between steel and wood material using polyurethane glue there is no standardised provisions or test method. The performance of such joints in the elements shall be verified by tests according to Annex A.

In order to demonstrate the applicability of the detailed structural design method the calculated results shall be compared with results from full scale structural bending tests of at least three elements of typical design. The full scale bending tests shall be performed on test specimens that are representative for typical element designs. The elements are tested with one single span, and ultimate load at failure shall be recorded. The loading system shall be linear loads that allows to measure both bending stiffness and shear deformations of the elements for comparison with structural calculations.

2.2.2 Reaction to fire

All materials and components of the roof elements, except roofing materials, shall be classified according to EN 13501-1.

Roofing materials shall be classified according to EN 13501-5, and the test method(s) used for the classification shall be specified.

2.2.3 Resistance to fire

The resistance to fire shall be verified by testing according to EN 1365-2. The result shall be classified according to EN 13501-2.

2.2.4 Water tightness and water vapour resistance

For the water tightness of the roofing for CE marked bought components such as bitumen sheets according to EN 13707 and plastic sheets according to EN 13956 the performance must be considered to be the one of the Declaration of Performance. The same applies for the water vapour tightness of the water vapour control layer according to EN 13984.

An inadmissible modification of moisture content caused by condensation from vapour diffusion or convection shall be avoided, and. the condensation protection shall be verified by calculation.

2.2.5 Airborne sound insulation

When required, airborne sound insulation for protection against external noise shall be determined by tests according to EN ISO 10140-2 and the result classified according to EN ISO 717-1. The R_w-value shall be declared in the ETA together with a detailed description of the element design for which the value is valid.

2.2.6 Thermal resistance

The thermal resistance shall be verified by calculations according to EN 6946 or tested according to EN ISO 8990, and declared as the total thermal resistance R_T or the thermal transmittance U for the elements. The calculations shall be based on the tabulated values in EN 10456 for the materials and components, and the results declared in the ETA together with a detailed description of the element designs for which the values are valid.

2.2.7 Airtightness

The air tightness of element joints without roofing shall be tested according EN 12114, and the result declared for a 50 Pa pressure difference.

The testing shall be done on transversal and longitudinal joints. The testing on longitudinal joint shall be done by placing at least two elements in the test rig. When testing the airtightness for the transversal joints there shall be used at least four elements.

2.2.8 Durability of structural components

Structural steel components shall be hot-dip galvanized with at least 275 g zinc coating as specified in cl. 1.1. and EN 10027 in order to ensure adequate corrosion protection.

Structural plywood shall be type Exterior according to EN 13986 class EN 636-3 to ensure adequate durability in case of accidental excessive moisture content.

2.2.9 Resistance to UV-radiation and heat

The performance depends on the characteristics of the roofing material, and verification shall be made by reference to the CE-marking, and the required performance according to EN 13707 and EN 13956.

Durability of the water vapour control layer shall be verified with the required performance according to EN 13984.

3 ASSESSMENT AND VERIFICATION OF CONSTANCY OF PERFORMANCE

3.1 System(s) 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 2003/728/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 procedure 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	Test or control method	Criteria	Minimum number of samples	Minimum frequency of control
Control of ingoing materials when delivered					
1	- Type and quality of all materials and components incorporated in the elements.	Detailed check of material specifications	According to specification	All	Every delivery
Control during production The control document shall include the following items:					
2	- Number and date of production drawings for the element.		According to specification	All	Every element
3	- Control of thickness of load bearing steel profile	Reference to the manufacturer's control manual	According to specification	3	3 points per loadbearing steel profile per shift and production line

4	- Control of thickness of load bearing plywood - Moisture content of wood - Surface control of wood flanges before gluing - Surface control of plywood before gluing - Surface control of steel before gluing - Mix of glue - Visual control of glue joint - Nail type and installation control - Installation of thermal insulation	Reference to the manufacturer's control manual	According to specification	1	For every shift and production line
Control of finished elements The control document shall include the following items:					
5	- Fixing of roofing material - Position of the tape on the long sides - Number and position of screws at the gable end plates - Position of holes in the elements for service installations	According to specification		All	Every element
Testing of samples					
6	Shear testing of glued joints between plywood and wood flanges and between steel and wood flanges.	Shear test according to the provisions specified in cl. 3.2.1	According to the manufacturer's control manual	Minimum 3 test specimens of each material combination	For every shift and production line

3.2.1 Shear tests during manufacture (Annex A)

The manufacturer shall perform continuous testing of glued connections during the production. The test method shall be part of the manufacturer's control manual, and specified as part of the ETA. The test procedure shall include the following:

- Shear test specimens shall be made from the same materials as used for the element production the same day.
- The shear tests shall be performed in the same climatic conditions as for the element production.
- The shear test specimens shall be made of 45 mm x 50 mm steel plates and plywood sheets which are glued to the wood flanges, with a light pressure from clamps during the curing period.
- After a curing period of minimum 24 hours the steel plates and the plywood sheets are loaded parallel to the glue line in a universal testing machine until failure.
- The loading speed shall be steady, with failure after approximately 5 – 10 sec.
- The failure load shall be recorded, and all results shall be filed and kept for minimum 5 years.
- The required failure mode shall be primarily in the wood materials
- A specific minimum failure load requirement shall be determined for the production control, based on the initial type-testing and verification of the glued joints performance.

3.3 Tasks of the notified body

The cornerstones of the actions to be undertaken by the notified body in the procedure of assessment and verification of constancy of performance for Light weight steel/wood load bearing roof elements are laid down in Table °4.

Table 4 Control plan for the notified body; cornerstones

No	Subject/type of control	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					
1	Initial assessment of the factory production control system shall normally be performed by the TAB. An assessment shall be carried out of each production unit to demonstrate that the factory production control is in conformity with the ETA and any subsidiary information. This assessment shall be based on an initial inspection of the factory. The relevant production units shall be specified in the ETA. - Control of ingoing materials - Control of production process - Control of storage - Control of journals for incoming materials and production process - Control of glue-line testing				
Continuous surveillance, assessment and evaluation of factory production control					
2	Subsequent continuous surveillance of factory production control is necessary to ensure continuing conformity with the ETA, and is the responsibility of the notified body. Surveillance inspections shall be conducted at least twice a year, and the inspections procedures shall be regulated by contracts between the manufacturer and the notified body. - Control of ingoing materials - Control of production process - Control of storage - Control of journals for incoming materials and production process - Control of glue-line testing	Reference to contracts between the manufacturer and the notified body			Biannual (twice-a-year)

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.

- EOTA TR 034 General BWR3 Checklist for EADs/ETAs – Dangerous substances
- EN 13501-1 Fire classification of construction products and building elements Part 1: Classification using data from reaction to fire tests
- EN 13501-2 Fire classification of construction products and building elements Part 2: Classification using data from fire resistance tests, excluding ventilations services
- EN ISO 717-1 Acoustics Rating of sound insulation in buildings and of building elements Part 1: Airborne sound insulation
- EN 6946 Building components and building elements Thermal resistance and thermal transmittance Calculation method
- EN 1990 Eurocode: Basis of structural design
- EN 1991-1-1 Eurocode 1: Actions on structures Part 1-1: General actions Densities, self-weight, imposed loads for buildings
- EN 1993-1-1 Eurocode 3: Design of steel structures Part1-1: General rules and rules for buildings
- EN 1995-1-1+A1 Eurocode 5: Design of timber structures Part 1-1: General Common rules and ruled for buildings
- EN 1365-2 Fire resistance for loadbearing elements Part 2: Floors and roofs
- EN 13707 Flexible sheets for waterproofing Reinforced bitumen sheets for roof waterproofing Definitions and characteristics
- EN 13956 Flexible sheets for waterproofing Plastic and rubber sheets for waterproofing Definition and characteristics
- EN 13984 Flexible sheets for waterproofing Plastic and rubber vapour control layers Definitions and characteristics
- EN ISO 10140-2 Acoustics measurement of sound insulation of building elements Part 2: Measurement of airborne sound insulation
- EN 12114 Thermal performance of buildings Air permeability of building components and building elements Laboratory test method
- EN 13986 Wood-based panels for use in construction Chareateristics, evaluation of conformity and marking
- EN ISO 8990 Thermal insulation Determination of steady-state thermal transmission properties Calibrated and guarded hot box (ISO 8990:1994)

ANNEX A – TESTS TO VERIFY AND ASSESS THE PERFORMANCE OF GLUED STEEL/WOOD STRUCTURAL CONNECTIONS USING POLYURETHANE GLUE

The structural glue line between the steel and the timber components in the element construction shall be tested according to the following program.

1 Tests of long term creep under shear load

1.1 Preparation of test specimen

Creep tests shall be performed by using circular test specimens as illustrated in fig. A, following the principles in EN 15337, in order to minimise edge effects. The wood material shall be natural clear wood of Pinus Sylvestris or Picea Abies without any additional substances. The moisture content in the wood material shall be 12 %.The steel bolts shall be hot-dipped galvanised with a surface similar to the steel profiles of the elements. The glue shall be the same as specified in cl. 1.1.2.

Predrilling of holes in the wood specimens shall be performed during the same day as the glue is applied. The bolt surface shall be cleaned by brushing with industrial Scotch Brite 7447 or similar before the glue is applied.

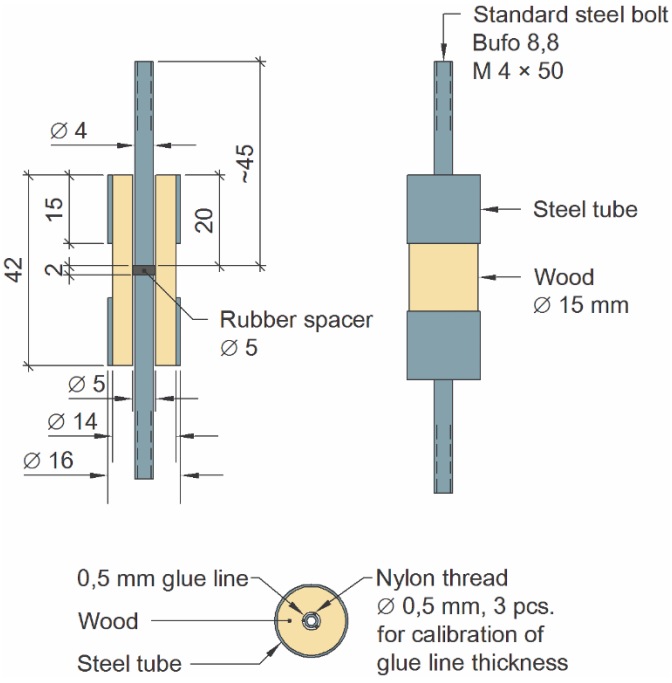

Fig. A1
Test specimen for long term creep under shear load.

1.2 Test set-up

The test specimens are placed inside a glass tube with water, in order to control the climate to 100 % RH around the specimen. The tube with the test specimen is placed inside a hot-box where the temperature can be controlled within ± 1°C, see fig. A2.
A loading device is made for applying a constant tensile load to the steel bolts and shear load in the glue lines as illustrated in fig. A2. The loading device shall be made with a displacement transducer for measurement of any creep in the glue lines before failure and a device to record time to failure.

1.3 Test program

Loading on test specimens shall be performed at temperatures of 23°C and 60°C, using specimens with successive increasing loads in order to establish curves for load versus time when failure in the

glue line occur. The number of tests shall be enough to determine on a log time scale the maximum load where failure does not occur.

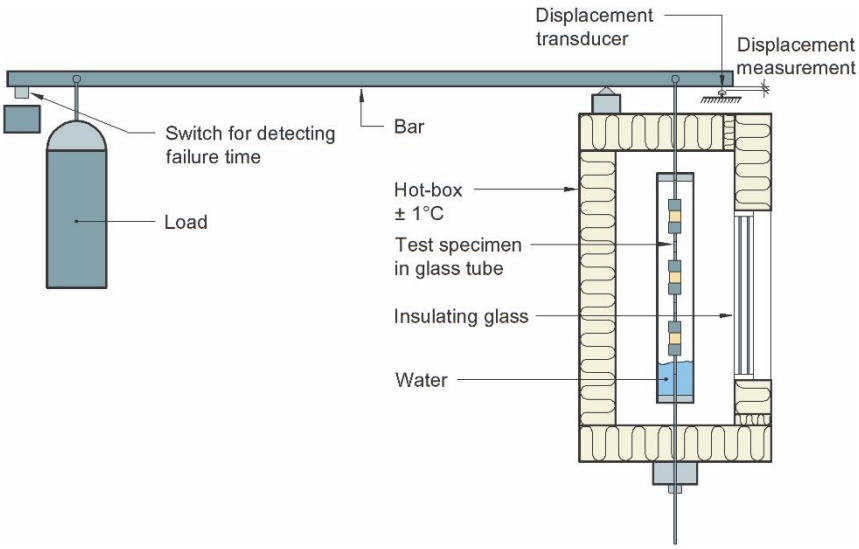

Fig. A2
Test set-up for controlling test climate, glue line loading, and time-to-failure and displacement recording.

1.4 Expression of test results

The test results shall be expressed as diagrams showing glue line stress in N/mm^2 versus time to failure, where the time axis is a log scale. The observed displacements and the failure mode recorded after examining the specimen shall be described (f. ex. if failure occurs in the glue itself, in the zinc oxidation layer, or in the wood).

2 Tests on microbiological growth in the glue line

The glue shall be tested for microbiological growth according to BS 1204 and fulfil the requirements set in the standard.

3 Tests on building of zinc hydroxide in the glue line

Small test specimens according to EN 1465, with a glue line between galvanized steel sheets similar to the steel used in the elements, shall be made in order to investigate building of zinc hydroxide in the glue line. The test specimens shall be kept at 23°C and 60°C for 100 days and the glue line then examined with FT-IR spectroscopy and x-ray to determine the development of white rust in the glue line. Shear testing of the glue line according to EN 1465 shall also be performed, and the result compared with strength values for new specimens without conditioning. The building of zinc hydroxide in the glue line shall be assessed not to have a noticeable effect on the structural performance of the glue line.