

VTT RAKENNUS- JA YHDYSKUNTATEKNIikka  
PL 1800 (Lämpömiehenkuja 2, ESPOO)  
02044 VTT  
Puh. (09) 4561  
Telekopio (09) 456 7031



Rakennusalan tuotteita koskevan jäsenvaltioiden  
lainsäädännön lähentämisestä 21 päivänä joulukuuta  
1988 annetun neuvoston direktiivin 89/106/EEC  
mukaisesti ilmoitettu tuotehyväksyntälaitos

EOTAN JÄSEN

## Eurooppalainen tekninen hyväksyntä European Technical Approval

ETA-02/0026

### **Kauppanimi:**

Trade name

### **Finnjoist I-joist, FJI**

### **Hyväksynnän haltija:**

Holder of approval:

Finnforest Engineered Wood

P.O.Box 24

FIN-08101 LOHJA

### **Tuotetyyppi ja sen käyttötarkoitus:**

Generic type and use of construction  
product:

### **Puuaineinen yhdistelmäpalkki rakenteelliseen käyttöön**

Light composite wood-based beam for structural purposes

### **Voimassaoloaika:**

Validity from/to

**2003-04-14-**

**2008-04-14**

### **Valmistuspaikka:**

Manufacturing plants:

UK Kings Lynn

Cross Bank Road

Kings Lynn, Norfolk PE30 2HD

### **Tämä hyväksyntä sisältää**

This European Technical Approval  
contains

Sivuja/liitteitä

Pages/Annexes

13 sivua sisältäen 3 liitettä

13 pages including 3 Annexes



Eurooppalainen tekninen hyväksyntäorganisaatio  
European Organisation for Technical Approvals

## I LEGAL BASIS AND GENERAL CONDITIONS

1. This European Technical Approval is issued by the Technical Research Centre of Finland (VTT) in accordance with:
  - Council Directive (89/106/EEC)<sup>1</sup> of 21 December 1988 on the approximation of laws, regulations and administrative provisions of Member States relating to construction products, modified by the Council Directive 93/68/EEC of 22 July 1993<sup>2</sup>;
  - Maankäyttö- ja rakennuslain (132/1999) 152 § 4 mom. ja 209 § 2 mom., Suomen rakentamismääräyskokoelman osan A3 rakennustuotteita koskevat määräykset (1995) sekä Ympäristöministeriön 14.10.1997 valtuutuspäätös (12/352/94).
  - Common Procedural Rules for Requesting, Preparing and the Granting of European Technical Approvals set out in the Annex of Commission Decision 94/23/EC<sup>3</sup>;
  - Guideline Nr 011 for European Technical Approval of Light Composite Wood-based Beams and Columns
2. The Technical Research Centre of Finland (VTT) is authorised to check whether the provisions of this European Technical Approval are met. Checking may take place in the manufacturing plant. Nevertheless, the responsibility for the conformity of the products to the European Technical Approval and for their fitness for the intended use remains with the holder of the European Technical Approval.
3. This European Technical Approval is not to be transferred to manufacturers or agents of manufacturer other than those indicated on page 1, or manufacturing plants other than those indicated on page 1 of this European Technical Approval.
4. This European Technical Approval may be withdrawn by the Technical Research Centre of Finland (VTT) pursuant to Article 5 (1) of the Council Directive 89/106/EEC.
5. Reproduction of this European Technical Approval including transmission by electronic means shall be in full. However, partial reproduction can be made with the written consent of the Technical Research Centre of Finland (VTT). In this case partial reproduction has to be designated as such. Texts and drawings of advertising brochures shall not contradict or misuse the European Technical Approval.
6. The European Technical Approval is issued by the approval body in its official language. This version should correspond fully to the version used by EOTA for circulation. Translations in other languages have to be designated as such.

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<sup>1</sup> Official Journal of the European Communities N° L 40, 11.2.1989, p. 12

<sup>2</sup> Official Journal of the European Communities N° L 220, 30.8.1993, p. 1

<sup>3</sup> Official Journal of the European Communities N° L 17, 20.1.1994, p. 34

## **II SPECIFIC CONDITIONS OF THE EUROPEAN TECHNICAL APPROVAL**

### **1 Definition of product and intended use**

Finnjoist I-joists are wood-based composite joists and columns the cross section of which is I-shaped. The flanges are made of LVL and the web of OSB and they are glued together. The materials, dimensions and tolerances are given in Annex 1. The standard cross sections are given in Annex 2.

Finnjoist I-joists are intended to be used as load-bearing parts of building constructions. With regard to moisture behaviour of the product, the use is limited in service classes 1 and 2 as defined in Eurocode 5.

The provisions made in this European Technical Approval are based on an assumed intended working life of the joists of 50 years<sup>4</sup>.

### **2 Characteristics of product and methods of verification**

#### **ER 1 Mechanical resistance and stability**

The mechanical properties of the standard joist sections are given in Annex 2. The I-joists are not intended to be used in areas where they might support seismic action.

#### **ER 2 Safety in case of fire**

The joists consist of materials classified to have reaction to fire class D-s2,d0 or better.

For resistance to fire, no performance is determined.<sup>5</sup>

#### **ER 3 Hygiene, health and environment**

Based on the declaration of the manufacturer, the joists do not contain harmful or dangerous substances as defined in the EU database, with exception of formaldehyde. The formaldehyde potential of the LVL is classified to be A in accordance with EN 1084. The formaldehyde potential class of the web board is classified to be E1 in accordance with EN 13986. The product does not contain pentachlorophenol.

In addition to the specific clauses relating to dangerous substances contained in this European Technical Approval, there may be other requirements applicable to the products falling within its scope (e.g. transposed European legislation and national laws, regulations and administrative provisions). In order to meet the provisions of the EU Construction Products Directive, these requirements need also to be complied with, when and where they apply.

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<sup>4</sup> This means that it is expected that when this working life has elapsed, the real working life may be, in normal use conditions, considerably longer without major degradation affecting the essential requirements of the works. The indications given as to the working life of a beam cannot be interpreted as a guarantee given by the producer or the approval body. They should only be regarded as a means for the specifiers to choose the appropriate criteria for beams in relation to the expected, economically reasonable working life of the works.

<sup>5</sup> Resistance to fire for structures where Finnjoist I-joists are incorporated shall be determined for the complete construction.

#### **ER 4 Safety in use**

Not relevant

#### **ER 5 Protection against noise**

Not relevant

#### **ER 6 Energy economy and heat retention**

The thermal conductivity  $\lambda$  for both web and flange material is 0,13 W/(m·K) according to EN 12524. The natural density variation of the materials is taken into account in this value.

#### **Aspects of durability, serviceability and identification**

The adhesive of type I also can be used in service class 3 but the untreated flange and web materials do not withstand attacks from fungi. Thus, Finnjoist I-joists can be used in service classes 1 and 2 according to Eurocode 5, and hazard classes 1 and 2 as specified in EN 335. The product may be exposed to the weather for a short time during installation.

Durability may be reduced by attack from insects such as long horn beetle, dry wood termites and anobium in regions where these may be found.

Serviceability of the joists and columns is understood as their ability to resist loads without unacceptable deformation. This characteristic is treated under ER 1.

The joists are identified by the flanges being of LVL and the web being of OSB board. The web bears the mark of the manufacturer of the joist and the CE-marking of the joist as described in clause 3.3.

### **3 Evaluation of Conformity and CE marking**

#### **3.1 Attestation of conformity**

The system of attestation of conformity specified by the European Commission in Decision 99/92/EC - Official Journal L 29, 03.02.1999 is System 1, according to Council Directive 89/106/EEC Annex III.2.(i), without audit-testing of samples, and provides:

(i) Certification of the conformity of the product by an approved certification body on the basis of:

- (a) (tasks for the manufacturer)
  - (1) factory production control;
  - (2) further testing of samples taken at the factory by the manufacturer in accordance with a prescribed test plan;
- (b) (tasks for the approved body)
  - (3) initial type-testing of the product;
  - (4) initial inspection of factory and of factory production control;
  - (5) continuous surveillance, assessment and approval of factory production control;

## **3.2 Responsibilities**

### 3.2.1 Tasks of the manufacturer

#### 3.2.1.1 Factory production control

The manufacturer shall exercise permanent factory production control according to the written quality manual, which is endorsed by the approved body. The factory production control includes checking of incoming components and process controls like glue spread and curing temperatures.

#### 3.2.1.2 Testing of samples taken at the factory

Testing of samples taken at the factory according to a prescribed test plan is part of the factory production control. The test plan is deposited at the VTT Building and Traffic, and is available to approved bodies involved in the attestation of conformity to this ETA.

### 3.2.2 Tasks of approved bodies

#### 3.2.2.1 Initial type testing of the product

Approval tests have been conducted by the approval body or under its responsibility in accordance with section 5 of the ETA Guideline. The approval body has assessed the results of these tests in accordance with section 6 of the ETA Guideline, as part of the ETA issuing procedure.

Product performance obtained in the initial test programme has been characterised sufficiently to serve as a basis for subsequent quality assurance evaluations (to ascertain whether a given production lot remains well represented by the initial test material).

The approved certification body has to conduct initial type testing to verify that the production line in question is able to manufacture products in conformity with the ETA. The necessary initial type testing has to be agreed between the Technical Research Centre of Finland (VTT) and the approved bodies involved. The initial type testing can be limited to testing of the adhesive bonded connections between web and flanges and the shear resistance of the web. Whenever the board will be changed, the shear resistance shall be verified by initial type testing.

#### 3.2.2.2 Initial inspection of the factory and the factory production control

The approved body shall conduct initial inspection of the factory in order to ensure that the manufacturer has acceptable premises, technical equipment, qualified personnel and a factory production control system which is in accordance with the provisions in the ETA Guideline and this ETA.

#### 3.2.2.3 Continuous surveillance, assessment and approval of the factory production control

The approved body shall visit the factory at least twice a year for regular inspection. It shall be verified that the factory production control is performed according to the manufacturer's quality manual, including tests of samples according to the prescribed test plan.

#### 3.2.2.4 Certification

When all the criteria of the Conformity Attestation are satisfied the approved certification body shall issue a Certification of Conformity with this European Technical Approval.

In cases where the provisions of the European Technical Approval and the prescribed test plan are no longer fulfilled the Certification of Conformity shall be withdrawn.

### 3.3 CE-Marking

The CE marking shall be affixed on each joist or column. The CE marking shall be accompanied by the following information:

- identification number of the notified certification body (System 1)
- the name or identifying mark of the producer and the registered address of the producer
- last two digits of the year in which the marking was affixed
- the number of the EC certificate of conformity (System 1)
- number of the ETA, valid as indication to identify the characteristics of the joist
- product name and type of cross section according to Annex 1 for the specification of the mechanical properties according to Annex 2 of this ETA.

## 4 Assumptions under which the fitness of the product for the intended use was favourably assessed

### 4.1 Manufacturing

Finnjoist I-joists are manufactured in the factory in accordance with the provisions of this European Technical Approval as identified during the inspection of the plant by the Technical Research Centre of Finland (VTT). Gluing of flanges to web and of web joints is performed according to specific provisions based on relevant standards for structural gluing of wood material.

### 4.2 Installation

Finnjoist I-joists shall be installed on the basis of a specific structural design for each installation, using the load-bearing capacities given in Annex 2 of this ETA.

Actions at joist supports shall not exceed the bearing resistance given in Annex 2.

The joists shall be installed by appropriately qualified personnel, following an installation plan and relevant construction details worked out for each individual building project. The installation plan shall be based on the manufacturers general guide and provisions for installing Finnjoist I-joists given in Annex 3.

Holes in the joists to provide openings for ducts, pipes etc. must only be made in the web, after the resistance has been checked. The rules for web holes given in Annex 3 shall be followed.

The manufacturer shall ensure that the information of these provisions is given to those concerned.

## **5 Recommendations**

### **5.1 Recommendations on packaging, transport and storage**

The joists shall be protected against harmful wetting during transport and storage.

The joists must not be lifted or stored in such a way that bending around the weak axis may cause damage to the joists.

The manufacturer shall ensure that the information of these provisions is given to those concerned.

### **5.2 Recommendations on use, maintenance and repair**

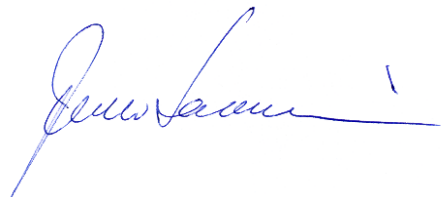
Before the installation it shall be controlled that the joists are not damaged during transport or storage. Damaged joists shall be replaced by sound ones.

If there is a need to modify or repair the construction this may be done if the installation guide in Annex 3 still can be followed.

The manufacturer shall ensure that the information of these provisions is given to those concerned.

On behalf of VTT Building and Transport

Espoo, 14 April 2003



Juho Saarimaa

Executive Director

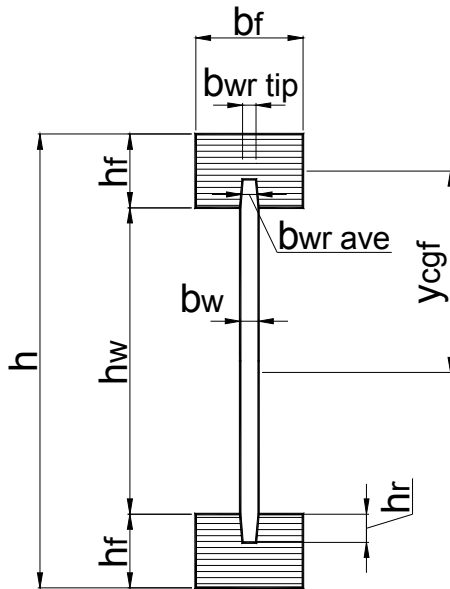


Kirsti Riipola

Lead Assessor, senior research scientist

## ANNEX 1 DESCRIPTION OF THE JOISTS

### 1 Cross sections and sizes



*Figure 1-1. Cross-section of Finnjoist I-joist.*

The shape of the joists is shown in Figure 1-1. The angle of the web-flange joint is 6° (nominal). In the tip of the web-flange joint a small space is left for the overflow glue. The depth of Finnjoist I joist is from 195mm to 600mm. The thickness of the web is 10 to 12 mm. The width of the flange is from 38 to 89mm and the depth from 36 to 45 mm. Tolerances measured in equivalent conditions when RH is 65 % and temperature 20 °C are given in Table 1-1. Standard cross sections are given in Annex 2 Table 2-4.

The type of cross section is given by a code, e.g. FJI 58/250, where the first figure indicates the width of the flange and the second one the depth of the joist.

The main direction of the flakes of the web board is perpendicular to the flanges. The joints of the web board are made as a V-shaped joint by gluing and they are allowed to be spaced deliberately. The nominal root depth of the joint is 10 mm.

The joists are provided with system holes (knock-outs), the diameter of which is 38 mm. The spacing between the hole centres is 300 mm.

*Table 1-1. Tolerances of the Finnjoist I-joists.*

|                      |       |               |
|----------------------|-------|---------------|
| Overall joist depth  | $h$   | $\pm 1,5$ mm  |
| Overall joist length | $l$   | - 0 / + 10 mm |
| Flange width         | $b_f$ | $\pm 1,5$ mm  |
| Flange depth         | $h_f$ | $\pm 2$ mm    |
| Web thickness        | $b_w$ | $\pm 0,8$ mm  |

## 2 Specifications of components

The flanges are made of KERTO LVL (laminated veneer lumber) produced by the Finnforest Lohja Mill or Punkaharju Mill. The LVL flanges are orientated such that their veneers are perpendicular to the plane of the web. The material properties of the flanges comply with prEN 14374. The characteristic strength values of the LVL shall be at least as given in Table 1-2 and they shall be certified by an approved body<sup>6</sup>.

Table 1-2. Characteristic strength values of the LVL used for flanges of Finnjoist I-joists needed in design of Finnjoist.

| Property   |             | N/mm <sup>2</sup> |
|--|-------------|-------------------|
| Bending strength                                       | $f_{m,k}$   | 48                |
| Tension strength parallel to grain                     | $f_{t,0,k}$ | 35                |
| Compression strength parallel to grain                 | $f_{c,0,k}$ | 35                |
| 5th percentile modulus of elasticity parallel to grain | $E_{0,k}$   | 11 600            |
| Mean modulus of elasticity parallel to grain           | $E_{mean}$  | 13 500            |

The web is made of OSB board – grade 3 in accordance with EN 300 and EN 12369-1. The characteristic strength values of the OSB shall be at least as given in Table 1-3.

Table 1-3. Characteristic strength values of the OSB used for web of Finnjoist I-joists.

| Property   | Thickness    | 10 mm             | > 10 mm           |
|--|--------------|-------------------|-------------------|
|  |              | N/mm <sup>2</sup> | N/mm <sup>2</sup> |
| Tension strength, bending calculations           | $f_{t,90,k}$ | 7,2               | 7,0               |
| Compression strength, bending calculations       | $f_{c,90,k}$ | 12,9              | 12,7              |
| Shear strength, panel shear                      | $f_{v,k}$    | 6,8               | 6,8               |
| Shear strength, planar shear                     | $f_{r,k}$    | 2,4               | 2,4               |
| Mean modulus of elasticity, bending calculations | $E_{w,t,0}$  | 3 000             | 3 000             |
| Mean shear modulus                               | $G_v$        | 1 080             | 1 080             |

The adhesive is of type I (full exposure to the weather) as defined in EN 301.

## 3 Moisture content

When manufactured, the moisture content of the flanges and the web are below the equilibrium value in use conditions. Due to changing temperature and relative humidity of the surrounding air the moisture content of the joists will continuously change.

<sup>6</sup> As long as the harmonised product standard is not endorsed, the certification may be done by a national body.

## ANNEX 2 MECHANICAL PROPERTIES OF THE JOISTS

The product is intended to be used in service classes 1 and 2 as defined in Eurocode 5. Characteristic resistances for the standard joist cross sections are based on characteristic strength values given in Table 2-1, which also may be used to calculate the properties for non-standard cross sections. The evaluation methods have been calculation or design assisted by testing. The structural properties of Finnjoist I-Joists within the ranges for joist depth and flange specification given in Annex 1 may be calculated using Finnforest's design procedures approved by VTT. For the standard range of Finnjoist I-Joists mechanical properties have been calculated in Table 2-4 using these procedures. The effect of the knock-outs has been taken into account in the shear force resistance value. For sizes other than given in the tables, mechanical properties may be calculated by interpolation.

*Table 2-1. Characteristic strength and modulus of elasticity and rigidity values to be used in calculations.*

| <b>Property</b>                                 | <b>Symbol</b> | <b>Value N/mm<sup>2</sup></b> |
|---|---------------|-------------------------------|
| Bending strength of flanges <sup>7</sup>        | $f_{mk}$      | 38,4                          |
| Tensile strength of flanges <sup>7</sup>        | $f_{t0k}$     | 28                            |
| Compression strength of flanges <sup>7</sup>    | $f_{c0k}$     | 28                            |
| Bending strength of web edgewise                | $f_{mk,w}$    | 7,2                           |
| Shear strength of web                           | $f_{vsk}$     | 6,8                           |
| Shear strength of web/flange joint              | $f_{vpk}$     | 2,4                           |
| Characteristic modulus of elasticity of flanges | $E_k$         | 11 600                        |
| Mean modulus of elasticity of flanges           | $E_f$         | 13 500                        |
| Mean modulus of elasticity of web               | $E_w$         | 3 000                         |
| Modulus of rigidity of web                      | $G_w$         | 1 080                         |

Serviceability of the joists is understood as their ability to resist loads without unacceptable deformation. Both bending deformation and shear deformation will cause deflection of the joist. Table 2-4 gives the mean stiffness values for the joists. These values are based on mean values of modulus of elasticity  $E$  and modulus of rigidity  $G$  given in Table 2-1, which also may be used to calculate the properties for non-standard cross sections. A higher value for the modulus of rigidity of the web may be used, if the manufacturer of the OSB has a higher value certified.

The modification factors for the joists,  $k_{mod}$  and  $k_{def}$  as defined in Eurocode 5, are given in Tables 2-2 and 2-3.<sup>8</sup>

<sup>7</sup> To be used in the calculations only.

<sup>8</sup> According to EUROCODE 5, final draft 2002-10-09.

Table 2-2. Values of  $k_{mod}$  for the Finnjoist I-joists.

| Duration of load | Bending and axial resistance |                 | Shear resistance |                 | Bearing resistance |                 |
|------------------|------------------------------|-----------------|------------------|-----------------|--------------------|-----------------|
|                  | Service class 1              | Service class 2 | Service class 1  | Service class 2 | Service class 1    | Service class 2 |
| Permanent        | 0,6                          | 0,6             | 0,40             | 0,30            | 0,6                | 0,6             |
| Long term        | 0,7                          | 0,7             | 0,50             | 0,40            | 0,7                | 0,7             |
| Medium term      | 0,8                          | 0,8             | 0,70             | 0,55            | 0,8                | 0,8             |
| Short term       | 0,9                          | 0,9             | 0,90             | 0,70            | 0,9                | 0,9             |
| Instantaneous    | 1,10                         | 1,10            | 1,10             | 0,90            | 1,10               | 1,10            |

Table 2-3. Values of  $k_{def}$  for the Finnjoist I-joists.

| Bending and axial deformation |                 | Shear deformation |                 |
|-------------------------------|-----------------|-------------------|-----------------|
| Service class 1               | Service class 2 | Service class 1   | Service class 2 |
| 0,60                          | 0,80            | 1,50              | 2,25            |

The structural performance of the product relies on adequate restraint to the compression flange. The effect of the restraint on the load-bearing capacity of the joist has to be taken into account as specified in Eurocode 5. The bending resistance values given in Table 2-4 are based on spacing of lateral constraints 300 mm. If the lateral bracing is spaced more sparsely the values shall be reduced according to the instructions given by the manufacturer.

The values to be used in design are given on the following page in Table 2-4. The values refer to flange depth 39 mm and web thickness 10 mm. Linear interpolation shall be used for sizes in between.

Table 2-4. Standard cross sections, basic properties and characteristic resistances and rigidity values to be used in calculations.

| Characteristic values |                |                       |                       |                          |   |                         |   | End bearing $\leq 1,1 \cdot \text{Shear Capacity}$<br>Intermediate bearing $\leq 2 \cdot \text{Shear Capacity}$ |         |          |         | NS = No stiffeners<br>S = With stiffeners |         |          |         |
|-----------------------|----------------|-----------------------|-----------------------|--------------------------|---|-------------------------|---|---|---------|----------|---------|---|---------|----------|---------|
| Joist Type            | Weight<br>kg/m | Af<br>mm <sup>2</sup> | Aw<br>mm <sup>2</sup> | Momen<br>Capacity<br>kNm | Flexural<br>Rigidity<br>Nmm <sup>2</sup> x 10 <sup>12</sup> | Shear<br>Capacity<br>kN | Shear<br>Rigidity<br>Nx 10 <sup>6</sup> | End bearing   |         |          |         | Intermediate bearing                      |         |          |         |
|                       |                |                       |                       |                          |   |                         |   | 45 mm   |         | 89 mm    |         | 89 mm                                     |         | 135 mm   |         |
|                       |                |                       |                       |                          |   |                         |   | NS<br>kN  | S<br>kN | NS<br>kN | S<br>kN | NS<br>kN                                  | S<br>kN | NS<br>kN | S<br>kN |
| 38/195                | 2,32           | 1355                  | 1425                  | 6,17                     | 0,241   | 7,61                    | 1,54                                    | 7,86  | 8,37    | 8,37     | 8,37    | 15,22                                     | 15,22   | 15,22    | 15,22   |
| 45/195                | 2,60           | 1628                  | 1425                  | 7,44                     | 0,287   | 7,89                    | 1,54                                    | 8,68  | 8,68    | 8,68     | 8,68    | 15,78                                     | 15,78   | 15,78    | 15,78   |
| 58/195                | 3,13           | 2135                  | 1425                  | 9,78                     | 0,372   | 8,40                    | 1,54                                    | 9,24  | 9,24    | 9,24     | 9,24    | 16,80                                     | 16,80   | 16,80    | 16,80   |
| 70/195                | 3,62           | 2603                  | 1425                  | 11,88                    | 0,450   | 8,68                    | 1,54                                    | 9,54  | 9,54    | 9,54     | 9,54    | 17,35                                     | 17,35   | 17,35    | 17,35   |
| 89/195                | 4,39           | 3344                  | 1425                  | 15,18                    | 0,574   | 8,68                    | 1,54                                    | 9,54  | 9,54    | 9,54     | 9,54    | 17,35                                     | 17,35   | 17,35    | 17,35   |
| 38/220                | 2,48           | 1355                  | 1675                  | 7,16                     | 0,323   | 9,22                    | 1,81                                    | 7,86  | 9,49    | 10,15    | 10,15   | 15,61                                     | 17,23   | 18,45    | 18,45   |
| 45/220                | 2,76           | 1628                  | 1675                  | 8,62                     | 0,385   | 9,56                    | 1,81                                    | 8,93  | 10,51   | 10,51    | 10,51   | 17,73                                     | 19,12   | 19,12    | 19,12   |
| 58/220                | 3,29           | 2135                  | 1675                  | 11,32                    | 0,499   | 10,18                   | 1,81                                    | 10,91   | 11,20   | 11,20    | 11,20   | 20,36                                     | 20,36   | 20,36    | 20,36   |
| 70/220                | 3,78           | 2603                  | 1675                  | 13,75                    | 0,604   | 10,51                   | 1,81                                    | 11,57   | 11,57   | 11,57    | 11,57   | 21,03                                     | 21,03   | 21,03    | 21,03   |
| 89/220                | 4,55           | 3344                  | 1675                  | 17,56                    | 0,770   | 10,51                   | 1,81                                    | 11,57   | 11,57   | 11,57    | 11,57   | 21,03                                     | 21,03   | 21,03    | 21,03   |
| 38/235                | 2,58           | 1355                  | 1825                  | 7,76                     | 0,379   | 10,09                   | 1,97                                    | 7,86  | 9,49    | 11,10    | 11,10   | 15,61                                     | 17,23   | 20,19    | 20,19   |
| 45/235                | 2,86           | 1628                  | 1825                  | 9,34                     | 0,451   | 10,46                   | 1,97                                    | 8,93  | 10,56   | 11,51    | 11,51   | 17,73                                     | 19,35   | 20,92    | 20,92   |
| 58/235                | 3,39           | 2135                  | 1825                  | 12,25                    | 0,584   | 11,14                   | 1,97                                    | 10,91   | 12,25   | 12,25    | 12,25   | 21,66                                     | 22,28   | 22,28    | 22,28   |
| 70/235                | 3,87           | 2603                  | 1825                  | 14,88                    | 0,707   | 11,51                   | 1,97                                    | 12,66   | 12,66   | 12,66    | 12,66   | 23,01                                     | 23,01   | 23,01    | 23,01   |
| 89/235                | 4,65           | 3344                  | 1825                  | 19,00                    | 0,902   | 11,51                   | 1,97                                    | 12,66   | 12,66   | 12,66    | 12,66   | 23,01                                     | 23,01   | 23,01    | 23,01   |
| 38/240                | 2,61           | 1355                  | 1875                  | 7,96                     | 0,399   | 10,31                   | 2,03                                    | 7,86  | 9,49    | 11,34    | 11,34   | 15,61                                     | 17,23   | 20,62    | 20,62   |
| 45/240                | 2,89           | 1628                  | 1875                  | 9,58                     | 0,474   | 10,69                   | 2,03                                    | 8,93  | 10,56   | 11,76    | 11,76   | 17,73                                     | 19,35   | 21,37    | 21,37   |
| 58/240                | 3,42           | 2135                  | 1875                  | 12,57                    | 0,614   | 11,38                   | 2,03                                    | 10,91   | 12,52   | 12,52    | 12,52   | 21,66                                     | 22,76   | 22,76    | 22,76   |
| 70/240                | 3,91           | 2603                  | 1875                  | 15,25                    | 0,743   | 11,76                   | 2,03                                    | 12,74   | 12,93   | 12,93    | 12,93   | 23,51                                     | 23,51   | 23,51    | 23,51   |
| 89/240                | 4,68           | 3344                  | 1875                  | 19,48                    | 0,948   | 11,76                   | 2,03                                    | 12,93   | 12,93   | 12,93    | 12,93   | 23,51                                     | 23,51   | 23,51    | 23,51   |
| 38/250                | 2,67           | 1355                  | 1975                  | 8,36                     | 0,440   | 10,73                   | 2,13                                    | 7,86  | 9,49    | 11,80    | 11,80   | 15,61                                     | 17,23   | 21,09    | 21,46   |
| 45/250                | 2,96           | 1628                  | 1975                  | 10,06                    | 0,523   | 11,12                   | 2,13                                    | 8,93  | 10,56   | 12,23    | 12,23   | 17,73                                     | 19,35   | 22,24    | 22,24   |
| 58/250                | 3,48           | 2135                  | 1975                  | 13,20                    | 0,677   | 11,84                   | 2,13                                    | 10,91   | 12,54   | 13,03    | 13,03   | 21,66                                     | 23,28   | 23,68    | 23,68   |
| 70/250                | 3,97           | 2603                  | 1975                  | 16,01                    | 0,819   | 12,23                   | 2,13                                    | 12,74   | 13,45   | 13,45    | 13,45   | 24,46                                     | 24,46   | 24,46    | 24,46   |
| 89/250                | 4,74           | 3344                  | 1975                  | 20,44                    | 1,044   | 12,23                   | 2,13                                    | 12,98   | 13,45   | 13,45    | 13,45   | 24,46                                     | 24,46   | 24,46    | 24,46   |
| 38/300                | 2,99           | 1355                  | 2475                  | 10,42                    | 0,676   | 12,45                   | 2,67                                    | 7,86  | 9,49    | 13,11    | 13,69   | 15,61                                     | 17,23   | 21,09    | 22,72   |
| 45/300                | 3,28           | 1628                  | 2475                  | 12,51                    | 0,803   | 12,90                   | 2,67                                    | 8,93  | 10,56   | 14,19    | 14,19   | 17,73                                     | 19,35   | 23,95    | 25,58   |
| 58/300                | 3,80           | 2135                  | 2475                  | 16,38                    | 1,038   | 13,74                   | 2,67                                    | 10,91   | 12,54   | 15,11    | 15,11   | 21,66                                     | 23,28   | 27,48    | 27,48   |
| 70/300                | 4,29           | 2603                  | 2475                  | 19,85                    | 1,254   | 14,19                   | 2,67                                    | 12,74   | 14,37   | 15,61    | 15,61   | 25,29                                     | 26,91   | 28,38    | 28,38   |
| 89/300                | 5,06           | 3344                  | 2475                  | 25,30                    | 1,598   | 14,19                   | 2,67                                    | 12,98   | 14,61   | 15,61    | 15,61   | 25,76                                     | 27,39   | 28,38    | 28,38   |
| 45/350                | 3,60           | 1628                  | 2975                  | 15,02                    | 1,147   | 14,04                   | 3,21                                    | 8,93  | 10,56   | 14,89    | 15,44   | 17,73                                     | 19,35   | 23,95    | 25,58   |
| 58/350                | 4,12           | 2135                  | 2975                  | 19,62                    | 1,480   | 14,95                   | 3,21                                    | 10,91   | 12,54   | 16,45    | 16,45   | 21,66                                     | 23,28   | 29,26    | 29,90   |
| 70/350                | 4,61           | 2603                  | 2975                  | 23,74                    | 1,787   | 15,44                   | 3,21                                    | 12,74   | 14,37   | 16,99    | 16,99   | 25,29                                     | 26,91   | 30,88    | 30,88   |
| 89/350                | 5,38           | 3344                  | 2975                  | 30,23                    | 2,273   | 15,44                   | 3,21                                    | 12,98   | 14,61   | 16,99    | 16,99   | 25,76                                     | 27,39   | 30,88    | 30,88   |
| 45/400                | 3,92           | 1628                  | 3475                  | 17,58                    | 1,557   | 16,61                   | 3,75                                    | 8,93  | 10,56   | 14,89    | 16,51   | 17,73                                     | 19,35   | 23,95    | 25,58   |
| 58/400                | 4,44           | 2135                  | 3475                  | 22,91                    | 2,005   | 17,69                   | 3,75                                    | 10,91   | 12,54   | 18,19    | 19,46   | 21,66                                     | 23,28   | 29,26    | 30,89   |
| 70/400                | 4,93           | 2603                  | 3475                  | 27,70                    | 2,418   | 18,27                   | 3,75                                    | 12,74   | 14,37   | 20,10    | 20,10   | 25,29                                     | 26,91   | 33,87    | 35,79   |
| 89/400                | 5,70           | 3344                  | 3475                  | 35,22                    | 3,073   | 18,27                   | 3,75                                    | 12,98   | 14,61   | 20,10    | 20,10   | 25,76                                     | 27,39   | 33,87    | 36,44   |
| 45/450                | 4,24           | 1628                  | 3975                  | 20,20                    | 2,035   | 17,93                   | 4,29                                    | 8,93  | 10,56   | 14,89    | 16,51   | 17,73                                     | 19,35   | 23,95    | 25,58   |
| 58/450                | 4,76           | 2135                  | 3975                  | 26,27                    | 2,615   | 19,10                   | 4,29                                    | 10,91   | 12,54   | 18,19    | 19,81   | 21,66                                     | 23,28   | 29,26    | 30,89   |
| 70/450                | 5,25           | 2603                  | 3975                  | 31,71                    | 3,151   | 19,72                   | 4,29                                    | 12,74   | 14,37   | 20,35    | 21,70   | 25,29                                     | 26,91   | 33,87    | 35,79   |
| 89/450                | 6,02           | 3344                  | 3975                  | 40,26                    | 3,998   | 19,72                   | 4,29                                    | 12,98   | 14,61   | 20,35    | 21,70   | 25,76                                     | 27,39   | 33,87    | 36,44   |
| 45/500                | 4,56           | 1628                  | 4475                  | 22,87                    | 2,584   | 17,71                   | 4,83                                    | 8,93  | 10,56   | 14,89    | 16,51   | 17,73                                     | 19,35   | 23,95    | 25,58   |
| 58/500                | 5,08           | 2135                  | 4475                  | 29,67                    | 3,313   | 18,86                   | 4,83                                    | 10,91   | 12,54   | 18,19    | 19,81   | 21,66                                     | 23,28   | 29,26    | 30,89   |
| 70/500                | 5,57           | 2603                  | 4475                  | 35,77                    | 3,986   | 19,48                   | 4,83                                    | 12,74   | 14,37   | 20,35    | 21,42   | 25,29                                     | 26,91   | 33,87    | 35,79   |
| 89/500                | 6,34           | 3344                  | 4475                  | 45,36                    | 5,051   | 19,48                   | 4,83                                    | 12,98   | 14,61   | 20,35    | 21,42   | 25,76                                     | 27,39   | 33,87    | 36,44   |
| 45/600                | 5,20           | 1628                  | 5475                  | 28,37                    | 3,897   | 17,39                   | 5,91                                    | 8,93  | 10,56   | 14,89    | 16,51   | 17,73                                     | 19,35   | 23,95    | 25,58   |
| 58/600                | 5,72           | 2135                  | 5475                  | 36,64                    | 4,976   | 18,52                   | 5,91                                    | 10,91   | 12,54   | 18,19    | 19,81   | 21,66                                     | 23,28   | 29,26    | 30,89   |
| 70/600                | 6,21           | 2603                  | 5475                  | 44,06                    | 5,971   | 19,13                   | 5,91                                    | 12,74   | 14,37   | 20,35    | 21,04   | 25,29                                     | 26,91   | 33,87    | 35,79   |
| 89/600                | 6,98           | 3344                  | 5475                  | 55,72                    | 7,548   | 19,13                   | 5,91                                    | 12,98   | 14,61   | 20,35    | 21,04   | 25,76                                     | 27,39   | 33,87    | 36,44   |

### ANNEX 3 INSTALLATION GUIDE FOR THE JOISTS

The installation guide of the manufacturer shall be followed. Especially the following points shall be noticed:

1. The instructions of the manufacturer regarding the restraint of the compression flange and temporary bracing shall be followed.
2. The bearing length to be used shall be larger than 45 mm. If the bearing length is more than 135 mm, the bearing resistance values given for 135 mm shall be used.
3. Web stiffeners may be used according to the instructions of the manufacturer. The characteristic bearing resistance with web stiffeners is given in Table 2-4.
4. During installation, the finished product may be exposed for conditions corresponding to hazard class 3 during a short time before immediate protection against rain.
5. It is assumed, that the knock-outs do not interfere and that the knock-out considered is a hole. Additional holes may be taken in the joist web for installations according to following rules:
  - The structural effect of all additional holes must be considered separately from case to case.
  - Holes shall be positioned at the centre of the web, except of holes smaller than 20 mm in diameter.
  - The spacing of the holes shall be such, that the length of the unbroken web between the holes is at least two times the diameter of the larger hole. Else, the group of holes shall be considered as one elongated hole.
  - For rectangular holes, the corners shall be made carefully and overcutting shall be avoided.
  - For joists with holes, the shear capacity can be calculated as follows:

$$V_{k,hole} = 1,1 \cdot k_{hole} \cdot V_k \leq V_k \quad (1)$$

where factor  $k_{hole}$  takes into account the effect of hole.

$$k_{hole} = \frac{h_w + h_f - k_{shape} \cdot h_{hole} - k \cdot 38}{h_{w,eff} - 38}, \quad 0 \leq k_{hole} \leq 1 \quad (2)$$

$$h_{w,eff} = \frac{35b_w}{h_w} (h_w + h_f) \leq h_w + h_f \quad (3)$$

$k_{shape}$  is 1 for round holes and 1,23 for rectangular holes.  $k$  takes into account the effect of the system hole that may be present near to the additional hole.  $h_{hole}$  is the diameter of the round hole. For rectangular holes,  $h_{hole}$  is the length or the height of the hole, which one is larger.

$$\text{When } H \leq 212\text{mm:} \quad k = \frac{250 - H - h_{hole}}{76}, \quad 0 \leq k \leq 1 \quad (4)$$

$$\text{When } H \geq 212\text{mm:} \quad k = \frac{H - h_{hole} - 174}{76}, \quad 0 \leq k \leq 1 \quad (5)$$