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IFC ASSESSMENT REPORT

PAR/15150/02

Assessment of the Fire Resistance of Timber Floors Incorporating BCI, FJI, JJI & Steico I-joists with Various Ceiling Linings for 60 Minutes Fire Resistance

Fire test standard: BS EN 1365: Part 2: 2014

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AMENDMENT RECORD

Date	Paragraph	Amendment

Revision	PAR/15150/02					
Author	CM					
Reviewer	MB/DC					

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1. INTRODUCTION

This report has been produced by International Fire Consultants Ltd (IFC) for our assessment of timber floors constructed using BCI, FJI, JJI & Steico engineered I-joists for 60 minutes fire resistance. IFC have performed the evaluations, analysis and preparation of the assessment report on the instruction of Marcroft Timber Consultancy Limited.

Fire resisting assemblies are rarely supplied in an identical form to that which was tested. The specification will invariably require the construction to be supplied at a size, at different joist centres, with different linings, spans, etc. which are different from that tested. The result of a fire resistance test can apply to variations in configuration/construction, as long as they do not reduce the performance to one which is below that specified. The influence of those variations is covered by a judgement, sometimes made by the approving authority.

Where the approving authority does not feel technically able to make such judgements, or, does not wish to take responsibility for them, then a third party expert opinion is often sought. Such an opinion is often expressed in the form of an assessment of the performance, which may be supported by numerical/quantifiable methods or may be purely an expert judgement.

When establishing the variations in the construction that can achieve the required fire resistance performance, IFC follow the guidance given in BS.ISO/TR12470: 1998, *"Fire resistance tests - Guidance on the application and extension of results".*

Where Building Regulations guidance requires that Fire Safety Information is given to the 'Responsible Person' [as defined under the Regulatory Reform (Fire Safety) Order 2005] for a building or project, an Assessment is used to provide essential information upon the design, construction and performance of relevant fire resisting assemblies.

The assessment is based upon the constructional information supplied to us (detailed in Section 2) and upon the fire resistance test evidence for parts of the constructions (detailed in Section 3). A full analysis of the fire resistance performance of these assemblies is presented in Section 4.

2. PROPOSAL

It is proposed that this Engineering Assessment Report shall establish the fire resistance performance of timber floors constructed using BCI, FJI, JJI & Steico engineered I-joists, if they were to be tested to the integrity, insulation and loadbearing capacity criteria of BS EN 1365-2: 2014, *"Fire resistance tests for load-bearing elements – Part 2 – Floors & roofs"*.

The assessed fire resistance of timber floors constructed using BCI, FJI, JJI, & Steico engineered I-joists is generally based upon details included in the fire test reports provided by Marcroft Timber Consultancy Limited, copies of which are kept on file by IFC for reference. The construction and details of the assemblies are summarised in Sections 2.1 to 2.4, below, but the documents should be read in conjunction with this report for full interpretation. Anyone using this report should verify that copies of documents in their possession match those copies which are kept on file by IFC. If variations occur between details described herein and those on the relevant documents, the former shall take precedence. Otherwise IFC should be contacted for clarification. Refer to Section 6 for recommendations with respect to audit and verification of the manufactured/installed assemblies. It should be noted that only the variations specified herein are approved.

2.1 Engineered Timber Based I-joists

Any joist listed in sections 2.1.1 to 2.1.4 herein may be used, installed at centres not exceeding 600mm (or as specified for ceiling lining option) and with a floor span defined by cold state design requirements.

2.1.1 Boise BCI-joists

BCI-joists are manufactured from Versalam laminated veneer lumber flanges and OSB/3 web in accordance with European Technical Approval ETA-09/0283.

The full range of BCI-joists are summarised as follows:

- 220mm depth: BCI4500, BCI6000, BCI60, BCI90
- 241mm depth: BCI4500, BCI6000, BCI60, BCI90
- 302mm depth: BCI4500, BCI6000, BCI60, BCI90
- 356mm depth: BCI6000, BCI60, BCI90
- 406mm depth: BCI6000, BCI60, BCI90

BCI-joists have the following dimensions:

- Web thickness: 10mm
- Flange thickness: 30mm (1000 series – BCI4500, BCI6000) and 38mm (10 series – BCI60, BCI90)
- Flange width: 45mm, 58mm, 89mm

2.1.2 Metsa Wood FJI-joists

FJI-joists are manufactured from Kerto laminated veneer lumber flanges and OSB/3 web in accordance with European Technical Approval ETA-02/0026.

The full range of FJI-joists are summarised as follows:

- 200mm depth: FJI38, FJI45, FJI58, FJI63, FJI70, FJI89, FJI96
- 220mm depth: FJI38, FJI45, FJI58, FJI63, FJI70, FJI89, FJI96
- 240mm depth: FJI38, FJI45, FJI58, FJI63, FJI70, FJI89, FJI96
- 300mm depth: FJI38, FJI45, FJI58, FJI63, FJI70, FJI89, FJI96
- 360mm depth: FJI45, FJI58, FJI63, FJI70, FJI89, FJI96
- 400mm depth: FJI45, FJI58, FJI63, FJI70, FJI89, FJI96
- 450mm depth: FJI45, FJI58, FJI63, FJI70, FJI89, FJI96
- 500mm depth: FJI45, FJI58, FJI63, FJI70, FJI89, FJI96

FJI-joists have the following dimensions:

- Web thickness: 10mm
- Flange thickness: 36mm, 39mm, 45mm
- Flange width: 38mm, 45mm, 58mm, 63mm, 70mm, 89mm, 96mm

2.1.3 James Jones JJI-joists

JJI-joists are manufactured from strength class C24 timber flanges and OSB/3 web in accordance with European Technical Approval ETA-10/0335.

The full range of JJI-joists are summarised as follows:

- 195mm depth: JJI195A+, JJI195B+, JJI195C, JJI195D
- 220mm depth: JJI220A+, JJI220B+, JJI220C, JJI220D
- 235mm depth: JJI235A+, JJI235B+, JJI235C, JJI235D
- 245mm depth: JJI245A+, JJI245B+, JJI245C, JJI245D
- 300mm depth: JJI300A+, JJI300B+, JJI300C, JJI300D
- 350mm depth: JJI350C, JJI350D
- 400mm depth: JJI400C, JJI400D
- 450mm depth: JJI450D

JJI-joists have the following dimensions:

- Web thickness: 9mm
- Flange thickness: 45mm
- Flange width: 47mm, 63mm, 72mm, 97mm

2.1.4 Steico I-joist

Steico I-joists are manufactured from either a hard fibreboard or OSB/3 web and either solid timber [grade L36] or laminated veneer lumber [grade 2.0E] flanges in accordance with European Technical Approval ETA-06/0238.

The full range of Steico solid timber-flanged I-joists are summarised as follows:

- 200mm depth: SJ45, SJ60, SJ90
- 220mm depth: SJ45, SJ60, SJ90
- 240mm depth: SJ45, SJ60, SJ90
- 250mm depth: SJ45, SJ60, SJ90
- 300mm depth: SJ45, SJ60, SJ90
- 350mm depth: SJ45, SJ60, SJ90
- 360mm depth: SJ45, SJ60, SJ90
- 400mm depth: SJ45, SJ60, SJ90
- 450mm depth: SJ60, SJ90
- 500mm depth: SJ60, SJ90

Steico solid-timber-flanged I-joists have the following dimensions:

- Web thickness: 8mm hard fibreboard or 10mm OSB/3
- Flange thickness: 45mm
- Flange width: 45mm, 60mm, 90mm

The full range of Steico LVL-flanged I-joists are summarised as follows:

- 200mm depth: SJ_L45, SJ_L60, SJ_L90
- 220mm depth: SJ_L45, SJ_L60, SJ_L90
- 240mm depth: SJ_L45, SJ_L60, SJ_L90
- 250mm depth: SJ_L45, SJ_L60, SJ_L90
- 300mm depth: SJ_L45, SJ_L60, SJ_L90
- 350mm depth: SJ_L45, SJ_L60, SJ_L90
- 360mm depth: SJ_L45, SJ_L60, SJ_L90
- 400mm depth: SJ_L45, SJ_L60, SJ_L90
- 450mm depth: SJ_L60, SJ_L90
- 500mm depth: SJ_L60, SJ_L90

Steico LVL-flanged I-joists have the following dimensions:

- Web thickness: 8mm hard fibreboard or 10mm OSB/3
- Flange thickness: 39mm
- Flange width: 45mm, 60mm, 90mm

2.2 Ceiling Linings

2.2.1 Board types

Table 1, below, shows the plasterboard types considered herein for ceiling linings along with their manufacturers. Table 1 also shows each of the manufacturer's respective resilient bars, which, where approved, can be used.

Plasterboard / Resilient bar type	British Gypsum	Siniat	Knauf
Type F to BS EN 520 (Plasterboard with improved core adhesion at high temperatures, typically used for purposes of enhanced fire resistance performance)	FireLine	GTEC Fire Board	Fire Panel
Resilient bar	RB1	GTEC Resilient Bar	Knauf Resilient Bar

Table 1: Materials/suppliers

2.2.2 Ceiling lining options

Ceiling linings for 60 minutes fire resistance are given below:

a) 2 No. 15mm Type F plasterboard fixed to resilient bar.
b) **For joists at maximum 450mm centres only,** 2 No. 15mm Type F plasterboard fixed directly to joist soffit.

2.2.3 Ceiling lining installation/detailing

For plasterboard fixed direct to the joist soffit the following apply:

- The plasterboard is installed with its short edges parallel to the joists (such that the joints at the short edges are backed up by the joists) and with staggered joints on adjacent boards.
- Plasterboard fixings to be black phosphate screws of 3.2mm diameter and at least 25mm longer than the thickness of plasterboard that they pass through.
- Plasterboard to be fixed back at all locations that are backed by a joist, i.e. in the field of the board, at maximum centres of 230mm. This applies to both layers if two are installed.
- All joints to be taped and filled using appropriate jointing compound and tape.
- Plasterboard to have staggered joints between layers when two layers are installed.

For plasterboard fixed using an intermediate Resilient bar system the following apply:

- Resilient bars should be fixed at right angles to the joist soffits at every intersection using 32mm long drywall screws through one flange of the bar sections.
- The Resilient bars should be installed at 450mm maximum centres and at the ceiling perimeters at right angles to the joists (i.e. the first and last rows). Where lengths of resilient bars are jointed these should have a minimum overlap of 200mm.
- The plasterboard is installed with its short edges parallel to the resilient bar (such that the joints at the short edges are backed up by the resilient bar) and with staggered joints on adjacent boards.
- Plasterboard fixings to be black phosphate screws of 3.2mm diameter and at least 10mm longer than the thickness of plasterboard that they pass through.
- Plasterboard to be fixed back at all locations that are backed by a resilient bar, i.e. in the field of the board, at maximum centres of 230mm. This applies to both layers if two are installed.
- All joints to be taped and filled using appropriate jointing compound and tape.
- Plasterboard to have staggered joints between layers when two layers are installed.

2.3 Floor Decking Materials

One of the following timber-based materials is fixed across the joists in a staggered pattern to form a floor deck.

- 22mm or 18mm flooring grade chipboard
- 15mm or 18mm OSB
- 18mm flooring grade plywood
- 21mm T&G softwood boarding

2.4 Floor Cavity Insulation (optional)

100mm thickness of mineral rock fibre or glasswool, maximum density 33 kg/m^3

3. TEST EVIDENCE

Test evidence generated in accordance with BS EN 1365-2: 2000 is available to demonstrate the performance of loaded timber floors constructed using engineered I-joists / Posi-joists with various plasterboard ceilings for 60 minutes fire resistance. The test evidence is summarised below.

Report no.	Joist details Depth x Width (mm)	Plasterboard Ceiling Details	Fire resistance based upon test report (min)
BRE 222207	Posi-joists 254mm x PS10	2 No. 15mm LaFarge Firecheck on Resilient bar.	92
BTC 13365F	TJI-joists 241 x 45 (100mm Isowool infill)	2 No. 15mm British Gypsum FireLine on RB1 Resilient bar.	63
PBIII/B-07-242*	Steico I-joists 220 x 45	15mm Type A Board on Timber battens under joists.	31

Table 2: Test evidence to BS EN 1365-2

** This evidence is included to support the web construction of the Steico I-joists.*

4. ANALYSIS

Evaluation of the fire resistance of the proposed BCI, FJI, JJI or Steico I-joist systems has addressed the factors that influence the overall fire performance of timber floor constructions under fire test conditions of BS EN 1365-2: 2014.

All assemblies have been assessed in respect of the integrity, insulation and loadbearing capacity criteria of BS EN 1365-2: 2014, *"Fire resistance tests for load-bearing elements – Part 2 – Floors & roofs"* for 60 minutes.

The three main components that contribute to the fire resistance (load bearing capacity) of floors constructed using timber based engineered I-joists are the ceiling lining, the engineered timber joists and the floor decking.

The variations proposed in Section 2 herein have been analysed and approved. The following sections present a summary of IFC's philosophy regarding the various factors that influence the fire resistance performance of floors constructed using timber based engineered I-joists.

4.1 BS EN 1365-2: 1999/2000 and BS EN 1365-2: 2014

The test evidence summarised herein (See Section 3) considers test on various floor constructions using timber based engineered I-joists. The testing has been carried out in accordance with the 1999 and 2000 versions of the BS EN 1365-2 standard.

It should be noted however that in the 1999 and 2000 versions of the standard when this testing was carried out, the load-bearing capacity would have been based on both the maximum deflection and rate of deflection criteria given in BS EN 1363-1: 1999 being exceeded. In the BS EN 1365-2: 2014 standard, the load-bearing capacity criteria given in BS EN 1363-1: 2012 would mean that failure occurs when EITHER the maximum deflection OR the rate of deflection criteria are exceeded. For this reason, tests summarised herein may actually have a poorer fire resistance performance had the most recent failure criteria been applied. IFC have taken this into consideration.

4.2 Ceiling Lining

Parameters which influence the performance of the ceiling lining in respect of its contribution to fire resistance of the floor are:

- The thickness of the lining
- The lining material
- The arrangement of joints
- The filling and backing of the joints
- The method of fixing to the timber joists
- Any applied finish to the ceiling (i.e. plaster scrim)

The ceiling is of vital importance to the fire resistance of a timber based engineered I-joist floor system. Once the ceiling lining, or parts of it, becomes loose or detaches, the joists are directly exposed to the heating conditions and chars rapidly. This rapid charring and consumption of the I-joist web will quickly lead to rapid deflection and collapse of the floor.

The ceiling linings considered herein are gypsum plasterboards. Gypsum contains approximately 20% water chemically bonded within the molecules ($CaSO_4$: $24H_2O$). When subjected to heating, the evaporating water content in the plasterboard slows the temperature development of the board. However, once the water has all evaporated the gypsum will lose its mechanical strength due to weakening of the internal molecular structure.

If the gypsum plasterboard has been reinforced with glass fibres (e.g. a Type F board such as British Gypsum FireLine), the mechanical strength can be retained longer once the water evaporates. This results in a higher contribution to fire resistance because the glass fibres contribute to internal bonding of the gypsum particles in the board, keeping the board in place longer.

4.3 Timber Based Engineered I-Joists

The proposed joists are listed in Section 2.1 herein. Based upon the test evidence available, the time between the plasterboard falling into the furnace (or start of charring) and failure of load-bearing criteria is in the order of 2 minutes.

It is noted that the Steico I-joist is a little different to the others in that the web is constructed using a hardboard web rather than OSB. IFC have reviewed the available evidence and are of the opinion that the performance of the Steico I-joist with a hardboard web is comparable with that of those constructed using an OSB web.

It is also noted that Test BRE 22207 incorporates Posi-joists rather than I-joists. This has been taken into consideration in IFC's analysis.

4.4 Resilient Bars

Several of the tested specimens incorporated ceiling linings installed on steel resilient bars. Due to improved fixity of the plasterboard when installed on resilient bars, IFC are of the opinion that when ceiling linings are installed on resilient bars, the fire resistance performance of the floor is slightly improved.

4.5 Floor Decking

The floor decking is fully exposed to fire conditions after the ceiling lining is compromised. Once fully exposed to the heating conditions the floor decking will char, leading to insulation and integrity failures on the upper surface of the floor.

From the available evidence it is apparent that due to rapid charring of the relatively thin I-joist web, when the mechanical link between the upper and lower I-joist flanges is lost, the joist is strongly reduced in strength. The prevalent failure mode in these types of floor systems is failure of load-bearing capacity. This occurs prior to insulation or integrity failure and hence failure of load-bearing capacity can be considered as the decisive mode of failure.

5. CONCLUSIONS

It is the opinion of International Fire Consultants Ltd that, if timber floors using BCI, FJI, JJI & Steico engineered I-joists were constructed, all as specified herein, then these floor systems would satisfy the loadbearing, integrity and insulation criteria for 60 minutes when tested for fire resistance in accordance with BS EN 1365-2:2014.

6. LIMITATIONS

This Assessment Report, which is only valid for floor constructions incorporating BCI, FJI, JJI & STEICO engineered timber based I-joists, all as specified herein, addresses itself solely to the ability of the assemblies described to satisfy the criteria of the fire resistance test. It does not imply any suitability for use with respect to other unspecified criteria.

This document only considers the floor constructions described herein, and assumes that the surrounding construction will provide no less restraint than the tested assembly, and that it will remain in place and be substantially intact for the full fire resistance period. The floor systems must be installed with a sufficient bearing and end support.

No apertures or openings are present in the ceiling (e.g. no service penetrations) except when fitted with an approved light or proven penetration sealing system appropriate to this form of construction.

This report does not address the fire resistance performance, to BS EN 1364-2:2015, of walls into which the assessed assemblies are installed. IFC recommend that consideration is given to this and that, where necessary, appropriate measures are taken.

Where the constructional information in this report is taken from details provided to International Fire Consultants Ltd (IFC) and/or from fire resistance test reports referenced herein, it is, therefore, limited to the information given in those documents. It is necessarily dependent upon the accuracy and completeness of that information. Where constructional or manufacturing details are not specified, or discussed herein, it should not, therefore, be taken to infer approval of variation in such details from those tested or otherwise approved.

Where the assessed constructions have not been subject to an on-site audit by International Fire Consultants Ltd, it is the responsibility of anyone using this report to confirm that all aspects of the assemblies fully comply with the descriptions and limitations herein.

This report does not purport to follow the guidance regarding direct or extended application of test results outlined in EN product standards, and the approvals herein should not be used as supporting evidence for CE marking.

Any materials specified in this report have been selected and judged primarily on their fire performance. IFC do not claim expertise in areas other than fire safety. Whilst observing all possible care in the specification of solutions, we would draw the reader's attention to the fact that during the construction and procurement process, the materials used should be subjected to more general examination regarding the wider Health and Safety, and CoSHH Regulations.

This Report is provided to the sponsor on the basis that it is a professional independent engineering opinion as to what the fire performance of the construction/system would be should it be tested to the named standard. It is IFC's experience that such an opinion is normally acceptable in support of an application for building approvals, certainly throughout the UK and in many parts of Europe and the rest of the world.

However, unless IFC have been commissioned to liaise with the Authorities that have jurisdiction for the building in question for the purpose of obtaining the necessary approvals, IFC cannot assure that the document will satisfy the requirements of the particular building regulations for any building being constructed.

It is, therefore, the responsibility of the sponsor to establish whether this evidence is appropriate for the application for which it is being supplied and IFC cannot take responsibility for any costs incurred as a result of any rejection of the document for reasons outside of our control. Early submittal of the Report to the Authorities will minimise any risks in this respect.

In compiling this assessment, International Fire Consultants Ltd have used judgmental data from other organisations, the quality or accuracy of which we have no control over. We have not had access to the original data and, therefore, IFC are not in a position to evaluate its technical validity. Should any failure be alleged of the product as a result of the quality of this information, International Fire Consultants Ltd cannot be held responsible.

7. VALIDITY

This assessment has been prepared based on International Fire Consultants Ltd's present knowledge of the products described, the stated testing regime and the submitted test evidence. For this reason anyone using this document after April 2021 should confirm its ongoing validity.

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