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June 2010

ITW Industry

software | components | fasteners | equipment

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EUROCODE 5 GUIDANCE NOTES

Members of the Trussed Rafter Association

Members of the UK Timber Frame Association

Members of the Irish Timber Frame Association

Members of the UK SIP Association

BM TRADA certification

ITW

ITW is a leading international business corporation with revenues of $US14 billion. With almost 100 years of experience in the design, development and manufacture of fasteners & components, and equipment & consumable systems, as well as a variety of speciality products for customers all around the world.

ITW's financial performance is generated by some 840 decentralised business units, employing over 59,000 people in 57 countries. ITW is typically amongst the top 100 patent holders in the USA, and holds over 5,000 product lines. ITW is well positioned to meet the challenges of today's global markets.

ITW Industry

ITW Industry, a division of Illinois Tool Works (ITW), specialises in products and services for the timber construction industry - offering a complete package including software, components, fasteners and equipment.

Software
ITW Industry develop and support *Alpine* roof truss & floor joist engineering software, Autodesk based *hsbCAD* 3D CAD / CAM and *VisionREZ* architectural software.

Components
ITW Industry supply a range of nailplate products which are specified by the Alpine engineering software for particular uses within the roof truss & floor joist industry.

Fasteners
ITW Industry are a leading supplier of a variety of powered fastening systems including: pneumatic, gas and powder actuated by the *Paslode*, *Duo-Fast*, *Haubold* and *SPIT* brands.

Equipment
ITW Industry supply, install and service automated fastening tools (*Toolmatic*), roof truss & floor joist production machinery and scaffold security & maintenance equipment.

Contents

Why are Eurocodes being introduced?

The Eurocodes are the result of a political decision: the signing of the treaty of Rome by the UK Government some decades ago. A consequence was the agreement to remove all artificial barriers to trade across Europe; National standards for construction are regarded as an example.

With the Eurocodes in place, engineers will be better placed to take on projects in other European countries: Likewise engineers in mainland Europe will be able to undertake projects to be constructed in the UK. The Eurocodes will apply in all EU countries. Where national variation is allowed, the Nationally Determined Parameters will be available in the respective National Annex document.

The Eurocodes incorporate updated best practices based on input from technical experts from all over Europe. They recognise the possibilities for hybrid structures of steel, timber, concrete and other materials, by utilising common engineering principles.

Historical background

In 1975, the Commission of the European Community (CEN) decided on an action programme in the field of construction (i.e. to eliminate technical obstacles).

The first generation of the Eurocodes was developed in the 1980s. In 1989 the Commission transferred this task to the CEN, the European Committee for Standardization.

Through a phase of Pre-Codes and NADs (National Application Documents) the CEN started to establish the first European Standards (EN) in 1997.

The publication of all 58 parts of the Eurocode was finished by the end of 2007.

All national codes were scheduled for withdrawal by the 31st of March 2010, but in practice there will be a period of co-existence.

Who produces the Eurocodes?

Each of the Eurocode parts are produced by the separate appropriate sub-committees under the guidance and co-ordination of a technical committee (CEN/TC 250). Delegates of the 20 CEN members are represented in CEN/TC 250 and its sub-committees.

Drafts of the Eurocode parts are elaborated by project teams, which are selected by the appropriate sub-committees. A project team consists of about six experts who represent the sub-committee. A vast majority of the project teams include a UK based expert.

A Eurocode is subject to extensive consultation before it is adopted. Progressive drafts are discussed and commented upon by CEN members and their appointed experts. A Eurocode part is adopted only after a positive vote by CEN Members.

What are the differences between the Eurocodes and the British Standard Codes?

The Eurocodes are less codified than the British Standard, with more aspects left open to be determined using alternative means. Where British Standards give guidance on the design of members (e.g beams, columns etc.). The Eurocode contain a limited number of principles for which there should be no other option and application rules that satisfy the principles, but are not necessarily unique solutions.

Key aspects

Building Regulations

Building regulations will be amended to allow structural timber design requirements to be calculated to the Eurocodes. For England and Wales this is expected to take place in 2013, whilst in Scotland changes are expected in 2011. Meanwhile the Department for Communities and Local Government has instructed that existing British Standards are withdrawn from 31st March 2010 (meaning they will not be reviewed or updated any more) and that Eurocodes may now be used.

Designers need to be aware of the risks of inappropriately mixing the new BS EN design standards with the withdrawn BS standards.

NDP

National regulations set the appropriate level of safety through Nationally Determined Parameters (NDP). Certain other parameters can be set by individual countries.

Principles and Application

The clauses in the Eurocodes are divided into principles and application rules. Principles are identified by (P) after the clause number and cover items for which no alternative is permitted. Application rules are recommended methods of achieving the principles but alternative rules may also be used.

Annex

There are two types of annex in the Eurocodes. Normative annexes are part of the requirements of the code.

Informative annexes provide guidance that can be adopted or not on a country by country basis.

National Annex

The national annex is a special type of informative annex that contains the choices made by a particular country. Typically the national annex will state values and classes applicable to that country, provide value where only a symbol is given in the Eurocode and provide country specific data. The national annex also chooses when alternatives are given in the Eurocode and indicates which informative annexes may be used. Finally it refers to non-contradictory complementary information (NCCI).

Non Contradictory Complementary Information (NCCI)

An NCCI is a way of introducing additional guidance to supplement the Eurocodes without contradicting them.

What are Eurocodes?

The structural Eurocodes are a set of unified international codes of practice for designing buildings and civil engineering structures, which will eventually replace national codes (e.g. BSI) in the European community.

The complete suite of structural Eurocodes are being produced by the Comite Europeen de Normalisation (CEN), the European committee for standardisation. EN presently has 20 members including the UK.

There are ten Eurocodes, each consisting a number of parts, the following standards are:

EN 1990	Eurocode 0 :	Basis of Structural design
EN 1991	Eurocode 1 :	Actions on structures
EN 1992	Eurocode 2 :	Design of concrete structures
EN 1993	Eurocode 3 :	Design of steel structures
EN 1994	Eurocode 4 :	Design of composite steel and concrete structures
EN 1995	Eurocode 5 :	Design of timber structures
EN 1996	Eurocode 6 :	Design of masonry structures
EN 1997	Eurocode 7 :	Geotechnical design
EN 1998	Eurocode 8 :	Design of structures for earthquake resistance
EN 1999	Eurocode 9 :	Design of aluminium structures

EN 1990, alone within the Eurocode suite gives all the operative material independent rules (e.g. partial factor for actions, load combination expressions for ultimate and serviceability limit states), and therefore EN 1992 to EN 1999, which do not provide material independent guidance, cannot be used without EN 1990.

Only three of the ten Eurocodes normally apply to Timber Construction:

EN 1990 Eurocode 0 : Basic of structural design
EN 1991 Eurocode 1 : Actions on structures
EN 1995 Eurocode 5 : Design of timber structures

The main standards relating to timber structures, including those which provide for CE marking of products;-
PD 6693 (EN 1995-1-1 NCC1 document) Part 1-2: Trussed Rafter Roof Design

BS EN 14250:2010 Product requirements for prefabricated structural members assembled with punched metal plate fasteners

BS EN 336:2003	Structural timber sizes, permitted deviations
BS EN 14545	Timber connectors, Joints, Nailed joints, Fasteners
BS EN 14566	Fasteners, Plasterboard, Gypsum plaster, Staples, Nails, Screws & Bolts

BS EN 14592 Dowel-type fasteners for timber structures.

CE Marking

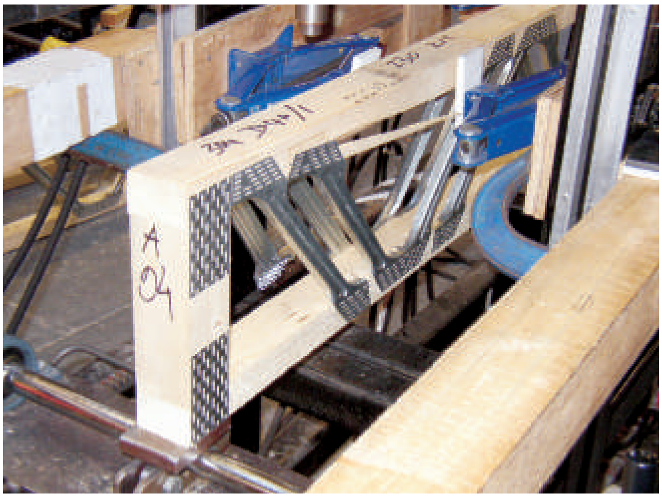
CE marking is the process by which a product is deemed to be safe and fit for a specific purpose. The Eurocode process allows for the CE mark to be used on a product by following one of these procedures;- compliance with a specific European product standard (e.g. EN14545), or where such a standard has yet to be established by obtaining a European Technical Approval (using a published ETAG (European Technical Approval Guideline) or where this does not exist, for example on a new or unique product, through creating a CUAP (Common Understanding Approval Procedure) through an accredited test authority.

CE marking is not always a quality mark, sometimes it is only dimensional, but often it does deal with durability, performance etc.

CE marking on construction products is not yet mandatory in the UK, but it is of growing importance and it eases the trade in such products across Europe.

ITW Industry's SpaceJoist was the first open web floor joist to be CE marked in UK and Ireland.

PICTURE: SPACEJOIST STRENGTH TEST



PICTURE: SPACEJOIST FIRE TEST

What are National Annexes?

The UK National Annex was published in 2006. It is the responsibility of each national standard body (e.g. the British Standards Institution (BSI)) to publish the structural Eurocodes as national standard and the national competent authority to authorise their use.

The BSI, are not permitted to change any part of the text in the core Eurocode document. However, they are allowed to add a National title page, a National Foreword and a National Annex.

As the Eurocodes are intended to be used as one approach to satisfy building regulations and other requirements that are not currently harmonised across the European Union they recognise the principle, stated in the Construction Products Directive.

The National Annex of each Eurocode part list the Nationally Determined Parameters (NDPs) and other points on which an element of national choice exists, for example, where there is the possibility of a choice of different design methods. The National Annex may also include reference to non-contradictory complementary information (NCCI), such as national standard or guidance documents.

Safety remains a national, not a European responsibility, and hence the safety factors given in the Eurocodes are recommended values and these may be altered by the national annex. Possible differences in geographical or climatic conditions (e.g. wind or snow maps) or in ways of life, as well as different levels of protection that may prevail at national, regional or local level, are taken into account by choices left open about values, classes, or alternative methods called 'nationally determined parameters'. They allow EU member states to choose the level of safety, including aspects of durability and economy applicable to work in their territory.

National annex for EN 1995-1-1

In general Eurocode 5 is only applicable with the respective national annex which has to be published by each member state.

The Eurocode 5 gives alternative procedures, values and recommendations with notes indicating where choices may have to be made.

National choice is allowed in EN 1995-1-1 through clauses:

2.3.1.2(2)P	Assignment of loads to load-duration classes
2.3.1.3(1)P	Assignment of structures to service classes
2.4.1(1)P	Partial factors for material properties
6.1.7(2)	Shear
6.4.3(8)	Double tapered, curved and pitched cambered beams
7.2(2)	Limiting values for deflections
7.3.3(2)	Limiting values for vibrations
8.3.1.2(4)	Nailed timber-to-timber connections: Rules for nails in end grain
8.3.1.2(7)	Nailed timber-to-timber connections: Species sensitive to splitting
9.2.4.1(7)	Design method for wall diaphragms
9.2.5.3(1)	Bracing modification factors for beam or truss systems
10.9.2(3)	Erection of trusses with punched metal plates fasteners; Maximum bow
10.9.2(4)	Erection of trusses with punched metal plates fasteners; Maximum deviation

The National Annexes that apply to the UK Timber Construction:

BS EN 1990 Eurocode 0 :Basis of structural design
BS EN 1991-1-1 Eurocode 1:Actions on structures
BS EN 1991-1-3 Eurocode 1:Actions on structures snow loads
BS EN 1991-1-4 Eurocode 1:Actions on structures wind actions

BS EN 1995-1-1 Eurocode 5:Design of timber structures common rules
BS EN 1995-1-2 Eurocode 5:Design of timber structures structural fire design

Irish National Annex

The National Standards Authority of Ireland (NSNI), as the national body member of CEN and the national publisher of all European (EN) standards, is coordinating the examination of all Eurocode parts and the development of national annexes through its National Eurocodes Advisory Committee. This committee comprises of experts (Liaison Engineers) for each of the 10 Eurocodes together with representatives from the department of the Environment, Heritage and Local Government, the Irish Concrete Federation, the National Roads Authority (NRA), the Office of Public Works as well as from academic and industry representative bodies.

While a comprehensive technical evaluation of each of the Eurocodes has been and continues to be carried out by the respective Liaison Engineers, particular consideration has been given to a number of the codes and individual parts through the application of externally contracted study programmes. Eurocode 1 parts 1-2 (actions on structures exposed to fire) and 1-4 (wind action) have been subject to such a study and while the EC 1 fire part national annex is now complete and published, the wind part is still under consideration but when available will include a definitive wind map for Ireland.

The National Annexes that apply to the Irish Timber Construction:

IS EN 1990	Eurocode 0 :Basis of structural design
IS EN 1991-1-1	Eurocode 1:Actions on structures
IS EN 1991-1-3	Eurocode 1:Actions on structures Snow Loads
IS EN 1991-1-4	Eurocode 1:Actions on structures Wind actions
IS EN 1995-1-1	Eurocode 5:Design of timber structures Common rules
IS EN 1995-1-2	Eurocode 5:Design of timber structures Structural fire design

Eurocode 5: Design of timber structures BS EN 1995 - Introduction

BS EN 1995 is in three parts:

Part 1-1:	General, common rules and rules for building
Part 1-2	General, structural fire design
Part 2	Bridges

With BS EN 1990 and three standards which provide essential material properties (BS EN 338, structural timber - strength classes, BS EN 1194, Timber structures - Glued laminated timber - strength classes and determination of characteristic values, and BS EN 12369, Wood based panels - Characteristic values for structural design) Eurocode 5 will replace BS 5268, Parts 2, 3, 4 and 6.

Key differences between Eurocode 5 and BS 5268

Design format - Eurocode 5, like all the Eurocodes is in limit state format: This does away with the existing anomaly of BS 5268 being the only current material code in permissible stress format. Compared to other British and European Standards

Material properties - Unlike BS 5268, Eurocode 5 does not include the design properties of structural materials.

Design method - The Eurocode attempts, as far as possible, to give design information in the form of analytical models, rather than tables of properties. This gives the advantage of a generality of solutions. For instance on fasteners it reduces the treatment of these as generic products, allowing for specific test data to be applied to support the use of fasteners with superior performance capabilities.

Construction advice - Variations in National practice make it impossible to give construction advice in the Eurocode to the level of detail found in BS 5268. Additional design information previously contained within BS 5268 can be found in:

Material properties	=	solid timber EN 338
	=	glulam EN 1194
	=	strength classes EN1912
Trussed rafters	=	design of timber structures PD6693 (EN 1995-1-1NCC1 document)

A comprehensive list of related ENs can be found in Eurocode 5 Part 1-1 Section 1.1

Key changes for designers

The differentiation between ultimate, serviceability and accidental limit states;

The partial factor format, which requires safety factors to be applied manually to both loads and material properties, rather than having them all built into tabulated grade or basic values;

New symbols and material strength modification factors;

That BS EN 1995 is a theoretical design code rather than a code of best practice, so formulae replace tabulated values and most of the helpful advice given in BS 5268 has disappeared.

Challenges for designers

Learning the new symbols;

Determining the critical load case for combined loads of different durations;

Remembering which material modification factors to use (in particular reducing the tabulated characteristic values to allow for load duration);

Designing trussed rafter roofs, which involves dozens of different load combinations and load cases;

Calculating the design resistance of connections.

Benefits and opportunities

To provide a common understanding regarding the design of structures between owners, operators & users, designers, contractors and manufacturers of construction products.

To increase the competitiveness of European building and civil engineering firms, contractors, designers and product manufacturers in their world-wide activities.

To facilitate the exchange of construction services between European Union member states.

To facilitate the marketing and use of structural components and kits of parts in European Union member states.

To be a common basis for research and development in the construction sector.

To allow the preparation of common design aids and software.

The same design basis is used for all materials including timber. Once designers become familiar with Eurocodes it should become much easier to switch between designing in timber and other materials.

As with other Eurocodes, multinational companies will benefit by being able to use the same timber design code in many countries both within and outside Europe.

Using a similar design format to that used for other structural materials will help to make timber design more accessible. Many buildings combine timber with concrete, masonry and steel.

The safety factors are transparent. Because the safety factors are all kept separate, it is easy to modify them when there is reason to do so. Sometimes this will yield more efficient material solutions.

Designs can sometimes be more economical. This is because all the required factors are built up separately, rather than sometimes including them globally in an unnecessarily conservative approach.

The separation of ultimate and serviceability design states permits the use of more rational design limits.

The separation of principles and application rules allows the engineer more freedom.

The direct use of characteristic test values simplifies the adoption of new timber materials and components.

The connection design formulae can cater for LVL, OSB and chipboard as well as solid timber materials.

Disadvantages

It is more complicated to use than BS 5268. This is because all issues are addressed separately.
No issues / factors are built into tabulated values. From a commercial point of view it is impossible to design without the efficient use of a computer.

More additional documents are required. For example, documents covering strength properties of timber, plywood and glulam etc.

Structural calculations to EC5 are generally considerably more complex, particularly for the design of connections, floors and deflections.

The loss of much helpful guidance such as standard bracing for trussed rafter roofs, lateral restraint for beams, trussed rafter bracing, methods of calculating spans for domestic members and masonry wind shielding.

Effects on the timber industry

Major changes in timber usage and specification are unlikely.

However:

- Characteristic strength properties for panel products and components such as timber I-joist and metal hardware must now be obtained in accordance with CEN test standards.
- Floors may have to be a little stiffer (i.e. more timber).
- Large roof structures without brittle finishes may not require so much timber.
- There will have to be yet more reliance on software for the design of trussed rafters, connections and timber frame walls.

What is limit state design?

Limit state design (LSD)

Refers to a design method used in structural engineering. The method is in fact a modernization and rationalization of engineering knowledge which was well established prior to the adoption of LSD. Beyond the concept of a limit state, LSD simply entails the application of statistics to determine the level of safety required by or during the design process.

Criteria

Limit state design requires the structure to satisfy two principal criteria: the ultimate limit state (ULS) and the serviceability limit state (SLS). A limit state is a set of performance criteria (e.g. vibration levels, deflection, strength, stability, buckling, twisting, collapse) that must be met when the structure is subject to loads. Any design process involves a number of assumptions. The loads to which a structure will be subjected must be estimated, size of members to check must be chosen and design criteria must be selected. All engineering design criteria have a common goal: that of ensuring a safe and functional structure.

Ultimate Limit State

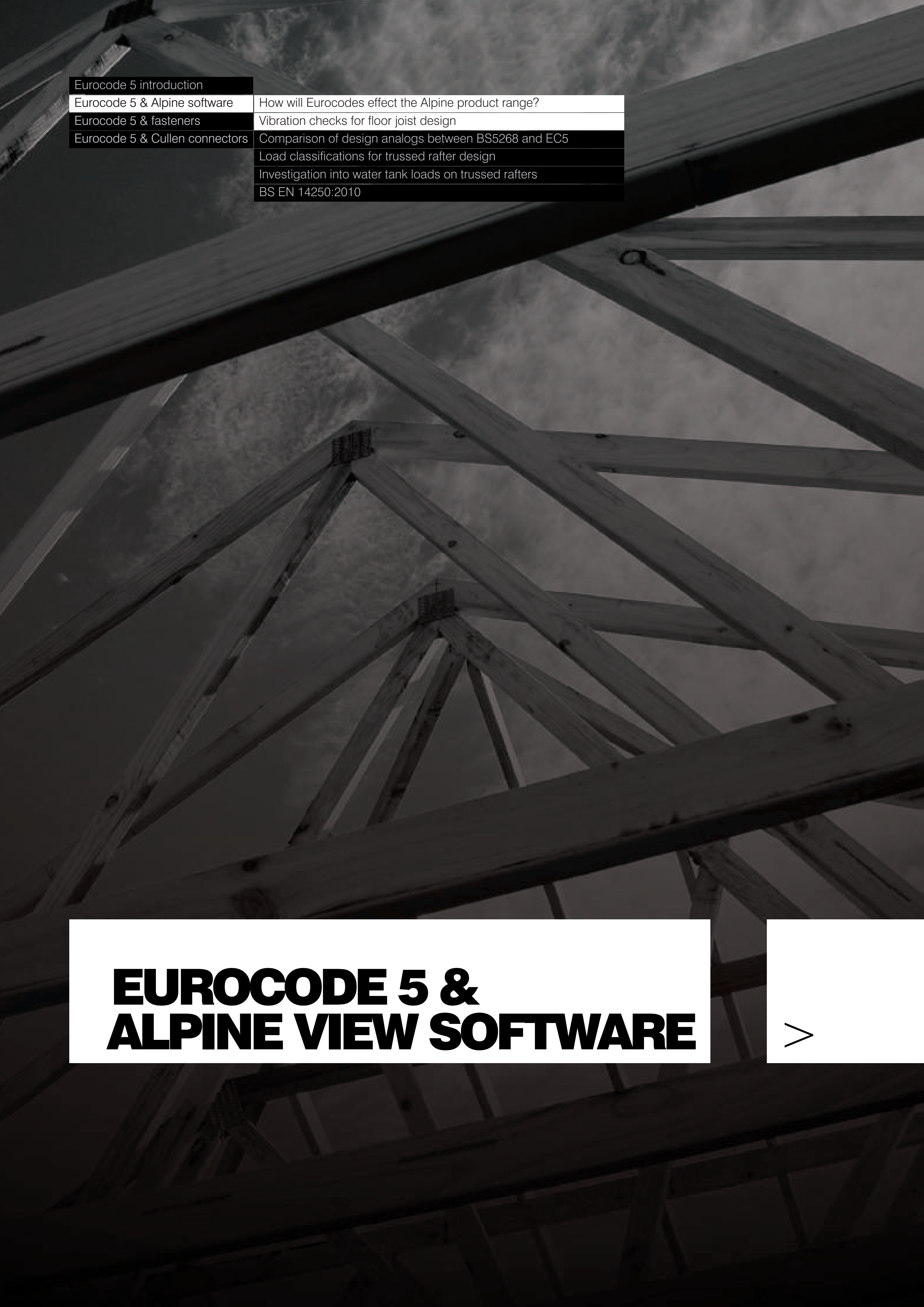
To satisfy the ultimate limit state, the structure must not collapse when subjected to peak design load for which it was designed. A structure is deemed to satisfy the ultimate limit state criteria if all factored bending, shear and tensile or compressive stresses are below the factored resistance calculated for the section under consideration. Whereas Magnification Factor is used for the loads, and Reduction Factor for the resistance of members. The limit state criteria can also be set in terms of stress rather than load. Thus the structural element being analysed (e.g. a beam or a column or other load bearing element, such as walls) is shown to be safe when the factored “Magnified” loads are less than their factored “Reduced” resistance.

Serviceability Limit State

To satisfy the serviceability limit state criteria, a structure must remain functional for its intended use subject to everyday loading, and as such the structure must not cause occupant discomfort under routine conditions. A structure is deemed to satisfy the serviceability limit state when the constituent elements do not deflect by more than certain limits laid down in the building codes, the floor fall within predetermined vibration criteria, in addition to other possible requirements as required by the applicable building code. A structure where the serviceability requirements are not met, e.g. the beams deflect by more than SLS limit, will not necessarily fail structurally. The purpose of SLS requirements is to ensure that people in the structure are not unnerved by large deflections of the floor, vibration caused by walking, sickened by excessive swaying of the building during high winds, and to keep beam deflections low enough to ensure that brittle finishes on the ceiling do not crack.

Factor Development

The load and resistance factors are determined using statistics and a pre-selected probability of failure. Variability in the quality of construction, consistency of the construction material is accounted for in the factors. A factor of unity (one) or less is applied to the resistances of the material and a factor of unity or greater to the loads. These factors can differ significantly for different materials or even between differing grades of the same material. Wood and masonry typically have smaller factors than concrete, which in turn has smaller factors than steel. The factors applied to resistance also accounts for the degree of scientific confidence in the derivation of the values - i.e. smaller values are used when there isn’t much research on the specific type of failure mode). Factors associated with loads are normally independent of the type of material involved, but can be influenced by the type of construction.



EUROCODE 5 & ALPINE VIEW SOFTWARE

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How will Eurocodes affect the Alpine product range?

The implementation of the Eurocodes will have an effect on the design results produced across the Alpine product range. In general the impact of the changes has been limited by the additional design rules introduced in the National Annex document, and the NCCI document (PD6693-1-1), however changes will still be observed by designers of Alpine products, and some of these are summarised on the following pages;

Vibration checks for floor joist design

Historically, floor joist designs have been limited to a maximum 14mm deflection when designed to BS5268:Part 2. This deflection limit for a fully loaded joist, aims to minimise the effect of floor vibration over long spanning joists. The NHBC introduced a decreased limit of 12mm for engineered joists, where there is no strutting in the floor, as acknowledgement of the effect that strutting has in the performance of floor structure against vibration.

The sources of vibrations in buildings fall into three categories;

- Occupant induced (for example due to occupants walking or running through a building)
- Mechanically induced (for example machinery in the building or passing traffic)
- Naturally induced (for example wind or earthquakes)

For domestic buildings EC5 looks to address the effect of the occupant induced vibrations. Many years of extensive research have resulted in a method being derived to more accurately assess the effect of vibration in domestic floors, addressing the human perception of the vibration of a floor, which can be highly subjective, and depend on aspects such as time of day, frequency of occurrence and individual expectations.

The vibration design checks allow for a 1 kN point load (foot fall) to be applied centrally to a floor span, and the deflection in this loadcase is limited to 1.8mm for spans ≤ 4000mm, and 16500/(Joist Length)1.1 for spans > 4000mm.

A design check is also carried out to assess the fundamental frequency (or lowest vibrational frequency) of the floor joist in question, which should always be greater than 8 Hz. An increase in the fundamental frequency increases human perception of an improvement in the performance of the floor.

If we consider the foot fall calculation, it can be seen that for spans greater than 4000mm, as the span of the joist increases, the allowable deflection for this action decreases. Therefore, for long spanning joists, at shallow depths, this action will be governing. When calculating the actual deflection of the joist under this action, we can take into account the proportion of this point load that is actually being supported on a single joist. However this factor has a lower limit of 30%, and joists at closer spacing where this limit has been reached, there is no advantage in reducing the spacing further. As such if we consider a joist at 400mm centres, and the same spanning joist at 300mm centres, the point load applied in the foot fall design calculations is the same, and the deflections produced for this action will be the same. Therefore, reducing the joist centres where the foot fall calculation is governing will not always produce a better design result.

It is possible for the deflections of floor joists to now exceed 14mm in some cases, provided that the vibrational criteria are met.

The vibration design checks apply to the design of attic trussed rafters to EC5, as well as the SpaceJoist™, TrimTrus™ and FloorTrus™ open web joist products.

The EC5 and National Annex design methods are fully accepted by the NHBC.

Comparison of design analogs between BS5268 and EC5

In our analysis software, the design analog is effectively the model we assume when we design the trussed rafters and open web floor joists.

The significant difference between BS5268 and EC5 is that we must now consider the effect of the nail plate in the design of the joint. In addition to the analysis members along the centreline of the chords and webs, we now introduce small analog members (plate members) into the design of the joint. The plate members basically join the centres of the effective plate area on each timber member to the centreline analog lines of the chords and webs of the truss or joist.

The proposed amendments to the analog representation for EC5 compared to BS5268 is detailed on the following pages.

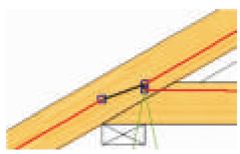
If we consider the ridge joint of a fink truss it can be seen that a small plate member is required to join the centroid of the effective area of the nail plate on the rafter, to the closest point on the centre line analog along the rafter. This plate member is producing eccentricity in the nail plate, requiring the nail plate to carry moment forces in addition to the axial forces currently considered in BS5268. This may require larger nail plates in some cases to carry these additional moment forces. By changing the plate geometry (plate size), or moving a plate away from the centre of a joint, larger eccentricities can be produced, and the moment forces to be carried in the plate will be increased.

Based on the above, changing an individual plate size after a full design process has been carried out could have unexpected results. By changing a nail plate, the analog representation at that joint will also change, and the whole truss would have to be re-designed. In some extreme cases, changing a nail plate may affect the timber sizes of a truss design. Connector plates located close to the centre of the joint of our members are generally desirable as they are unlikely to have any adverse effect on the member design.

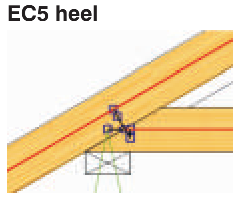
This design representation could also have a dramatic affect on the impact of plate mis-positioning. Consider a quarter point joint on the rafter of a fink truss. Where the nail plate is central on the joint, all the analog members are in direct line. If this plate is positioned off centre, additional plate members will be introduced to join the centroid of the effective areas of the plate back to the centre line of the web and rafters, therefore inducing eccentricities in the plate design. Invariably this will require an increase in plate size. It will no longer be a matter of checking plate area coverage, or counting nails, where a nail plate has been significantly mis-positioned.

DIAGRAM: ANALOG JOINTS IN THE ALPINE VIEW SOFTWARE

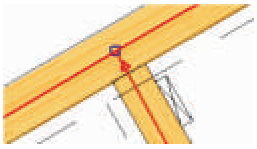
BS5268 heel



EC5 heel



BS5268 1/4 point



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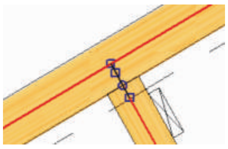
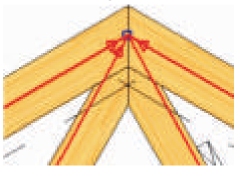
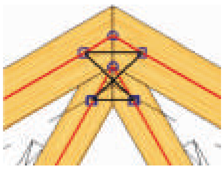


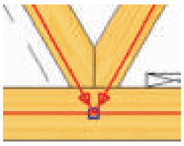
BS5268 ridge



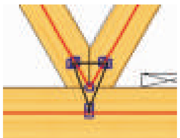
EC5 ridge



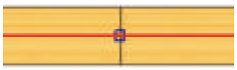
BS5268 1/3 point



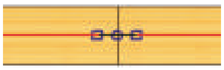
EC5 1/3 point



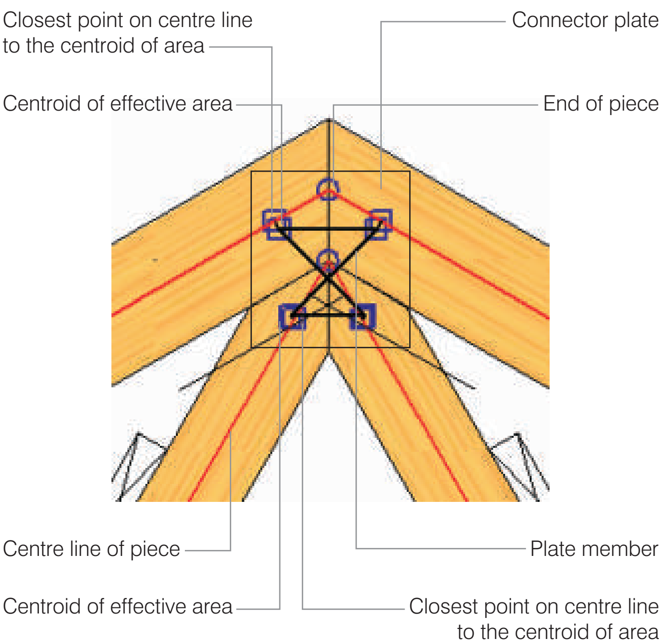
BS5268 1/3 point



EC5 1/3 point



PICTURE: RIDGE ANALOG



Load classifications for trussed rafter design

The load classifications, or actions, for trussed rafter design have been revised to suit the limit state analysis methods. The new action classifications are listed in the NCCI Document PD6693-1-1.

TABLE: SUMMARY OF ACTIONS FOR DUO-PITCH AND MONO-PITCH TRUSSED RAFTERS

Type	Load	Position on trussed rafter	Load duration class
A1	Self weight	Full length of external and internal members	Permanent
A2	Tiles + battens	Full length of top chord	Permanent
A3	Ceiling + insulation	Full length of bottom chord	Permanent
A4	Water tank[1]	At two bottom chord nodes nearest water tank	Long term
A5	Plant & services	As appropriate	Long term
A6	Storage load	Full length of bottom chord	Long term
A7	Snow	Full length of top chord & asymmetrically distributed	Short term
A8	Snow (asymmetrical)	Asymmetrical distributed to either top chord	Short term
A9	Man load top chord[2]	Centre of and each side of any top chord bay and 300mm from the end of unsupported overhangs exceeding 600mm	Short term
A10	Top chord service load	Where the roof is not accessible except for maintenance and repair apply q_k from Table NA.7 of NA to BS EN 1991-1-1 on full length of top chord	
A11	Man load bottom chord	Centre of and each side of any bottom chord bay where clearance is greater than 1.2m	Short term
A11	Wind	Full length of chord including end vertical members which are exposed to wind	Instantaneous

1 Water tank actions can be taken as 2 x 0.45kN for 300 litre tanks or 2 x 0.675kN for 450 litre water tanks. The actual weight of the tanks and their contents should be considered if their capacity exceeds 675 litres.
2 On roof slopes > 30° the man load on the top chord need not be applied.

continued...

The load duration classes are defined as the following, from BS EN 1995-1-1:2004;

TABLE: LOAD-DURATION CLASSES

Load duration class	Order of accumulated duration characteristic load
Permanent	More than 10 years
Long Term	6 months - 10 years
Medium Term	1 week - 6 months
Short Term	Less than one week
Instantaneous	

Please note that the Irish National Annex has slightly different accumulated durations attributed to Short-term and Instantaneous load duration class;
Load Duration class short term has an order of accumulated duration of 3 minutes to 1 week.
Load Duration class instantaneous has an order of accumulated duration of less than 3 minutes.

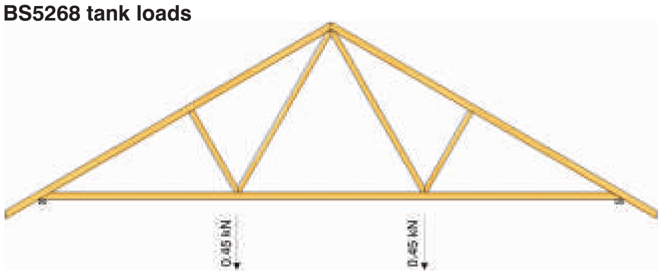
Investigation into water tank loads on trussed rafters

When we apply tank loads in our design software to trussed rafters, the representation of the load applied seen on the structural calculations will be different to the actual load applied.

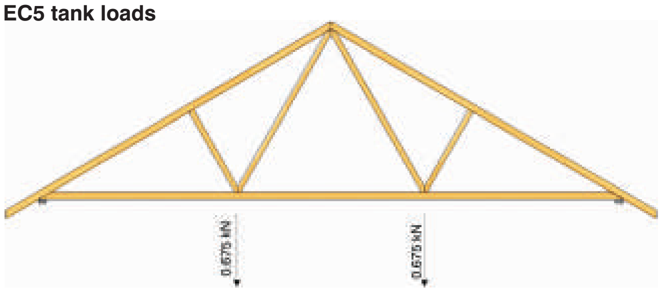
Water Tank loads are classed as variable actions, and have an 'unfavourable' effect in the design of the trussed rafters, in accordance with BS EN 1990:2002. As such, the design loadings are modified in accordance with γQ partial safety factor for variable loads for design purposes. The value of γQ is 1.5 on this occasion.

DIAGRAM: TANK LOADING

BS5268 tank loads



EC5 tank loads



Please note that when considering tank loads, the basic unmodified point loads applied to the adjacent truss nodes can be taken as 0.450 kN for 230 Litre and 300 Litre water tanks, and 0.675 kN for 450 Litre water tanks, where the water tanks are supported as per Figure B1 in the NCCI document PD6693-1-1 (refer to footnote to Summary of actions for Duo-Pitch and Mono-Pitch Trussed Rafters on previous page). As such if you consider a 450 Litre water tank, the loading applied to the adjacent nodes in the structural calculations would be 0.675 x γQ = 0.675 x 1.5 = 1.013 kN.

BS EN 14250:2010

This document is the code of practice for Timber Structures – Product requirements for prefabricated structural members assembled with punched metal plate fasteners. This provides guidance on the fabrication of trussed rafters and similar products, and provides guidance similar to that outlined in BS5268:Part 3.

Most of the guidance provided in this document is similar to that outlined in BS5268:Part 3, with the following significant differences;

Clause 4.1.1 – The limits for maximum bow in members used in fabrication have been tightened to 6mm per 2m length. The limits for maximum twist have been relaxed to 2mm per 25mm width per 2m length.

Clause 5.4.11 – The rules on allowable gaps between the underside of nail plate and timber has been tightened to maximum 1mm for all cases.

Clause 6.1 – Product Documents. This states that adequate drawings and written instruction should be provided with the products relating to their transport, handling, storage, erection, positioning and internal bracing, together with any fixing details necessary to construct compound or multi-part structures.

Clause 7.3.1 – Factory production control. This states that the manufacturer shall establish a factory production control system, and lists the minimum requirements of such a system. It also states that a system conforming to EN ISO 9001 will be considered satisfactory, when made specific to the standards of the full BS EN 14250:2010 document. These standards include Daily Controls, Weekly Controls, Regular Controls and the keeping of records.

EUROCODE 5 & FASTENERS

>

Eurocode 5 & fasteners

A range of standards have been created to supplement the rules of EC5 with more specific detail.
Concerning fasteners two standards are particularly relevant;-

- EN14592 Dowel type fasteners (nails, staples, screws)
- EN14566 Gypsum fasteners

Where fasteners are used to attach 3D connectors, such as joist hangers, (approved for CE marking under ETAG015) more specific test rules have been established by a CUAP (Common Understanding on Assessment Procedure) to allow these to be CE marked and approved for this application.

These standards allow the possibility of CE marking fasteners, but more importantly set Europe wide rules on the way fasteners are described, test methods, expression of results and quality control procedures to be followed to provide comparable data for use in structural calculations (EN14592) or to provide full and comparable data and ensure environmental considerations are met (EN14566). CE marking is intended to provide a standard Europe-wide process whereby a product can be deemed to be safe and fit for a specific purpose.

EN14592

It is important to note that the scope and important elements of EN14592 are already being discussed with a view to revision. However, it still creates a basis for providing fastener performance data to input into EC5 calculations. Significant changes from BS5268 are;-

- Provision is made for the use of nails from 1.9mm to 8.0mm in diameter (BS5268 only detailed nails from 2.7mm to 8.0mm diameters)
- Default calculation performances are allowed for some applications, but not for others. Particularly for applications where the fastener must withstand axial loading, performance data must be based on testing under controlled conditions. (BS5268 treated fasteners as generic, whereas EC5 recognises that performance is specific to the design, manufacture and material of individual fasteners.)
- EN14592 recognises that in some markets staples have been widely used for some structural applications for many years. It provides the opportunity to consider these as alternatives to nails or screws. (BS5268 did not include staples)
- BS5268 does not concern itself with head pull-through as a mode of failure for fasteners. EC5 calculations require data to be inputted on this, recognising that it can be a significant performance limiting factor.
- Essentially EN14592 reflects the advances in formalising technical understanding of how fasteners function in timber structures and recognises the need to treat these as specific technical components, the quality of which can affect the structural integrity of timber buildings.

The scope of EN14592 does not yet include resin coated fasteners, however it is expected that the scope will be extended to include resin coatings which are applied to improve driveability, increase withdrawal resistance or to retain fasteners within a collation. It is therefore currently not possible to CE mark most fasteners used for structural timber to timber connection, but where performance values are required for structural calculations, ITW believes the requirements of EN14592 coupled with product testing at accredited test centres provide a suitable basis for obtaining these values.

EN14566

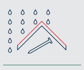
As fasteners for attaching gypsum based boards are not usually considered structural the level of testing and control is considerably lower to obtain a CE mark under this standard. However, where they are used for structural applications it is both necessary and possible for the same fastener to be certified under both standards. ITW Industry offer a wide range of CE marked staples, nails and screws in compliance with EN14566, which has now come into force in the UK and Eire.

Service Class / Environment – choice of corrosion protection

Corrosion Resistance

Paramount in determining the appropriate corrosion resistance of any element of a timber structure is the EC5 requirement to design for a minimum life, normally 50 years (10 years for temporary structures, 100 years for monumental structures or bridges). Eurocode 5 provides three Service Classes, relating to the moisture content of timber. Within EN14592 minimum standards are set for fastener materials and coatings;-

TABLE: SERVICE CLASSES

	Eurocode 5 Service Class[b]		
	1	2	3
Average moisture content in softwood	≤ 12%	≤ 20%	> 20%
Fastener			
Nails and screws with diameter ≤4mm	None	Fe/Zn 12c[a]	Fe/Zn 25c[a]
Nails and screws with diameter <4mm	None	None	Fe/Zn 25c[a]
Staples	Fe/Zn 12c[a]	Fe/Zn 12c[a]	Stainless steel

a If hot dip zinc coating is used, Fe/Zn 12c should be replaced by Z275 and Fe/Zn 25c by Z350 in accordance with EN10147.
b For more corrosive conditions, heavier hot dip coatings or stainless steel may be necessary.

It is important to note that these Service Classes do not specifically take into account:

- local environmental conditions
- the interaction between some specific wood types and certain metals or coatings
- the interactions between timber treatments, climatic conditions and fastener material or coating

The following pages cover the practical choice of fastener material / coating.

We strongly recommend reference to ISO12944 part 2 which deals with the life expectancy of various metals and coatings under a variety of environmental conditions:

TABLE: ENIRONMENTAL CLASSIFICATION

Environmental classification	Typical conditions (temperate climate)
C1	Inside heated or air-conditioned buildings with clean atmosphere, low relative humidity and no likelihood of damp or condensation.
C2	Internal occasional damp or wet conditions, unheated buildings where condensation may occur. External environment with low level of pollution and dry climate, mostly rural areas, sheltered conditions.
C3	Urban and industrial environments, moderate sulphur dioxide pollution. Coastal areas with low salinity.
C4	Industrial areas with high sulphur dioxide and coastal areas with moderate salinity.
C5	Industrial areas with high humidity and aggressive atmospheres. Coastal areas with high salinity.

To help in the choice of fastener coating, the fasteners offered by ITW Industry feature colour coded labels detailed on the following page.

It is also necessary to consider wood treatments and wood species as these can react with different coatings. For instance, it is always recommended to use stainless steel fasteners to attach Western Red Cedar, Douglas Fir and Oak cladding.

Colour code

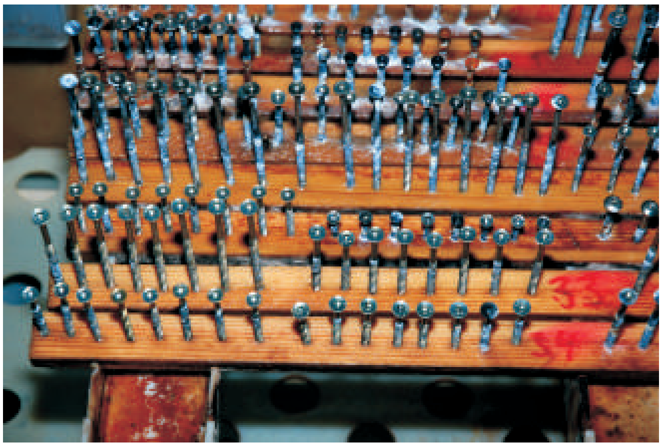
To help in the choice of fastener coating, the fasteners offered by ITW Industry under the Paslode, DuoFast and Haubold brands utilise the following colour codes on product labels. We are in the process of implementing the same colour code for nail plates and connectors, to help ensure the correct combinations are used. To avoid bimetallic corrosion, stainless steel and mild steel should never be placed in contact with each under Service Class 2 or Service Class 3 conditions.

TABLE: COLOUR CODE

Bright steel = no corrosion protection*
Meets Eurocode 5 Service class 1 requirements for nails in dry internal locations.
Electro galvanised 5μm
Meets Eurocode 5 Service Class 1 requirements for nails. Typical life in C2 environmental class is 7 years or 2.5 years in C3.
Electro galvanised 12μm
Meets Eurocode 5 Service Class for nails and staples. This is the minimum protection for staples, even in Service Class 1. Typical life in C2 environmental class is 17 years or 6 years in C3.
GalvPlus®
Exceeds Eurocode 5 Service Class 2 requirements for both nails and staples. Typical life in C2 environmental class is 28 years or 10 years in C3. GalvPlus® is an ITW developed coating combining zinc and aluminum which is applied to wire to a minimum thickness of 15μm before nails are manufactured.
Hot dipped galvanised
Fasteners are dipped in a bath of molten zinc to achieve minimum coating of 55μm. Meets Eurocode 5 Service Class 3 requirements. Typical life in C2 environmental class is 70 years or 25 years in C3.
Stainless Steel A2-304
Meets Eurocode 5 Service Class 3 requirements. Will provide over 50 years life in C3 environment. Superficial discolouration can occur. To avoid this select A4-316.
Stainless steel A4-316
Meets Eurocode 5 Service Class 3 requirements. Suitable for C4 and C5 environmental classes. Will not discolour.

* The NHBC has issued guidance that even under Service Class 1 conditions they believe all fasteners should have some protective coating.

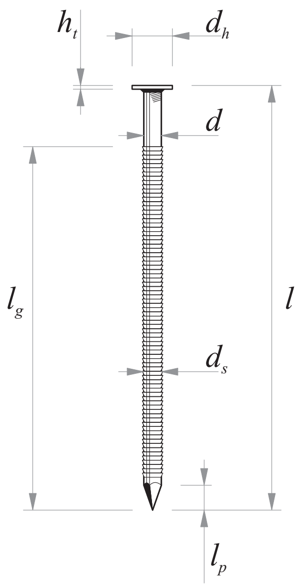
PICTURES: SALT SPRAY TEST CABINETS AT ITW WOOD FASTENER R & D



Fastener types and dimensions as detailed in EN14592

EN14592 is only concerned with fasteners within the parameters detailed on these pages. Other wood fasteners cannot be CE marked under these rules and for their performance to be accepted under Eurocode 5 they would need to be tested and certified through a specific ETAG or CUAP, such as exists for fasteners used to attach steel plate connectors including joist hangers. EN14592 also sets out the procedures by which initial type testing and factory production control should be carried out. ITW carries out initial type testing at several European independent test centres which specialise in timber engineering.

DIAGRAM: DIMENSIONAL RULES FOR NAILS WITH SMOOTH AND PROFILED SHANKS

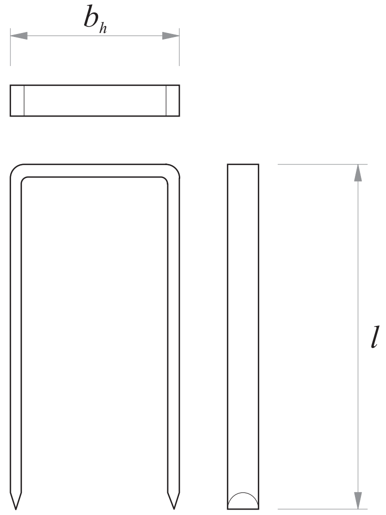


d = nail diameter (measured as original wire diameter), between 1.9 and 8.0mm
ds = maximum diameter of profile
l = total length of nail
l_g = profiled section (ring / screw shank nails) must be at least 6 x d in length. Only this profiled section is considered capable of withstanding permanent or long term withdrawal loads.
h_t = head thickness, must be at least 0.25 x d
d_h = head diameter. Surface area of the head Ah must be ≥ 2.5d^2
l_p = Nail tip length must be between 0.5 and 1.5d

EN14592 also details the allowable tolerances for these dimensions and stipulates minimum tensile strength of original wire as 600 N/mm^2.

n.b. for a nail to be defined as a threaded nail (and therefore considered capable of resisting a long term or permanent withdrawal load) characteristic withdrawal parameter $f_{ax,k}$ must be at least 4.5 N/mm^2 when measured on timber with a characteristic density of 350kg/m^3 when conditioned to constant mass at 20°C and 65% relative humidity.

DIAGRAM: DIMENSIONAL RULES FOR STAPLES WITH ROUND, SQUARE OR OVAL LEGS

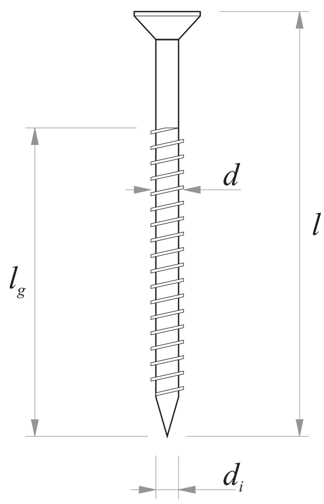


d = leg diameter (measured as original wire diameter), between 1.47 and 2.02mm. For staples with rectangular cross section, the leg diameter shall be taken as the square root of the product of both dimensions.
l = total length of staple
b_h = staple crown width (measured between outer edges of staple legs) must be ≥ 6d

EN14592 also details the allowable tolerances for these dimensions.

It also stipulates minimum tensile strength of original wire as 800 N/mm^2.

DIAGRAM: DIMENSIONAL RULES FOR SCREWS WITH SHARPLY FORMED OR CUT THREADS



d = screw diameter (outside diameter of thread), between 2.4 and 24.0mm

d_i = inner thread diameter of screw must be between 0.6d and 0.9d

l = total length of screw

l_g = threaded section of screw must be at least 6d in length

EN14592 also details the allowable tolerances for these dimensions.

Fastener spacing as detailed in EN1995-1-1

Because timber is a natural material, subject to considerable variation, it is necessary to take particular care to consider the individual timber when determining how closely fasteners may be spaced to each other or to the edges of timber. The following are absolute minimum distances. Performance will be severely diminished where timber is split and care must be taken to avoid this.

Special rules for laterally loaded connections

Smooth nails and staples in end grain should not be considered capable of transmitting lateral forces. Under certain conditions other fasteners may be allowed.

Special rules for axially loaded connections

Smooth nails or staples shall not be used to resist permanent or long term axial loading! For threaded nails only the threaded part should be considered capable of transmitting axial load. Nails in end grain should be considered incapable of transmitting axial load

Fastener minimum spacing rules

Fastener minimum spacing rules for timber density $\rho_k \leq 420$ kg/m^3 without pre-drilling. For nails < 5.0mm and screws < 6.0mm diameter. Minimum angle of staple crown to grain = 30°

TABLE: LATERAL LOADS

Lateral loads	Nails		Staples	Screws
	Smooth	Threaded		
Penetration in pointside timber	8d	6d	14d	4d
Minimum distance to loaded edge of member	7d	7d	20d	7d
Minimum distance to unloaded edge of member	5d	5d	10d	5d
Minimum distance to loaded end of member	15d	15d	10d	5d
Minimum distance to unloaded end of member	10d	10d	15d	10d
Minimum spacing of fixings parallel to grain	10d	10d	15d	10d
Minimum spacing or fixings 90° to grain	5d	5d	15d	5d

TABLE: AXIAL LOADS

Axial loads	Nails		Staples	Screws
	Smooth	Threaded		
Penetration in pointside timber	12d*	8d	14d*	6d
Minimum distance to unloaded edge of member	5d	5d	10d	4d
Minimum distance to unloaded end of member	10d	10d	15d	10d
Minimum spacing of fixings parallel to grain	5d	5d	10d	7d
Minimum spacing of fixings 90° to grain	5d	5d	15d	5d

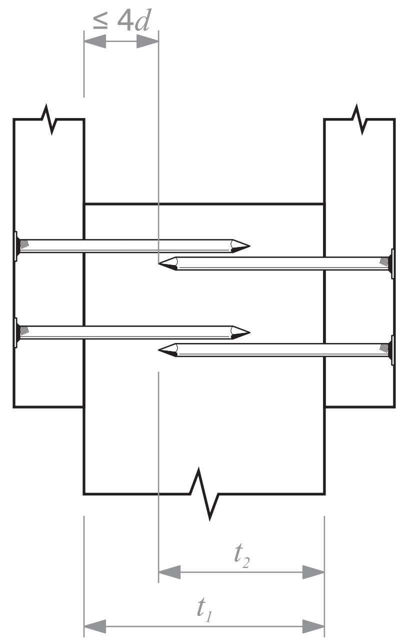
* Only for medium-term, short-term and instantaneous loads

Timber should be pre-drilled in any of these cases:

- where the characteristic density of the timber is greater than 500 kg/m³
- where the diameter of the nails exceeds 6 mm
- where the thickness of the member is smaller than

$$t = \max \left\{ \begin{array}{l} 7d \\ (13d - 30) \dfrac{\rho k}{400} \end{array} \right\}$$

Some timber species are more prone to splitting than others, for these minimum spacings should be increased or holes pre-drilled; for example Fir, Douglas Fir and Spruce.



Fastener spacing for floor, roof and wall diaphragms

Number of fasteners required to provide sufficient rigidity in these elements must be calculated using alternative methods detailed in Eurocode 5 and the National Annex, but should always be subject to the minimum spacings shown on previous page and these maximum spacings:

	Threaded nails	Smooth nails for walls only	Screws for walls
Along the edges of the sheathing panels	150mm	150mm*	200mm
Internal studs and elsewhere	300mm	300mm*	300mm

* Smooth nails may be used for all lateral loads, but only for medium-term, short-term and instantaneous axial loads

Fasteners used in panel-to-timber connections are to be considered as relating to an unloaded edge.

Nailing into a timber member from both sides

In a three-member connection, nails may overlap in the central member provided $(t_1 - t_2)$ is greater than $4d$.

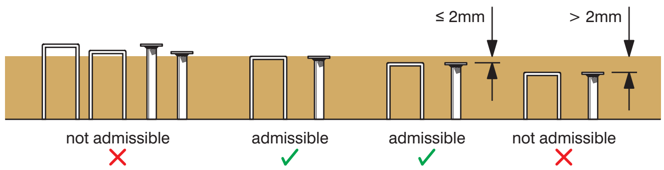
Fastening timber members

Unless otherwise specified, nails should be driven in at right angles to the grain and to such depth that the surfaces of the nail heads are flush with the timber surface.

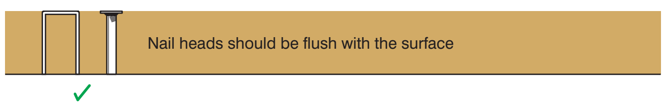
Fastening wood based boards, such as OSB, plywood etc…

It is recommended that fastener head should not penetrate deeper than 2mm into the connected panel or board. Board manufacturers' instructions should be adhered to.

HEADSIDE PENETRATION FOR WOOD-BASED BOARDS



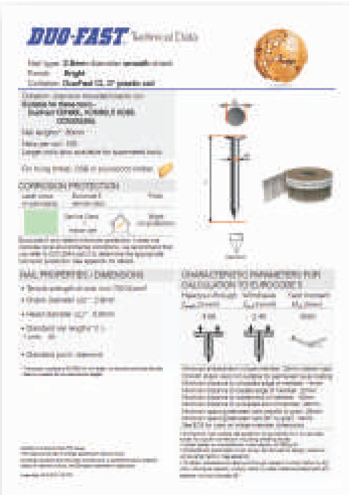
TIMBER-TO-TIMBER CONNECTIONS



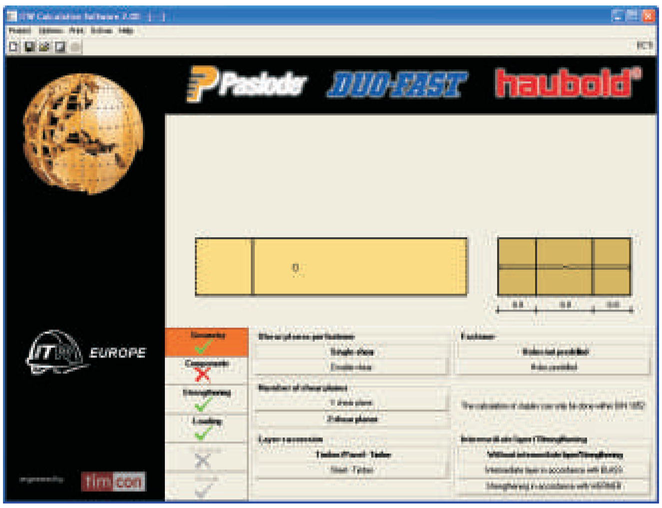
Fastener performance for EC5 calculations

ITW Industry is in the process of publishing datasheets on all structural fasteners, to provide the necessary input data for calculation to EC5 rules along with fastener calculation software. These will be available for download from www.itw-industry.com or through Customer Services on +44(0)1792 563540.

PICTURE: NAIL DATA SHEET



PICTURE: FASTENER CALCULATION SOFTWARE



Part of the process of obtaining the right to CE mark fasteners for structural timber connections is carrying out independent testing to ascertain these performance characteristic design values;- withdrawal, head pull-through and yield moment. More information on these and their use is given in the datasheets and the appropriate appendix for each fastener range.

Nails and staples

There must always be at least two nails or staples in any connection.

Staples and smooth shank nails must not be used to resist permanent or long term axial loading!
For threaded nails only the threaded part should be considered capable of transmitting axial load
Nails and staples in end grain should be considered incapable of transmitting axial load.

Screws

In addition to requirements for provision of characteristic head pull through, withdrawal and yield moment capabilities, to ensure that the head of the screw will not be stressed close to failure a safety ratio between the characteristic torsional strength, $f_{tor,k}$ and the torsional resistance to insertion in timber, $R_{tor,k}$ must be maintained such that: $f_{tor,k} \geq 1.5\, R_{tor,k}$

All fasteners

For structural timber which is installed at or near fibre saturation point, and which is likely to dry out under load, the values should be multiplied by 2/3.

continued...

Characteristic vs. design values

The load parameters stated in the Technical Data Sheets are characteristic values. These values shall always be used in accordance with the partial factor method as described in Eurocode 5. With the partial factor method security is built into the construction as:

1. Security on the load parameters
2. Security on the material parameters

The design value of a nail is found by the following expression:

$$Xd = k_{mod} \frac{X_k}{\gamma M}$$

d = design value, parameter or load

k_{mod} = modification factor taking the load duration and service class (moisture content) into consideration, e.g. for solid timber, service class 1, permanent action is 0,60

γM = the partial factor for a material property – e.g. for fastener connections is 1,3 (see National Annex for partial factors for material properties and resistances)

X = can be expressed by e.g. a load carrying capacity (R) or a force (F)

TABLE:
VALUES FOR k_{mod} FOR SOME COMMON MATERIALS

Material	Service Class	Permanent action	Long Term action	Medium Term action	Short Term action	Instantaneous action
Timber, Glulam & LVL	1	0.60	0.70	0.80	0.90	1.10
	2	0.60	0.70	0.80	0.90	1.10
	3	0.50	0.55	0.65	0.70	0.90
Plywood	1	0.60	0.70	0.80	0.90	1.10
	2	0.60	0.70	0.80	0.90	1.10
	3	0.50	0.55	0.65	0.70	0.90
OSB/2	1	0.30	0.70	0.65	0.85	1.10
OSB/3	1	0.40	0.50	0.70	0.90	1.10
OSB/3	2	0.30	0.40	0.55	0.70	0.90
OSB/4	2	0.30	0.40	0.55	0.70	0.90

For other board types see EC5 Table 3.1

Correction of fastener performance to timber density

Density correction

The density of all the test results has been reduced according to EN28970. Use the expression.

$$\left[\frac{\rho k}{350}\right]^2$$

to correct between actual characteristic timber density and a characteristic density of 350 kg/m3 ;-

ρk is the actual characteristic wood density

Thereby ρk is limited for panels to 380 kg/m³ and for timber to 500 kg/m³.

Example calculation:
Characteristic withdrawal force = 1500 N
Actual characteristic timber density = 310 kg/m³
The withdrawal force should be modified by a factor of = 0,78
=> The characteristic withdrawal force is 1500 x 0,78 = 1170N

Strength classes and timber densities

TABLE: STRENGTH CLASSES – CHARACTERISTIC DENSITIES ACCORDING TO EN 338

Strength class	C14	C16	C18	C20	C22	C24	C27*	C30	C35	C40
Characteristic density p_k[kg/m³]	290	310	320	330	340	350	370	380	400	420
Mean density p_{mean}[kg/m³]	350	370	380	390	410	420	450	460	480	500

Note: The number following the "C" is the bending strength of the wood, $f_{m,k}$ in N/mm².
*C27 can be used when determining nail values for fixing into TR26.

TABLE: TYPICAL DENSITIES FOR CONSTRUCTION WOOD, NORTHERN EUROPE (SOURCE: TEKNOLOGISK INSTITUT, DENMARK)

Wood	Density min-max [kg/m^3]
European spruce	370 – 440
Douglas fir	440 – 530
Larch	520 – 600
Red cedar	380
Pine	450 – 500

For further values and hardwood species, see EN 338

Fastener (Anchor nail) performance for attaching timber connectors

The method for obtaining the right to CE mark fasteners to confirm that they are suitable for use in fastening 3D timber connectors is a Common Understanding of Assessment Procedure (CUAP); "Annular ring shank nails and connector screws for use in nailing plates and three-dimensional nailing plates in wood structures." (3D timber connectors themselves are CE approved under ETAG015). ITW has carried out the appropriate testing and anticipates approval being granted and datasheets being published detailing performance by the end of May 2010.

The scope of this approval is for nails from 2.5mm diameter x 35mm length up to 6.0mm x 100mm and for screws from 4.0mm diameter x 30mm length up to 5.0mm x 50mm. Testing is carried out at an independent, accredited laboratory using a methodology to determine the characteristic behaviour of these fasteners in attaching steel plate connectors to timber. The requirements stated for both nails and screws are:

- Lateral load carrying capacity and withdrawal capacity should be determined by tests or calculation according to Eurocode 5 (which refers to the relevant test standards) Both values shall be given in the ETA.
- The tensile capacity (head tear-off or tear-off in the area of thread) should be determined according to EN 1383 and declared.
- The torsional strength of screws shall be determined according to EN 14592 and shall comply with the requirement of the same standard. This ensures that the head of the screw will not be stressed close to failure by demanding a ratio between the characteristic torsional strength, $f_{tor,k}$ and the torsional resistance to insertion in timber, $R_{tor,k} \geq 1.5$.
- The corrosion protection shall be in accordance with Eurocode 5 (according to the relevant service class).

In addition to the performance of these fasteners in situ, the method of their installation must be considered. ITW manufacture both pneumatic and gas powered tools specific to this task. These feature noses with the ability to locate holes in connector plates. Furthermore, where appropriate we harden and temper these nails to minimise risk of injury even when the operator fails to locate the centre of pre-punched holes and the fastener is accidentally fired into the steel itself. (To achieve published connector performance, nails should always be correctly located in appropriate holes, following manufacturer's instructions).

PICTURE: ALL COMPONENTS OF A SYSTEM CONTRIBUTE TO PERFORMANCE

EUROCODE 5 & CULLEN CONNECTORS

>

Eurocode 5 & Cullen connectors

Eurocode 5, European Technical Approvals and Load Tables

Eurocode 5 (BS EN1995-1-1)

From March 2010 the present British Standards relating to Timber design will be withdrawn and replaced with the new harmonised European design standards Eurocodes. The purpose of the Eurocodes is to establish a common set of standards for the design of buildings across all European member states, although each member can have its own National Annex which is used in conjunction with the Eurocodes for design.

European Technical Approvals (ETAGs)

Previously in the UK all timber to timber connectors were tested in accordance with the TRADA proposed test arrangement detailed in TRADA Technology's research report number 115/06. With the introduction of Eurocodes all hangers have to meet the requirements of the new method detailed in ETAG015 for 3 dimensional nailing plates. ETAG015 sets out 3 methods for determining the characteristic capacity of hangers etc.

1 Calculation
2 Calculation assisted by testing
3 Testing

The method which Cullen has used at present is by Testing only which has been carried out by an independent UKAS accredited testing lab and submitted for European approval by an approved notified body BBA. As part of the process the ETA report is circulated round all European member states for a 2 month period and once complete allows the products to be CE marked. Masonry hangers are slightly different where these are tested by an independent accredited test lab to meet the requirements of BS EN845-1 & BS EN846-8 also enabling them to be CE marked.

Load Tables

In the UK, timber design is currently carried out to BS 5268-2:2006 which is based on permissible stress design, EC5 is based on limit state design. The following table is an extract from the Cullen brochure stating two different sets of values:

1 Safe working loads – permissible values calculated to BS 5268-2:2006 and have factors of safety applied to them e.g. Long Term – 2.4, Medium Term – 2.1 and Short Term – 2.0
2 Characteristic hanger capacity – are based on ultimate limit states and are unfactored.

EXAMPLE TABLE

Product code	Dimensions			Fixings (3.75 x 30mm)		
	W	H	B	Face	Back / top	Joist
U-50-195	50	195	50	6	2	2

TABLE: PERMISSIBLE VALUES CALCULATED TO BS 5268-2-2006 MODIFIED BY SAFETY FACTORS

Safe working loads - kN			
Uplift	Header specification		
	Open web	Glulam (min GL28)	LVL to LVL
0.85	5.18	7.88	9.47

TABLE: CHARACTERISTIC CAPACITY VALUES UNFACTORED

Safe working loads - kN			
Uplift	Header specification		
	Open web	Glulam (min GL28)	LVL to LVL
1.19	8.37	12.93	11.21

continued...

What does this mean for our products? - Timber to timber connectors

In addition to publishing safe working loads that have already been factored down, Cullen will be publishing characteristic values for each product. The characteristic values is the lower 5th percentile obtained from the test results. A series of modification factors must be applied to the characteristic value to calculate the design value.

$$\text{Design Value} = \frac{(F_k \text{ x } k_{mod})}{\gamma M}$$

F_k = characteristic value

K_{mod} = Modification factor for duration of load and moisture content (EN1995-1-1 table 3.1)

γM = Partial factors for material properties and resistances (1.3 for connections EN1995-1-table 2.3)

PICTURE: WORKED EXAMPLE FOR SPACEJOIST

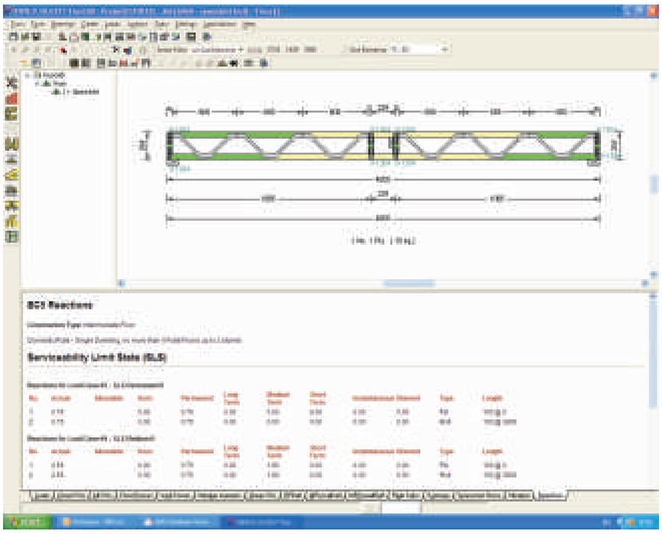


TABLE: U-HANGER CHARACTERISTIC CAPACITY FOR OPEN WEB HEADER 8.37kN

Design value (medium term action)	=	$\frac{8.37 \text{ x } 0.8}{1.3}$	=	5.15kN

SpaceJoist reaction for ULS medium term 3.72kN <u>As the Design Value exceeds the joist reaction this hanger is acceptable.</u>

What does this mean for our products? Timber to masonry connectors

All masonry hangers are tested to the requirements of BS EN846-8 and declared value is determined to BS EN845-1, the declared value is the lower of the mean ultimate and the load at 2mm deflection multiplied by 3. "The declared vertical load capacity can be considered as a characteristic strength for use in design."

$$\text{Design Value} = \frac{F_k}{\gamma M}$$

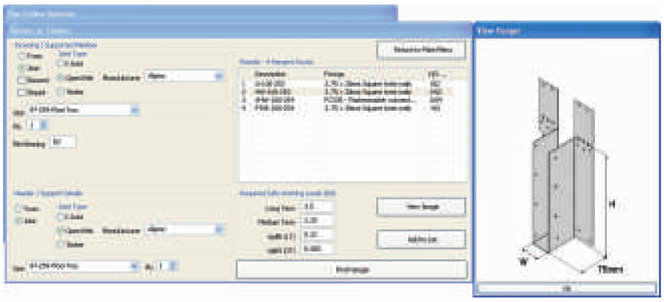
F_k = characteristic value

γM = Partial factors for material properties and resistances (1.5 for masonry – BS EN845-1)

Cullen Product Selector

The Cullen product selector is a fast and efficient software package, which allows you to determine the exact connection detail you require to EC5 requirements. The software is available to download from www.cullen-bp.com

PICTURE: THE CULLEN SELECTOR



Further reading

Trada Construction Briefings – Embracing Eurocode 5
http://www.trada.co.uk/downloads/constructionBriefings/Embracing%20EC5%20CB.pdf

Scottish Building Standards
The latest updates and consultations are at: www.sbsa.gov.uk/latestupdates/consul_structure09.htm

A draft of Annex B for domestic buildings is at:
www.sbsa.gov.uk/pdfs/Consult_Struct_ANNEXB.pdf

A draft of Annex C for non-domestic buildings is at:
www.sbsa.gov.uk/pdfs/Consult_Struct_ANNEXC.pdf

Eurocodes expert:
www.eurocodes.co.uk

The Institution of Structural Engineers:
www.istructe.org

BSI Eurocodes:
http://shop.bsigroup.com/en/Browse-by-Subject/Eurocodes/?t=r

“Practical design of timber structures to Eurocode 5"
by Hans Larsen and Vahik Enjily, published by Thomas Telford ISBN 978-0-7277-3609-3

References

Eurocodes Expert
www.eurocodes.co.uk

Eurocodes Briefing
http://www.ice.org.uk/downloads//Eurocodes%20briefing.pdf

BSI Structural Eurocodes Companion
www.bsigroup.com/standards

Eurocode 5: Design of timber structures BS EN 1995
http://shop.bsigroup.com/en/Browse-By-Subject/Eurocodes/Descriptions-of-Eurocodes/Eurocode-5/

Irish Eurocode
http://www.nsai.ie/Our-Services/Standardization/About-Standards/Eurocodes.aspx

Trada construction briefings
http://www.trada.co.uk/downloads/constructionBriefings/Embracing%20EC5%20CB.pdf

Wikipedia
http://en.wikipedia.org/wiki/Limit_state_design#Ultimate_Limit_State

National Roads Association (NRA)
http://www.nra.ie/Publications/DownloadableDocumentation/RoadDesignConstruction/file,11473,en.pdf

“Practical design of timber structures to Eurocode 5"
by Hans Larsen and Vahik Enjily, published by Thomas Telford. ISBN 978-0-7277-3609-3

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