# COMPOSITE WOOD-CONCRETE FLOORS

## CTL BASE
## dowel and crampon connectors

ETA 18/0649
DoP: 18/0649

AVIS TECHNIQUE

## CTL MAXI
## dowel and crampon connector

ETA 18/0649
DoP: 18/0649

AVIS TECHNIQUE

TECNARIA®

# FLOOR STRENGTHENING

# TECNARIA MODERN STRENGTHENING SYSTEMS





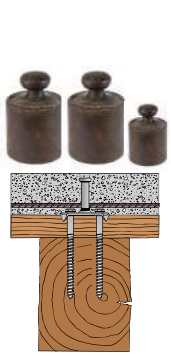
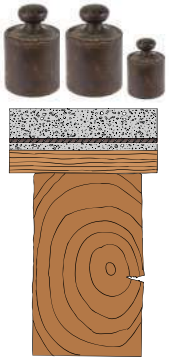

## THE SOLUTION TO A PROBLEM

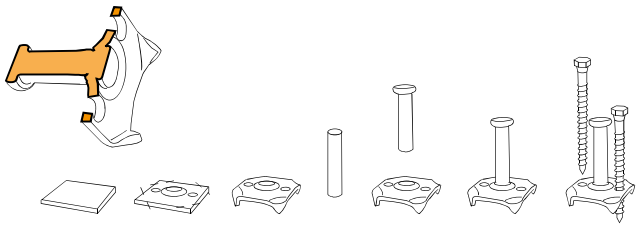
**Old timber floors** often need strengthening and stiffening as they were designed to bear moderate loads and almost always suffer from excessive deflections with respect to current requirements.
Intervening with load-bearing concrete is an optimum solution as it allows the existing floor to be reused rather than replaced, with only a modest change in the existing floor thickness.

**New timber floors** must be made with larger section beams than traditional ones if they are to be sufficiently strong and stiff. In both cases, the most convenient and easiest of solutions is to lay and connect a thin concrete slab, adequately reinforced, over the existing structure either to strengthen and stiffen existing timber floors or to allow shallower beams to be used when building new floors.
The composite wood and concrete system can also be used to make flat or pitched roof structures.
Dowel and crampon connectors placed between the timber beams and the concrete slab make the two materials collaborate with each other, resulting in a structurally efficient structure in which the concrete is mainly under compression and the timber mainly under tension.
The composite timber-concrete structure will therefore be **stronger and stiffer** than a simple timber structure. There will also be an improvement in the dynamic behaviour with less **vibrations**, a better value of **acoustic insulation** and **thermal inertia**. The addition of a concrete slab is an excellent technical solution in masonry buildings located in **seismic areas** since it enables load bearing walls to be connected to each other through a rigid floor which distributes horizontal seismic forces more easily. The weight of composite wood and concrete floors is also much less than standard solutions, making them preferable in seismic areas. TECNARIA dowel and crampon connectors have been specially designed and widely tested to join timber structures to concrete slabs.

The connector's function is assured by the strong base plate, supporting the dowel, which is toothed with crampons to improve its grip on the wood and to provide a better shear stress absorption. Numerous laboratory tests have demonstrated the absolute efficacy of this solution. The base plate remains firm and avoids any play of the screws, which is almost inevitable when common screws or nails are used as connection systems. Nails, screws and crampons, old and tested elements, now have a new task.

Fastening is completely mechanical, no resins or chemical additives are required. This makes the connection process fast, economic, clean and reversible.

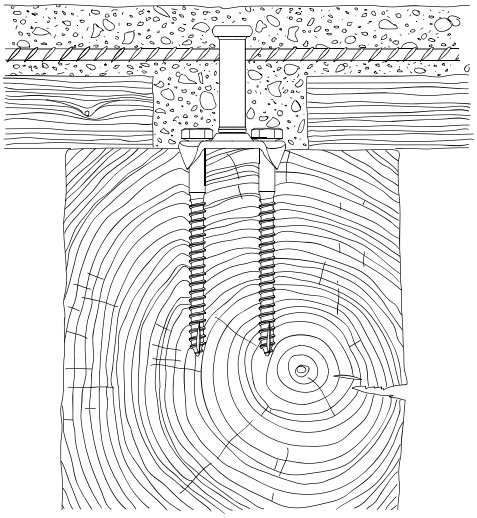
| Beam sec. 12x20 cm **not connected** bearing capacity 280 kg/m² | Beam sec. 12x20 cm **connected** bearing capacity 700 kg/m² | Beam sec. 12x28 cm **not connected** bearing capacity 700 kg/m² |
|---|---|---|
|  |  |  |
| | bearing capacity: 250 % | height: 140 % |



The most obvious advantages for composite timber-concrete structures can be seen in a greater load-bearing capacity, a lower total height of the floor structure, greater rigidity, and improved fire resistance.

The example on the left shows the different bearing capacities of the beams at fixed deformation level.

# BASE connector base plate 50x50 mm screws Ø 8 mm



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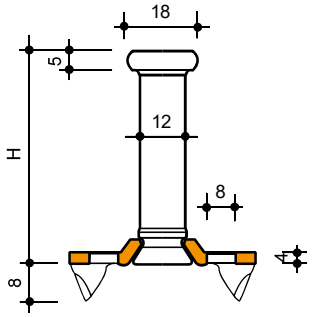
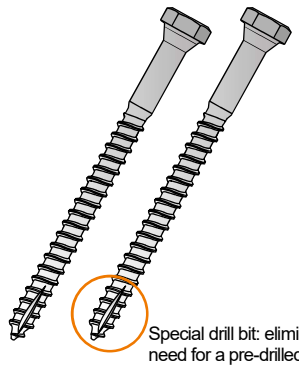
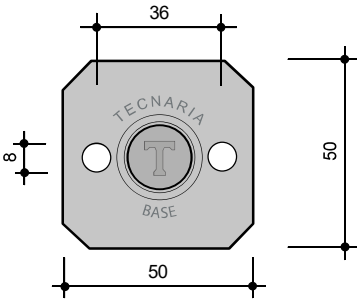





Special drill bit: eliminates the need for a pre-drilled hole.

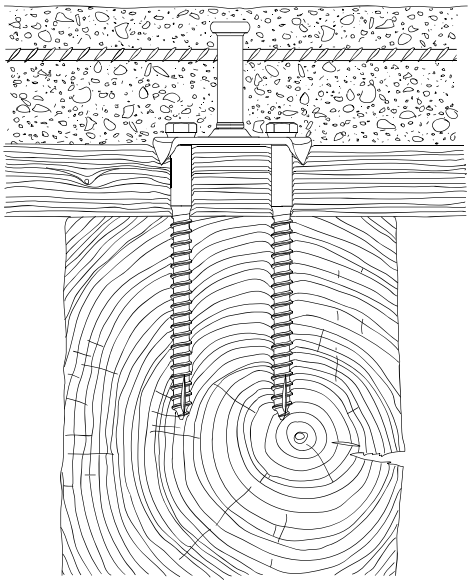
**Specifications:** dowel connector comprising a 50x50x4 mm base plate with crampons and two holes for 8 mm diameter screws with tapered necks and a 12 mm diameter zinc coated dowel, riveted to the plate. Available dowel heights: 20, 30, 40, 60, 70, 80, 105, 125, 150, 175 and 200 mm. Available screw lengths: 70, 100 and 120 mm. CE certified.

Mechanical values of the connector

| Connector | Boarding | Timber | Characteristic resistance $F_{v, Rk}$ | Slip modulus under service load $K_{ser}$ | Slip modulus under ultimate load $K_u$ |
|---|---|---|---|---|---|
| | cm | | kN | kN/mm | kN/mm |
| BASE | 0 | C16, GL24 and + | 17,20 | 17,90 | 9,99 |
| | 0 | D30 and + | 19,50 | 16,50 | 9,87 |
| | 2 | C16, GL24, D30 and + | 8,96 | 4,00 | 2,49 |
| | 4 | C16, GL24, D30 and + | 5,86 | 1,43 | 1,20 |

| Code | Dowel heights |
|---|---|
| CTLB020 | 20 mm |
| CTLB030 | 30 mm |
| CTLB040 | 40 mm |
| CTLB060 | 60 mm |
| CTLB070 | 70 mm |
| CTLB080 | 80 mm |
| CTLB105 | 105 mm |
| CTLB125 | 125 mm |
| CTLB150 | 150 mm |
| CTLB175 | 175 mm |
| CTLB200 | 200 mm |

# MAXI connector base plate 75x50 mm screws Ø 10 mm



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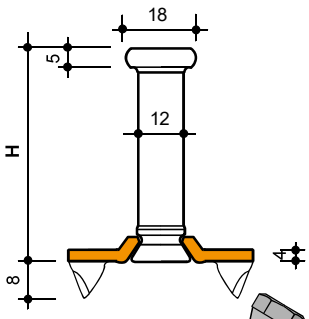
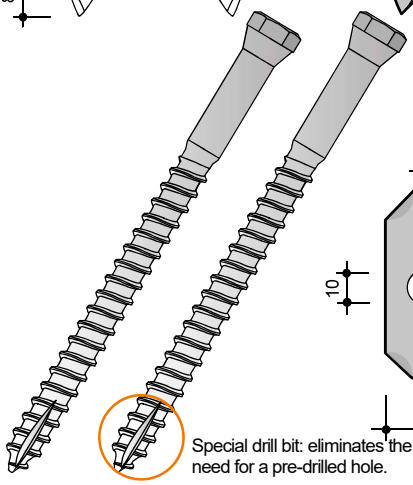
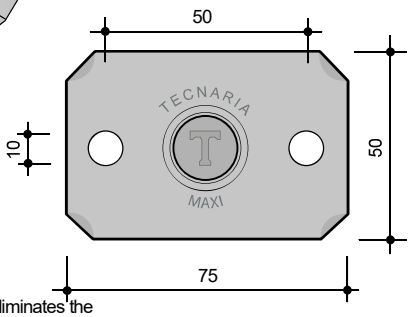





Special drill bit: eliminates the need for a pre-drilled hole.

**Specifications:** dowel connector comprising a 75x50x4 mm base plate with crampons and two holes for 10 mm diameter screws with tapered necks and a 12 mm diameter zinc coated dowel, riveted to the plate. Available dowel heights: 20, 30, 40, 60, 70, 80, 105, 125, 150, 175 and 200 mm. Available screw lengths: 100, 120 and 140 mm. CE certified.

Mechanical values of the connector

| Connector | Boarding | Timber | Characteristic resistance $F_{v, Rk}$ | Slip modulus under service load $K_{ser}$ | Slip modulus under ultimate load $K_u$ |
|---|---|---|---|---|---|
| | cm | | kN | kN/mm | kN/mm |
| MAXI | 0 | C16, GL24 and + | 19,30 | 18,60 | 10,40 |
| | 0 | D30 and + | 24,50 | 21,20 | 13,60 |
| | 2 | C16, GL24, D30 and + | 15,00 | 7,68 | 4,35 |
| | 4 | C16, GL24, D30 and + | 11,30 | 3,06 | 2,66 |

| Code | Dowel heights |
|---|---|
| CTLM020 | 20 mm |
| CTLM030 | 30 mm |
| CTLM040 | 40 mm |
| CTLM060 | 60 mm |
| CTLM070 | 70 mm |
| CTLM080 | 80 mm |
| CTLM105 | 105 mm |
| CTLM125 | 125 mm |
| CTLM150 | 150 mm |
| CTLM175 | 175 mm |
| CTLM200 | 200 mm |

# THE WOOD-CONCRETE FLOOR

## Wood

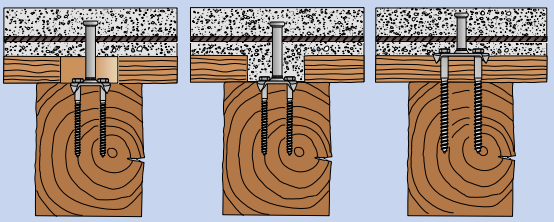
When restoration projects are undertaken it is important to analyse the geometry and mechanical characteristics of the wood. Solid wood, glue-laminated timber can be used for new floors

## Floor Boards

The formwork onto which the concrete is cast can be made of wood boards, terracotta tiles or hollow bricks, fiberglass panels.

## Mesh reinforcement

A suitably dimensioned electro-welded mesh is always placed in the middle of the slab (normally Ø 6 mesh 20x20 cm). It is not necessary to tie the mesh to the connectors.




## Tecnaria connectors

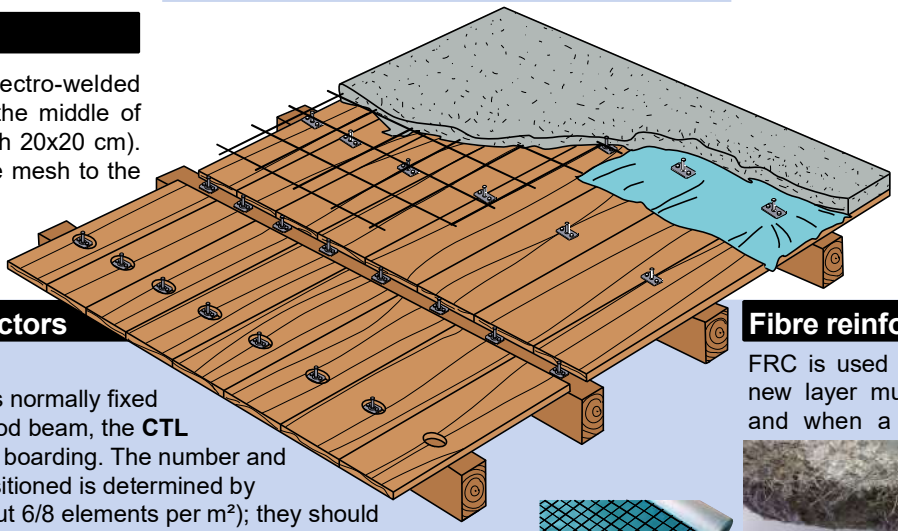
**CTL BASE:** with Ø8 mm screws, it is normally fixed in direct contact with the wood beam
**CTL MAXI:** with screws Ø10 mm in diameter, it is normally fixed on top of the boarding.

## Concrete

Structural concretes of at least class C25/30 are normally used, with a thickness of no less than 5 cm. No technical installations (tubes, wires or other) must be inserted within the load-bearing slab.

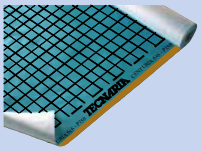
## Light structural concretes

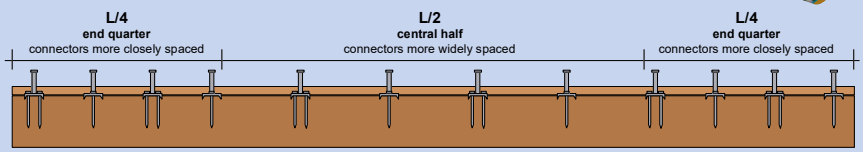
The use of structural light-weight concrete is recommended especially in seismic areas as it reduces the dead load of the strengthened slab yet maintains a high mechanical strength.




## Positioning of connectors

The **CTL BASE** connector is normally fixed in direct contact with the wood beam, the **CTL MAXI** normally on top of the boarding. The number and type of connectors to be positioned is determined by calculation (on average about 6/8 elements per m²); they should be fixed closely spaced near the walls and more widely spaced in the centre of beam. It is advisable to turn the base plate so that the screws are not aligned.






## Fibre reinforced concrete (FRC)

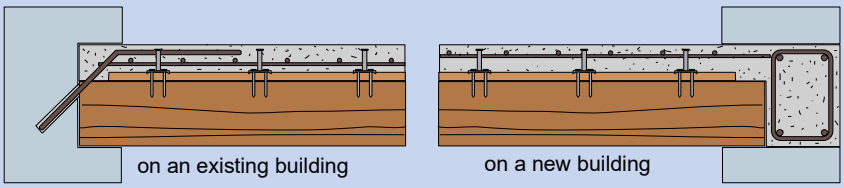
FRC is used when the thickness of the new layer must exceed 20 or 30 mm, and when a reduction of the load is

## Protective sheet

TECNARIA 'Centuria' breathable waterproof sheet is impermeable to the passage of water yet permeable to vapour. It prevents mortar from dripping through joints, cracks and pores in the boarding, the timber from absorbing any water from the cast concrete and dust from depositing on the underlying floors in the long run. Vapour condensation on its underside will be avoided even in the presence of high saturation of the areas below the floor structure thus preserving the wood boarding. The protective sheet must be laid in contact with the wood, before the connectors are fixed in position. A 6x6 cm grid is printed on the sheet which facilitates the marking of the spacing. Duel faced fixing tape and eyelets are also supplied for perfect sealing .

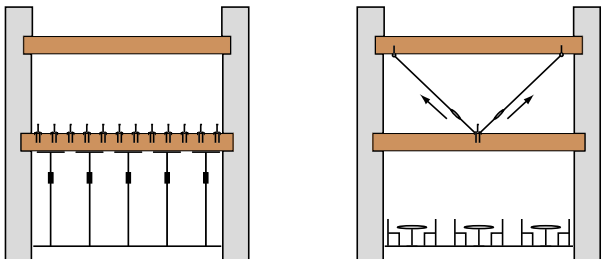
## Connection to the walls

It is advisable to join the slab to the bearing masonry walls on all sides of the floor. This precaution will also bring benefits in terms of stiffness and seismic resistance of the floor. This can be achieved in various ways, depending on the type of wall.

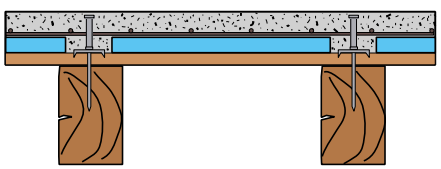



## Shoring

It is important to shore with props the floors while the concrete sets. Where it is not possible to have access underneath the floor structure, it will be necessary to hang the floor by means of stays.



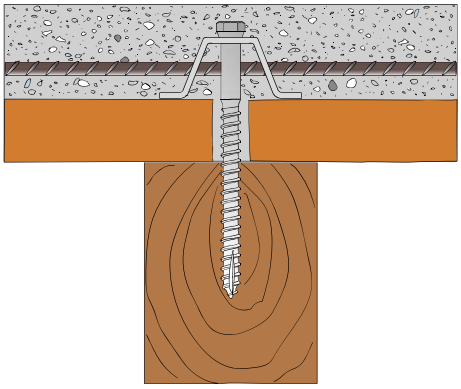
## Insulation



The insertion of a panel of rigid insulating material increases the section of the composite wood-concrete floor and beams without increasing the dead weight. The greater depth **improves the reinforcement** giving the advantages obtained in terms of strength, stiffness, number of connectors required and thermal and acoustic insulation values.

# OMEGA connector plate 38x30x90 mm screws Ø 10 mm

## Consisting of a screw and stabilising plate



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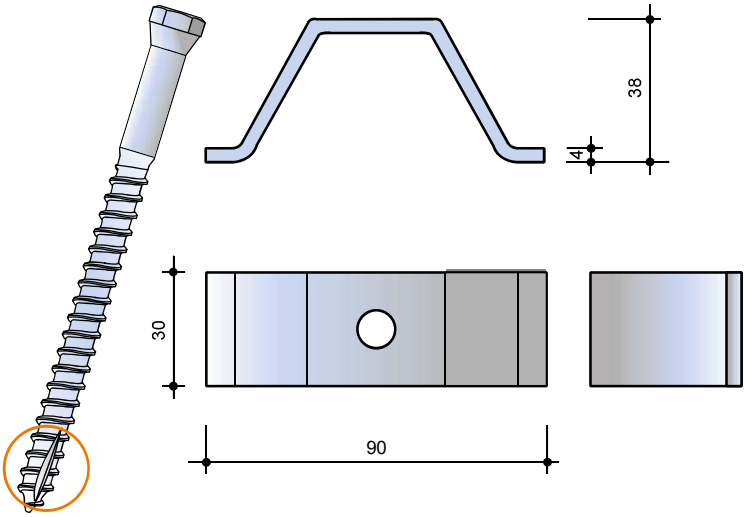



Special drill bit: eliminates the need for a pre-drilled hole.

**Specifications**: Connector composed of a 10 mm screw, length 100/120/140 mm with tapered neck and a plate H38x30xL90 mm, thickness 4 mm, bent in Omega shape, having a hole for the coach screw to pass through. CE certified.

**Mechanical values of connectors**

| Connector | Boarding | Timber | Characteristic resistance $F_{v, Rk}$ | Slip modulus under service load $K_{ser}$ | Slip modulus under ultimate load $K_u$ |
|---|---|---|---|---|---|
| | cm | | kN | kN/mm | kN/mm |
| OMEGA | 2 | C16, GL24, D30 and + | 7,89 | 2,09 | 1,48 |
| | 4 | C16, GL24, D30 and + | 6,64 | 1,89 | 1,32 |

| Code | Dowel height |
|---|---|
| CVT 40V-10/100 | 40 mm |
| CVT 40V-10/120 | 40 mm |
| CVT 40V-10/140 | 40 mm |

The Omega connector is used to connect small dimensioned secondary joists in double-joisted floors to the new concrete slab. The minimum size of the joists is 6 cm with a minimum height of 8 cm. The application is especially suited where the secondary joists are covered by a thin layer of boarding or tile. The connector screws can be fixed though the board or tile into the joist. BASE or MAXI connectors must be used on the principal beams.

## Installation

The OMEGA connector must be installed directly on the boarding or tiles. The screw has a special tip, which normally avoids the need for a pre-drilled screw hole. However with particularly hard wood (e.g. deciduous trees) a Ø 8 mm pre-drilled hole will be necessary.

### DIMENSIONING TABLE

| | | FLOORS | | | | | | | ROOFS | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Joist section | Lenght cm | 140 | 160 | 180 | 200 | 220 | 240 | 260 | 140 | 160 | 180 | 200 | 220 | 240 | 260 |
| 8x8 cm | connector spacing cm | 48 | 36 | 36 | 36 | 22 | | | 48 | 48 | 36 | 36 | 36 | 36 | 36 |
| | n° conn. per joist | 4 | 5 | 6 | 7 | 11 | | | 4 | 4 | 6 | 7 | 7 | 8 | 8 |
| | n° conn. per sq.m | 8,0 | 9,7 | 9,5 | 9,4 | 13,7 | | | 8,0 | 7,7 | 9,5 | 9,4 | 9,2 | 9,1 | 9,0 |
| 8x10 cm | connector spacing cm | 48 | 48 | 36 | 36 | 36 | 28 | | 48 | 48 | 48 | 48 | 48 | 36 | 36 |
| | n° conn. per joist | 4 | 4 | 6 | 7 | 7 | 10 | | 4 | 4 | 5 | 5 | 6 | 8 | 8 |
| | n° conn. per sq.m | 8,0 | 7,7 | 9,5 | 9,4 | 9,2 | 11,4 | | 8,0 | 7,7 | 7,5 | 7,4 | 7,3 | 9,1 | 9,0 |
| 10x10 cm | connector spacing cm | 48 | 48 | 48 | 36 | 36 | 36 | 18 | 48 | 48 | 48 | 48 | 48 | 36 | 36 |
| | n° conn. per joist | 4 | 4 | 5 | 7 | 7 | 8 | 15 | 4 | 4 | 5 | 5 | 6 | 8 | 8 |
| | n° conn. per sq.m | 8,0 | 7,7 | 7,5 | 9,4 | 9,2 | 9,1 | 17,0 | 8,0 | 7,7 | 7,5 | 7,4 | 7,3 | 9,1 | 9,0 |
| 10x12 cm | connector spacing cm | 48 | 48 | 48 | 48 | 48 | 36 | 36 | 48 | 48 | 48 | 48 | 48 | 48 | 48 |
| | n° conn. per joist | 4 | 4 | 5 | 5 | 6 | 8 | 8 | 4 | 4 | 5 | 5 | 6 | 6 | 6 |
| | n° conn. per sq.m | 8,0 | 7,7 | 7,5 | 7,4 | 7,3 | 9,1 | 9,0 | 8,0 | 7,7 | 7,5 | 7,4 | 7,3 | 7,1 | 7,1 |

Calculation data:
Composite beam composed of a reinforced concrete load-bearing slab C25/30 , 5 cm thick, cast on solid terracotta tiles 3 cm thick, connected by means of the connector with 10 mm coach screw and Omega shaped plate to wood joists C24 (according to EN 338) spaced at 35 cm centres and shored until the cast concrete has set.
Design loads for “FLOORS”: self-weight + 2.0 kN/m2 (permanent) and 2.0 kN/m2 (variable). Maximum deformation at time 0 < L / 500 and at infinite time < L / 350.
Design loads for “ROOFS”: self-weight + 1.0 kN/m2 (permanent) and 1.0 kN/m2 (variable). Maximum deformation at time 0 < L / 300 and at infinite time < L / 250.
All the data inserted in this table is purely for information purposes. It is up to the designer to check the composition of the composite floor.
For an exhaustive calculation use the appropriate Tecnaria software.

# TECNARIA CONNECTORS: APPLICATIONS

Dowel and crampons connectors are extremely easy to install; no skilled workmanship or special site requirements are necessary. **Installing the connectors is as simple as tightening two screws!** Connectors can either be fixed directly to the beam or to floorboards. A sheet of 'Centuria' breathable waterproof material should be laid under the connectors before pouring the concrete. Pre-drilling is necessary (6 mm diameter for **BASE** connectors with 8 mm screws) when working with hardwood. **MAXI** connectors use 10 mm diameter screws for which 8 mm diameter holes must always be prepared when working with hardwood. The three types of installation are described below.

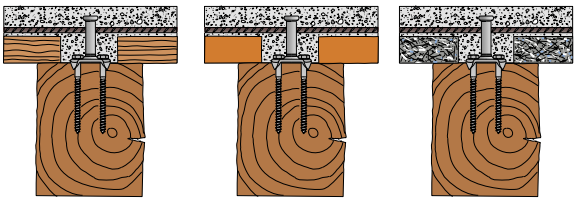
## A INTERRUPTED BOARDING

**Maximum performances - New floors**

**Connector fixed in direct contact with the wood beam.**

A continuous concrete beam has to be created on top of the timber beam. This can be done by cutting the boarding with a circular saw or laying boards cut to size. A similar situation occurs when the decking is made of terracotta tiles, hollow bricks or composite wood panels. This solution guarantees that the connector has a high mechanical performance but it requires the added preparation in that the boarding has to be altered.

BASE type connectors are usually employed with this solution. Recommended for new floors.



## B BORED BOARDING

**Maximum performances floor recovery**

**Connector fixed in direct contact with the wood beam.**

TECNARIA has a range of equipment for hire to facilitate the installation of the connectors. A drill with support cuts holes in the boarding.

Holes must be made in the boarding where the connector is to be positioned: Ø 65 mm for a BASE connector using a pointed drill. This solution guarantees a high mechanical performance of the connector but requires the boarding to be prepared. BASE type connectors are usually employed. This application is not recommended in the case of hardwood boarding, or existing boarding fixed with a lot of nails.

## C CONTINUOUS BOARDING

**Maximum installation speed – Existing Floors**

**Connector fixed on top of the boarding.**

The connector is installed directly on top of the boarding. MAXI type connectors are usually employed which require two pilot holes, with 8 mm diameter, to be drilled to receive the screws. Recommended in the case of restoration of the existing structure.

This solution is the quickest form of installation.

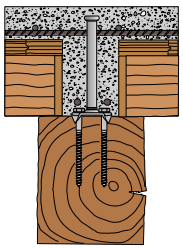
A Tecnaria double drilling machine with stand-up frame can be used for rapid pre-drilling and impact wrench for tightening the screws (both available on hire).

# DOUBLE JOISTED WOOD FLOOR

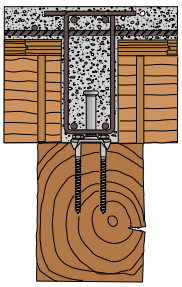
## Main beams

These form the bearing element of the entire floor, on which the secondary joists rest, with the function of distributing the load. Connectors must be fixed in direct contact with the main beam. A suitably reinforced connecting concrete beam must be created on top of the beam. “BASE” or “MAXI” connectors can be used, according to the different application solutions.

Double-frame floor viewed from below: the main beams can be seen with the secondary joists laid transversely.



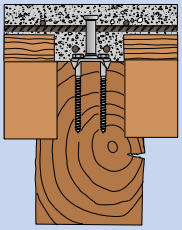
Connector on the main beam: the head of the connector must be higher than the mesh reinforcement. If correctly sized the connection can be used without stirrups.



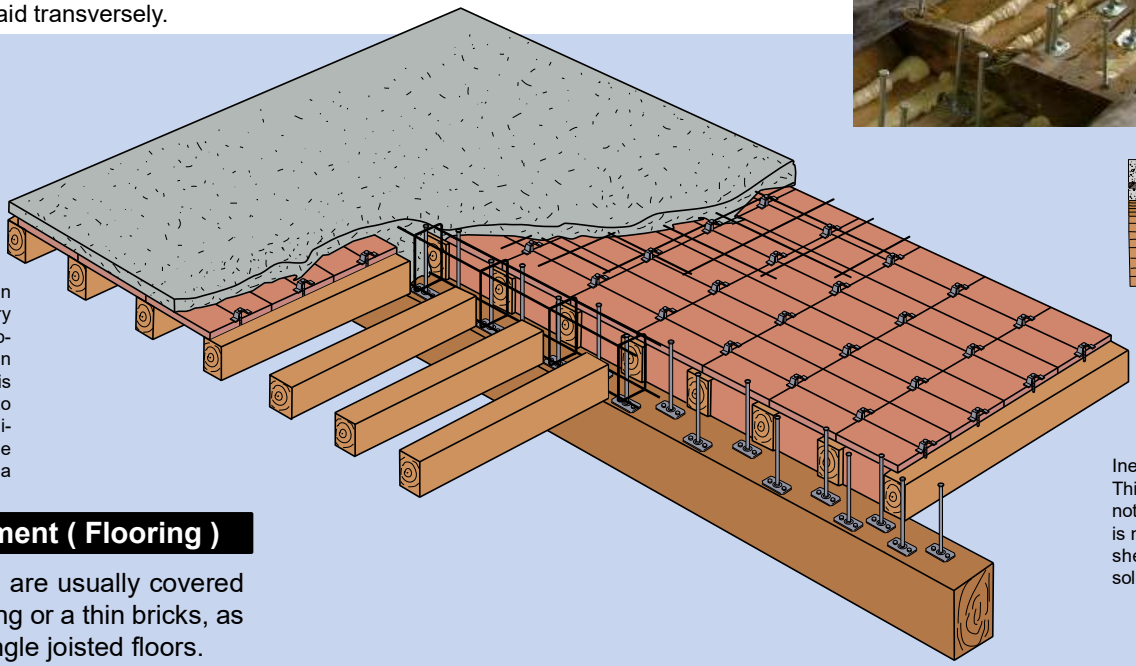
Connector on the main beam with stirrups.

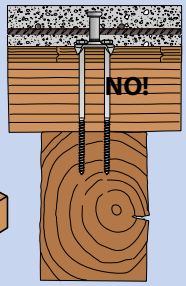
## Casting containment

Formwork, usually made of wood, must be provided between one joist and another, to contain the poured concrete. The operation can be quite laborious in the presence of irregular geometries. The joints must be sealed with polyurethane foam.



Connector on the main beam with secondary beams at the same upper level of the main beam. In these cases it is always preferably to place the connector in direct contact with the beam, by removing a portion of the boarding.






Inefficient connection. This kind of connection is not feasible, as the screw is not able to transmit the shear stresses. This solution offers no benefit.

## Spanning element ( Flooring )

Secondary joists are usually covered by timber boarding or a thin bricks, as in the case of single joisted floors.

## Secondary beams (joists)

Joists can be continuous, that is pass over the main beam, or interrupted on meeting the main beam. The latter situation is the more favourable. The calculation for the spacing of the connectors on the secondary beams will be carried out in the same way as for a single-joisted floor.

### Interrupted joists

The formation of a continuous concrete beam on top of the timber one makes the strengthening uniform and efficient.

### Continuous joists

The presence of joists causes discontinuity of the concrete beam, which should have to be suitably reinforced.

### Omega Connector

Omega connectors are mainly used on small sectioned joists.

# TECNARIA CONNECTORS: ACCESSORIES

Tecnaria proposes a series of accessories to facilitate the installation of BASE, MAXI and OMEGA connectors.

## Rotary drill and column support (code ACT-TRAPCOL)

High-torque drill mounted on a steady support; allows large holes to be drilled in the boarding to accommodate the “BASE” connectors in full operator safety.
Weight: 6.6 kg
For connectors: **BASE**
*Related item: 65 mm drill (code ACT-FL65)*

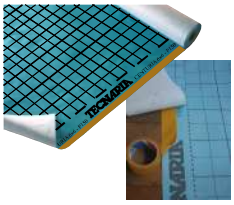
## Stand-up drilling machine (code ACT-DOPPTRAP)

Two electric drills mounted on an ergonomic frame allow two holes to be made simultaneously in the wood at the correct distance to receive the screws of the MAXI connector.
Weight: 9.1 kg
For connectors: **MAXI**
*Related item: drill bits for wood 8x160 mm (code PL08165135)*

## Impact wrench (code ACT-DW292)

Electric impact driver; its characteristics make it ideal for fixing the connector screws into the wood, 1/2” square fitting.
Weight: 3.2 kg
For connectors: **BASE, MAXI, OMEGA**
*Related item: hexagonal bush 13 mm, 1\2” fitting (code ACT-BE13-Q)*

## ‘Centuria’ sheet (code ACT-TTCEN)



Breathable waterproof sheet, to separate the wood boarding from the poured concrete.
Dimensions: roll of 50 x 1.5 metres (75 m2), weight of one roll 10.6 kg
For connectors: **BASE, MAXI, OMEGA**
*Related item: double-sided tape (code ACT-TTNB100)*

## Self feed wood bit Ø 65 mm (code ACT-FL65)

65 mm diameter drill with centring point. Makes holes in the boarding and removes all chippings
For drills with chuck.
For connectors: **BASE**

## Hole saw for 65 mm Ø holes (cod. ACT-FL65)

65 mm diameter hole saw with centring tip.
For drilling core holes in floorboards.
For drills with rack chuck.

For connectors: **BASE**

*Spare drill bit: code ACT-STLRIC0650*

## 13 mm 1/2” socket (code ACT-BE13-Q)

13 mm hexagonal drive, with 1/2” square fitting
For connectors: **BASE, MAXI, OMEGA.**

## 13 mm 1/4” hex socket (code ACT-BE13-E)

13 mm hexagonal drive, with hexagonal fitting for chuck.
For connectors: **BASE, MAXI, OMEGA.**

## CE Certification

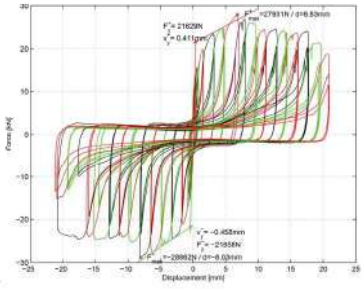
The entire range of Tecnaria connectors for timber structures are CE marked and are intended for use on both new and existing structures.
The BASE, MAXI and OMEGA connectors have the European Technical Assessment ETA 18/0649 dated 18/9/2018 and are subject to a quality control system.
The CE certification also allows the connectors to be used in fire resistance calculations for mixed structures.

**ETA 18/0447**
**DoP: 18/0447**

## Approvazione AVIS TECHNIQUE

**BASE** and **MAXI** Tecnaria connectors, together with the overall design method for composite wood-concrete floors, have been approved by the independent association CSTB, member of EOTA, the European Organisation for Technical Assessment, and been issued with the "Avis Technique" Technical Approval Certificate.

**MAXI** connectors have undergone cyclic testing and have been shown to be suitable for seismic stress transmission in both high ductility and low ductility structures.



## IL SOFTWARE PER IL CALCOLO: un prezioso aiuto al progettista

Tecnaria offers professionals a useful design tool: a calculation programme for rapidly dimensioning composite wood-concrete floors with dowel and crampon connectors.
It can be downloaded free of charge from **www.tecnaria.com**