

TECNARIA®

CONNECTORS FOR FLOOR REINFORCEMENT

COMPOSITE STRUCTURES AND CONNECTORS

When two different materials are firmly held together they behave as a single element from a structural point of view.

This principle is used to create "composite floors" for the building industry, which have the advantage of reducing the internal stresses in the materials and creating greater rigidity with smaller thicknesses.

If a reinforced concrete slab is laid and connected to the upper surface of a load-bearing beam, the characteristic properties of the two materials will be exploited to the best advantage: the upper layer of concrete will have a higher performance because it is correctly compressed, while the lower element, the wood or steel beam, will be effectively tensioned.

An interest in this type of structure originated in the Twenties by noting the way bridges made of riveted steel beams, designed and made as non composite structures, demonstrated that, in fact, they had a greater rigidity than an ordinary steel beam, and that the increased rigidity was caused by the friction generated by the partial cohesion of the concrete to the steel beam, and, above all, by the presence of the heads of large rivets on the upper surface of the beam which prevented the two elements from slipping apart.

The idea of artificially creating this friction led to the conception of connectors, developed in the early Thirties for steel structures (made with cylindrical pins with head welded to the beam) and then for timber structures which are notoriously less rigid and more elastic.

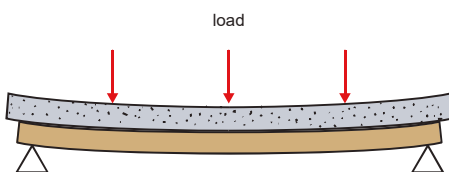
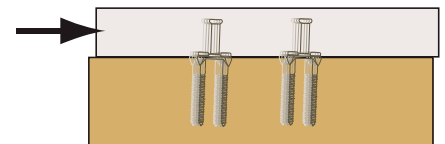


In modern construction the use of concrete as a finishing element for floor slabs is widespread because, it provides a rigid surface, redistributes loads, limits vibrations and the transmission of noise and provides adequate resistance to fire, due to its mass and rigidity.

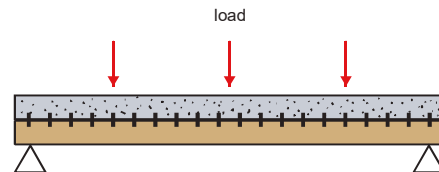
In composite floors, concrete, if it is efficiently connected to the supporting beam, behaves as a structural element and not simply as additional weight.

The connectors oppose any slipping movement that is generated between the two materials when loads are applied.

The composite structure therefore exploits the best characteristics of both materials, as the concrete works under compression and the beams under tensile stress.



DEFORMABLE UNCONNECTED STRUCTURE



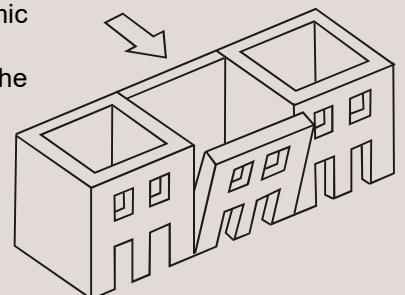
RIGID CONNECTED STRUCTURE

ANTISEISMIC BEHAVIOUR OF COMPOSITE STRUCTURES

One of the fundamental requirements of earthquake-resistant structures is the formation of "boxes" where masonry walls are linked to a rigid slab which is able to distribute the seismic load to the walls in the direction of their maximum resistance.

The best way of achieving this rigid surface is by forming a concrete slab connected both to the joists and the perimeter to the walls.

See section 4.2.1.5 in EN 1998-1-1 (Eurocode 8).



COMPANY PROFILE

Tecnaria S.p.A. is a company specialized in the design and production of connectors for composite floor slabs: wood-concrete, steel-concrete and concrete and masonry elements. Tecnaria understands the demands of the continuously evolving construction market and has sought to anticipate its needs.

The company was founded in 1949 to market products for the building industry. Over the years it has evolved and specialized its commercial offer, creating its own products. The company's present goal is to strengthen its know-how in the design of structural floor slabs and to produce a wealth of products.

A brief history of connectors

The first connectors were designed for **composite steel-concrete structures** in 1989 and tested at the University of Padua (Italy) in collaboration with Eng. Giorgio Romaro. The **CTF** connector was launched on the market in 1992. It was originally conceived for making new floors with profiled sheeting, but also became widely used for the restoring and strengthening of existing floors. During the early Nineties, the construction market had begun to show a great interest in innovative techniques for restoration and consolidation

In the mid Nineties, solutions were called for the restoration of **wood floors** which, as with steel floors, presented all the characteristics of effectiveness, simple installation and guaranteed results.

The CTL connector for composite wood-concrete floors was born from the idea of adapting and slightly modifying the same connector that was used for steel structures that had already found favour on the market. It proved to be a success. The base plate was reinterpreted with crampons that penetrated the wood and, instead of nails, screws were used for fixing. The first "BASE" connector appeared in 1994. Its evolution, the **MAXI**, arrived 8 years later.

The spread of the use of connectors, however, was hampered by a cultural problem: wood structures were very rarely studied in schools and Universities, so designers often encountered difficulties in calculating composite structures. The huge demand for this sort of intervention, however, led Tecnaria to make the bold decision of developing a calculation software that would be easy to use, and distribute it free of charge. It was now possible to spread a knowledge of composite structures.

The exponential growth of the Internet has made the use of this useful tool possible and created a greater knowledge and use of composite structures. Many prestigious works have been undertaken using these connectors, both in Italy and abroad.

Around the year 2000 customers were often faced with problems of restoring and strengthening the commonly used concrete and masonry **beam and pot floor structure**, which often did not comply with the new standard of seismic values. The **CTCEM** connector thus appeared in 2002, completing the range of connecting elements for the various types of floor structures. The product was backed up by a calculation software in this case too and the company's technical department was strengthened with highly specialized personnel to provide technical assistance in design.

The latest connector for wood structures, **Omega**, appeared in 2005 as a response to the types of floors characterised by the presence of terracotta tiles.

In 2007 the new **Diapason** connector was conceived for use in new steel-concrete structures with high load bearing capacity.

In 2009 Tecnaria obtained the important "Avis Technique" certification for its BASE and MAXI wood floor connectors from the French Institute CSTB, and in 2013 the Socotec certification for its CTF and DIAPASON steel floor connectors. Over the years a series of accessories for the various connectors has been developed for making installation simple and work on site faster and safer.

In 2015 the company completed and tested the **MINI CEM** connector for the reinforcement of hollow brick and concrete floors (beam and pot) with a thin fibre reinforced concrete (FRC) slab. I

n July 2017, the Avis Technique certificate was updated with the inclusion for the MAXI connector of the possibility to transmit actions of a seismic nature.

Since 2018, the CTF and DIAPASON connectors have the European Technical Assessment ETA.

The CE certification of almost the entire range of products was achieved in 2021.



The early Nineties brought the first studies and prototypes of CTF connectors for steel floors.



Studies and prototypes of the connectors for wood floors **CTL BASE (1994)** and **CTL MAXI (2002)**



2002: prototypes of the CTCEM connector for concrete and masonry floors.



2015: some prototypes of the MINI CEM connector



2007: some prototypes of the Diapason connector, still in the design stage.

COMPOSITE WOOD-CONCRETE FLOORS



**CTL BASE
dowel and crampon
connectors**



ETA 18/0649
DoP: 18/0649



**CTL MAXI
dowel and crampon
connector**



ETA 18/0649
DoP: 18/0649



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.


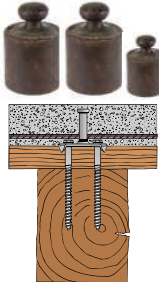
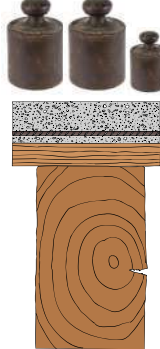
The composite wood and concrete system can also be used to make flat or pitched roof structures.

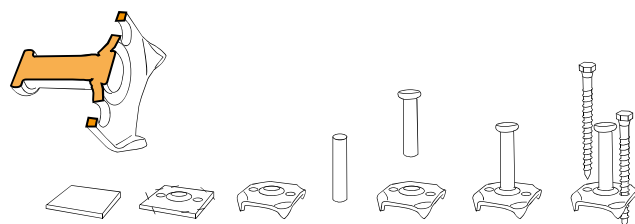
Dowel and crampon connectors placed between the timber beams and the concrete slab make the two materials collaborate with each other, resulting in a structurally efficient structure in which the concrete is mainly under compression and the timber mainly under tension.

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/m ²	Beam sec. 12x20 cm connected bearing capacity 700 kg/m ²	Beam sec. 12x28 cm not connected bearing capacity 700 kg/m ²
		
	bearing capacity: 250 %	height: 140 %

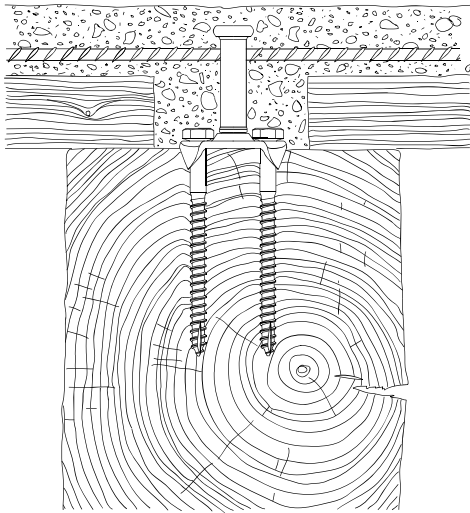


The most obvious advantages for composite timber-concrete structures can be seen in a greater load-bearing capacity, a lower total height of the floor structure, greater rigidity, and improved fire resistance.

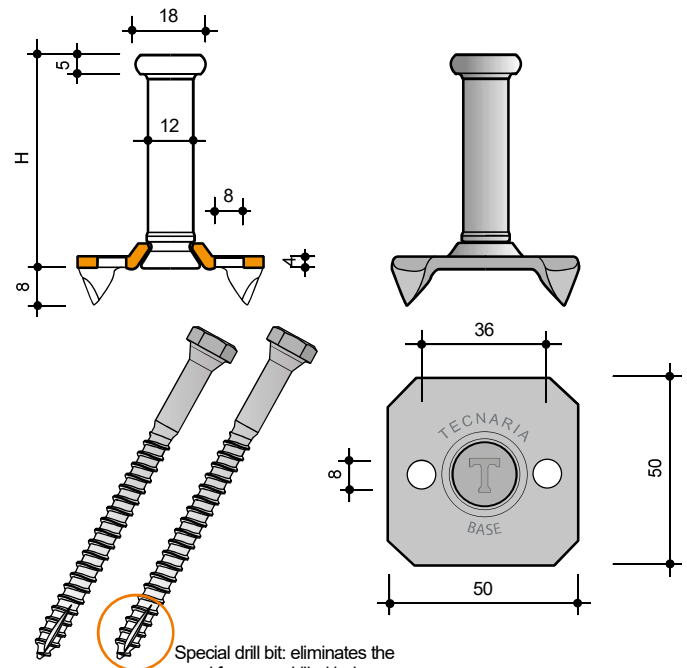
The example on the left shows the different bearing capacities of the beams at fixed deformation level.

BASE connector

base plate 50x50 mm screws Ø 8 mm



ETA 18/0649
DoP: 18/0649



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.

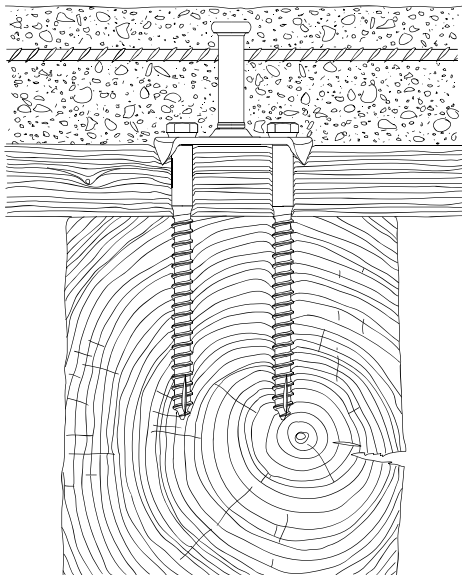
Mechanical values of the connector

Connector	Boarding	Timber	Characteristic resistance F_v, R_k	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

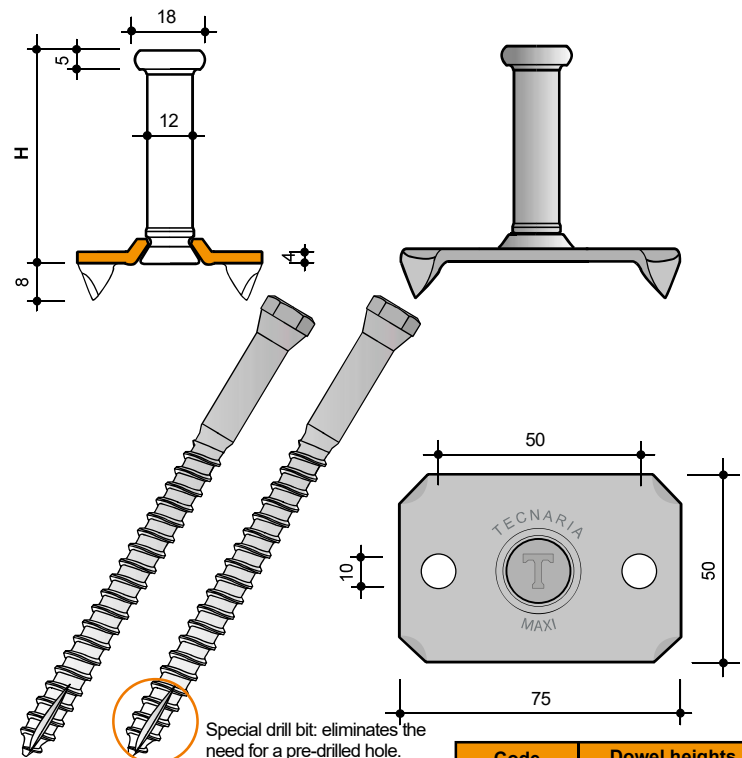
Code	Dowel heights
CTLB020	20 mm
CTLB030	30 mm
CTLB040	40 mm
CTLB060	60 mm
CTLB070	70 mm
CTLB080	80 mm
CTLB105	105 mm
CTLB125	125 mm
CTLB150	150 mm
CTLB175	175 mm
CTLB200	200 mm

MAXI connector

base plate 75x50 mm screws Ø 10 mm



ETA 18/0649
DoP: 18/0649



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, R_k	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

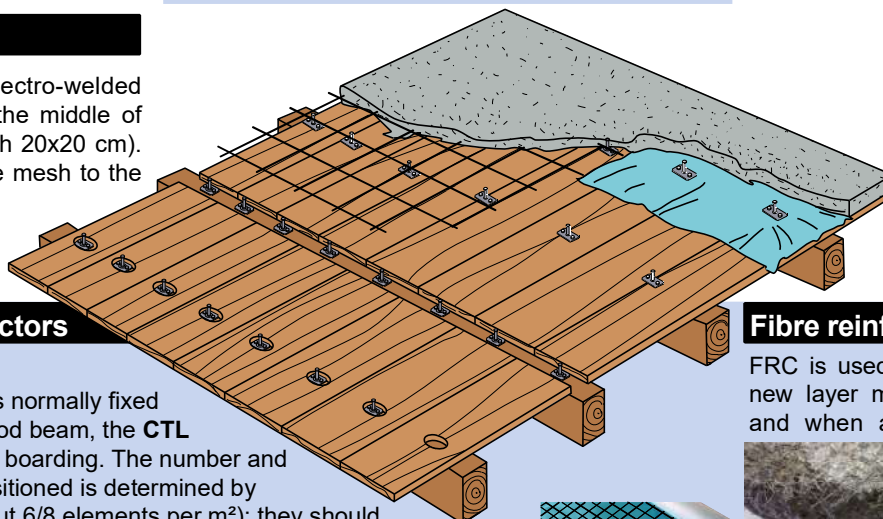
When restoration projects are undertaken it is important to analyse the geometry and mechanical characteristics of the wood. Solid wood, glue-laminated timber can be used for new floors

Floor Boards

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

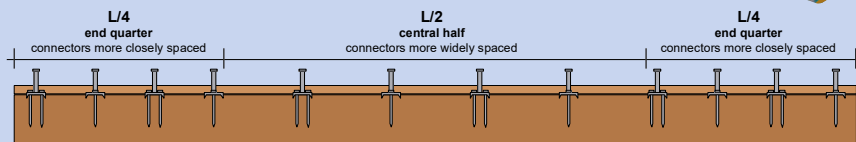
Mesh reinforcement

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.



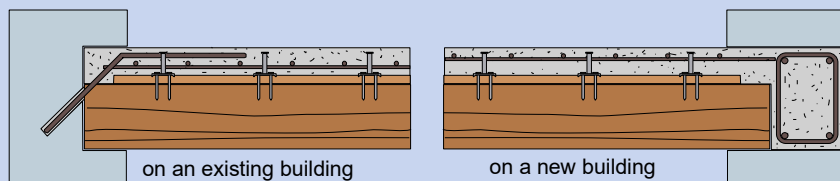
Positioning of connectors

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.



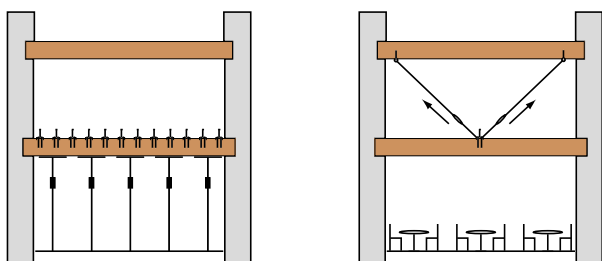
Connection to the walls

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



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.



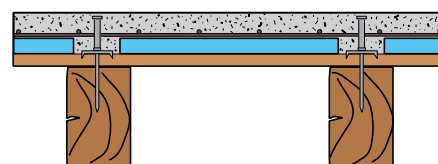
Fibre reinforced concrete (FRC)

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. Dual faced fixing tape and eyelets are also supplied for perfect sealing.

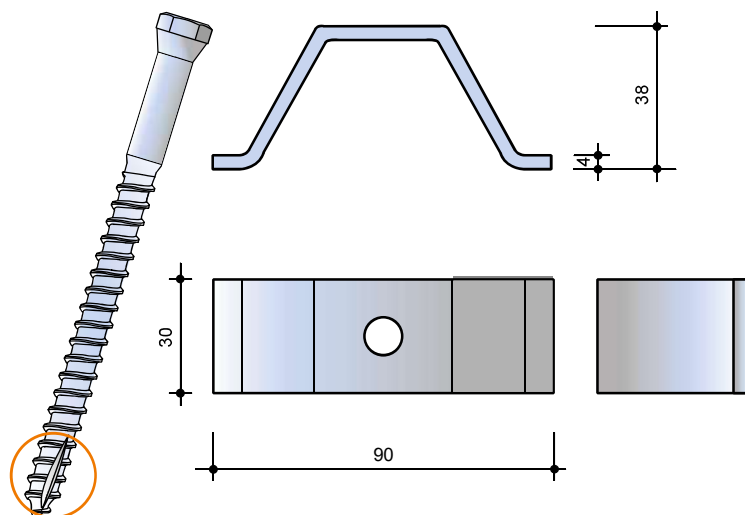
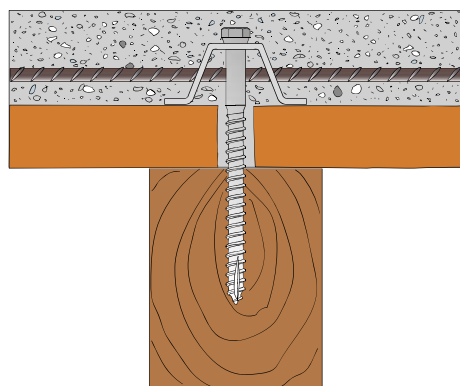


The insertion of a panel of rigid insulating material increases the section of the composite wood-concrete floor and beams without increasing the dead weight. The greater depth **improves the reinforcement** giving the advantages obtained in terms of strength, stiffness, number of connectors required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

OMEGA connector

plate 38x30x90 mm screws Ø 10 mm

Consisting of a screw and stabilising plate



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.

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

Mechanical values of connectors

Connector	Boarding	Timber	Characteristic resistance F_v, R_k	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 through 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

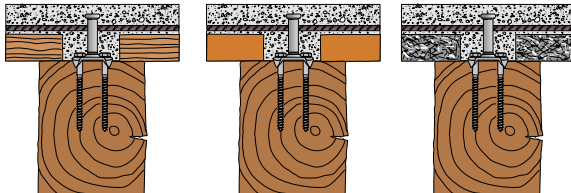
Maximum performances - New floors



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).

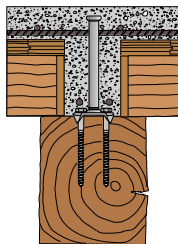
DOUBLE JOISTED WOOD FLOOR

Main beams

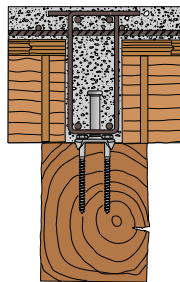
These form the bearing element of the entire floor, on which the secondary joists rest, with the function of distributing the load. Connectors must be fixed in direct contact with the main beam. A suitably reinforced connecting concrete beam must be created on top of the beam. "BASE" or "MAXI" connectors 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.



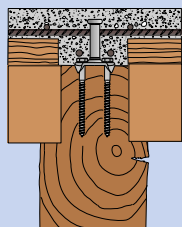
Connector on the main beam: the head of the connector must be higher than the mesh reinforcement. If correctly sized the connection can be used without stirrups.



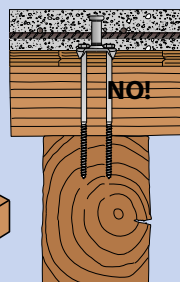
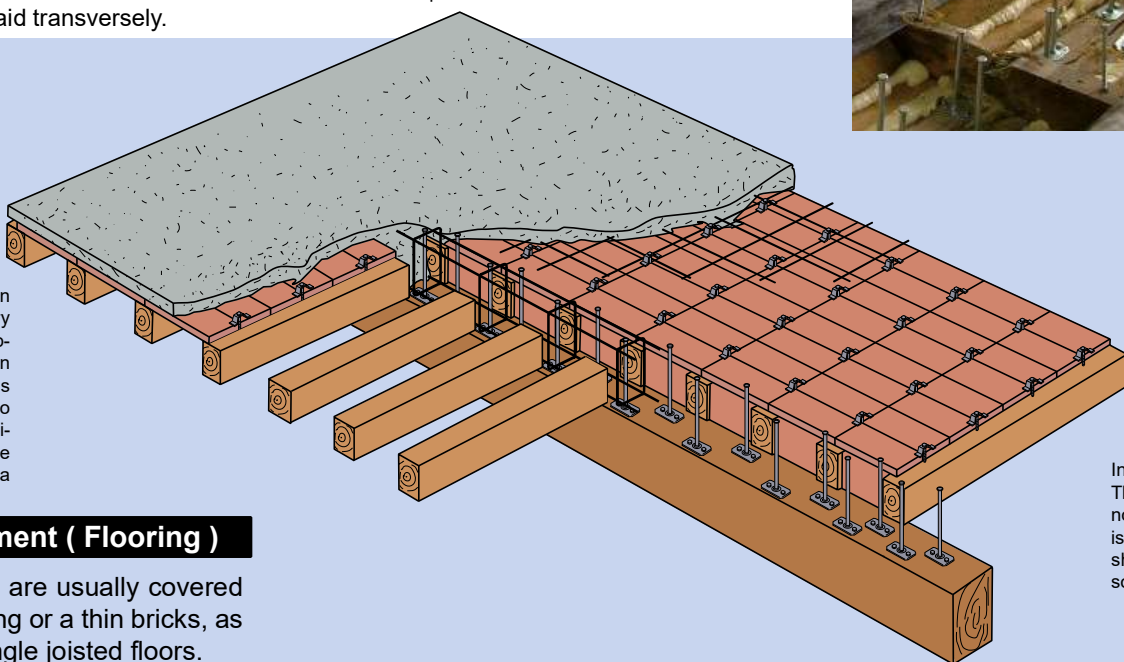
Connector on the main beam with stirrups.

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)

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**

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)

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

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**

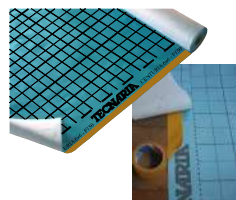
Related item: hexagonal bush 13 mm, 1/2" fitting (code ACT-BE13-Q)

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



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

'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)

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.



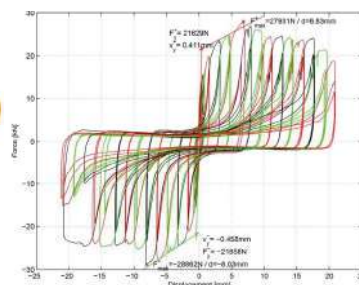
ETA 18/0447

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

COMPOSITE STEEL-CONCRETE FLOORS



CTF stud connectors



ETA 18/0447
DoP: 18/0447



**DIAPASON
plate connectors**



ETA 18/0355
DoP: 18/0355

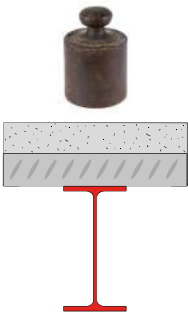
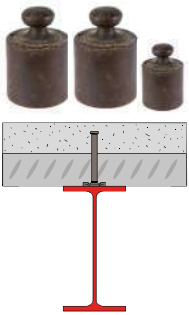
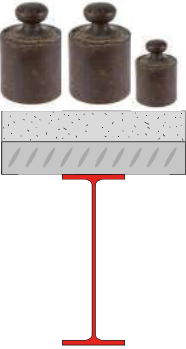
TECNARIA®

FLOOR STRENGTHENING

HIGH-PERFORMANCE FLOORS

Composite steel and concrete structures offer remarkable static and economic advantages compared to the non composite equivalent. A load-bearing steel structure, suitably bonded to an overlying concrete cast by means of connectors, guarantees the static unity of the two different materials while enabling them to exploit their individual characteristics.

Composite steel and concrete structures: static and economic

IPE 240 not connected bearing capacity 400 kg/m ²	IPE 240 connected bearing capacity 1050 kg/m ²	IPE 330 not connected bearing capacity 1050 kg/m ²
		
	bearing capacity: 260%	beam height: 137% beam weight: 160%

The most evident advantages are a **greater load-bearing capacity**, the **reduced weight** of the steel structure, the **reduced height of the floor structure**, **greater flexural rigidity**, and greater fire resistance.

The diagrams on the left demonstrate the advantages of the composite structure. 600 cm long S275JR steel beams are spaced at intervals of 180 cm, with Hi-Bond 55 profiled sheet decking and a 6 cm thick slab of C25/30 concrete covering the sheeting. Props are to be used in the transitional phase and deformations are limited within 1/250 of the length. 3.7 CTF105 connectors per sq.m. are required to create the composite beam.

The advantages of the TECNARIA connection

The commonly adopted solution for shear connection in composite steel/concrete structures is the headed stud, welded to the beam.

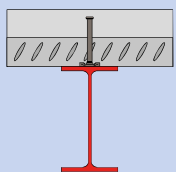
In molti casi la saldatura dei pioli comporta significative difficoltà

TECNARIA offers special **connectors**, simply fastened to the beams with high-strength nails using a special nail gun, avoiding any need for welding. This simplifies the construction procedures with consequent low costs.

- The **continuity of the profiled sheeting** on top of the beams can be maintained because the nail passes through the sheeting;
- The fastening operation is not affected by the **surface treatment of the connected parts** (painted or hot-galvanised);
- Fastening on site is not affected by **low temperatures** or the **presence of water**;
- No skilled manpower is required for installation, only a diligent use of the equipment;
- No toxic fumes are released during fastening;
- The **nailer is very light and easy to handle**, it does not require an electrical connection and can be hired.

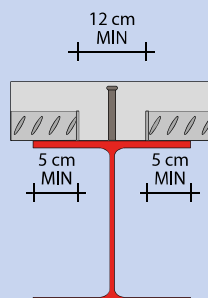


Comparison between nailed connectors and welded connectors



Example of connection with a Tecnaria CTF connector fixed through continuous profiled sheeting

- Possibility of shooting through 1 sheet (1 x 15/10) or 2 sheets (2 x 10/10).
- Suitable for all types of steel and all profiles with a thickness greater than 8 mm.
- Minimum profile IPE 120 or HEA 100.
- Tecnaria connectors are particularly advantageous for applications on beams with profiled sheeting.



Examples of connection with a welded stud

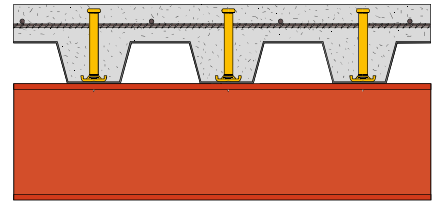
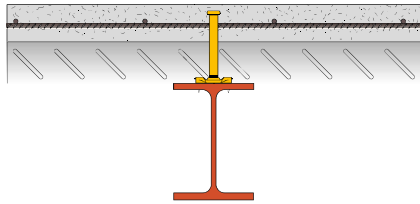
- Connector welded directly onto the beam with interrupted plate. A minimum profile HEA 240 is required and shuttering at the head of the decking to contain the casting.
- Connector welded onto the beam and plate pre-drilled locally in the points where the connectors are to be positioned
- The connector can also be welded onto the beam through the plate, but this requires a large input of electric power as well as suitable equipment and personnel.

STEEL-CONCRETE FLOORS

CTF Connectors



The connector consists of a headed stud, inserted into a base plate into which **two nails** are inserted for fixing. The limited size makes its main use for floors not subject to high loads and for general restoration work where a great flexibility of use is required

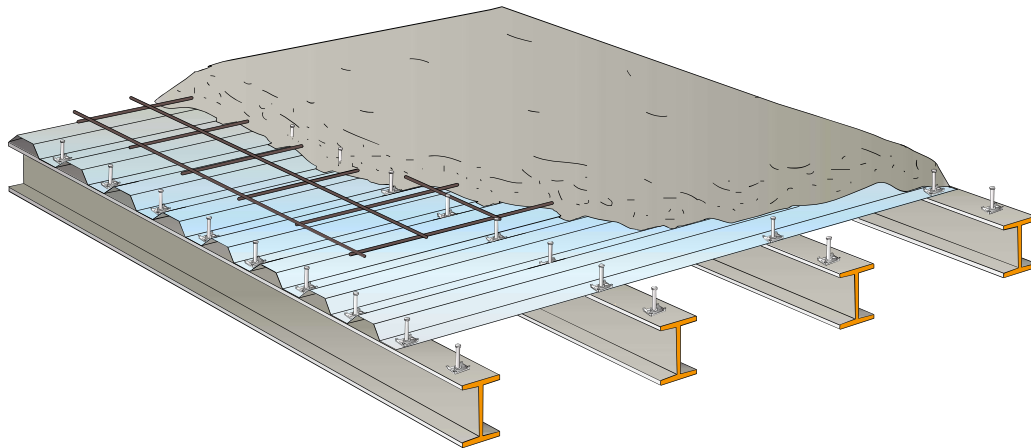


Concrete

Structural concretes of minimum class C25/30 are normally used, with a minimum thickness above the steel deck of no less than 5 cm. No technical installation must pass through the slab. Lightweight concrete can also be used. A mesh reinforcement or equivalent reinforcement must be inserted.

P560 Nail Gun

The nails are fastened with a **SPIT P560 nail gun** which can be **hired** from Tecnar. Once the profiled sheeting is in position over the steel beam, it is sufficient to shoot the high-strength nails supplied with the connector. The nail gun is easy to use on the site. Other types of nailers must not be used.



Mesh reinforcement

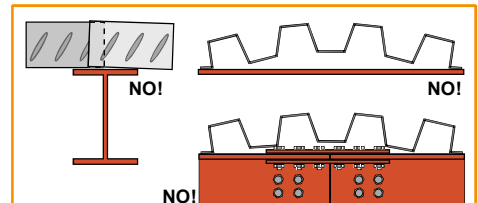
A suitably sized mesh reinforcement is always laid in the slab. Normally, a $\varnothing 8$ mm, mesh 20x20 cm is placed in the middle of the slab. It is not necessary to fix the mesh to the connectors

Steel profiles

S235, S275 and S355 steel beams can be used, even when painted or hot-galvanised. The connectors can be fixed to profiles with a minimum flange thickness of 8 mm. The nails can also be fixed into solid steel.

Profiled sheeting

Metal decking is generally laid on top of the beams. In order to fasten the connector the sheeting must adhere correctly to the beam. Maximum thickness of the steel deck 1.25 mm. A maximum of two sheets with a total thickness of 2 mm may be laid one on top of the other. Hi-Bond 55 sheets (or similar) are normally used, with fret height 55/60 mm.

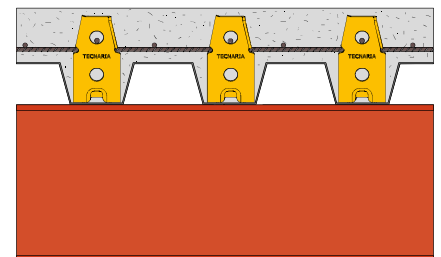
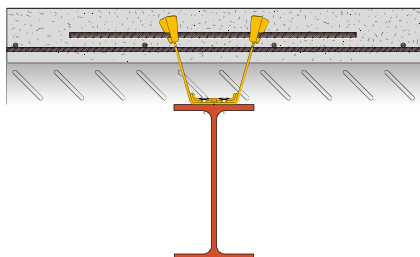


The connectors **CANNOT** be fixed where there is irregular overlapping of several layers of sheeting, on sheeting that does not adhere well to the beam, or on bolted beams.

Diapason Connectors



The DIAPASON connector is made of galvanised plate 3 mm thick, shaped so as to obtain a base to be fixed with **four nails** to the steel beam and two wings to create a more effective connection with the concrete. This connector provides a high mechanical performance.



The DIAPASON connector is used whenever it is necessary to fix 2 CTF connectors side by side.

CTF Connector

Base 38x54 mm fixed with 2 nails

Data Sheet

The **TECNARIA CTF** shear stud connector consists of:

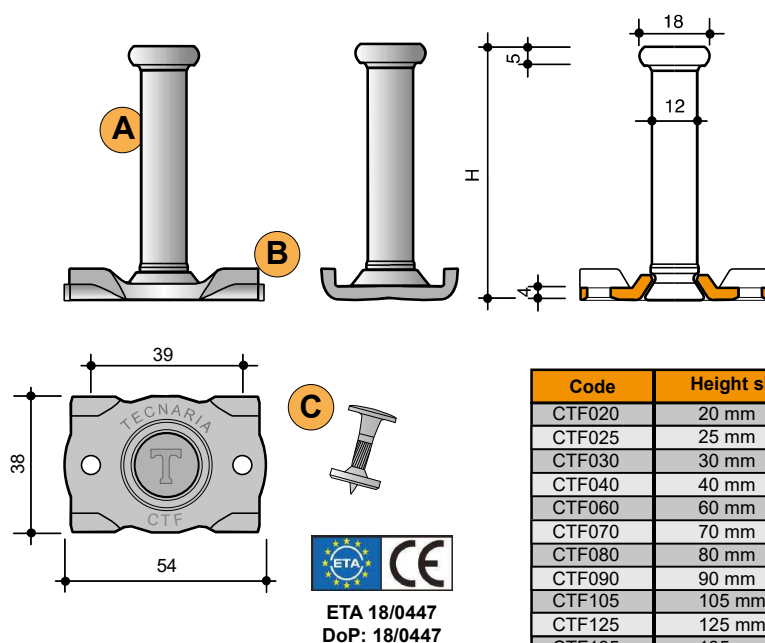
A) a 12 mm headed stud

B) a rectangular 38x54 mm pressed steel base plate, 4 mm thick. The stud connector and the base plate are riveted together.

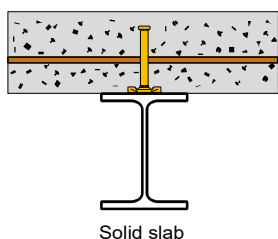
C) two carbon steel nails Ø 4.5 mm, length 22.5 mm, Ø head 14 mm, to pass through the two holes in the plate.

All the connector components are zinc plated with an average protection thickness of 8 µm, corresponding to 2 cycles of "Kesternich" corrosion resistance.

Specifications: zinc plated steel shear stud connector, 12 mm shank diameter with head, cold riveted to a 38 x 54 x 4 mm base plate, fastened to the steel structure by the two nails. Available shank heights: 20, 25, 30, 40, 60, 70, 80, 90, 105, 125 and 135 mm. CE certified.



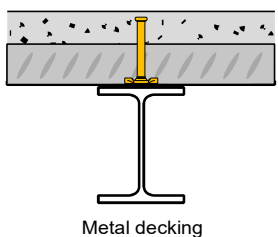
Design shear resistance of the Tecnaria CTF connector



Type	Example	Connector	Shear resistance P_{Rd}	Connector behaviour
Solid slab		CTF040 CTF060 CTF070	30.9 kN	Rigid
		CTF080 CTF090 CTF105 CTF125 CTF135	39.8 kN	Ductile

The value of the resistance indicated refers to the example using class C30/37 concrete.

Design shear resistance of the CTF connector with slab on continuous profiled sheeting



When a connector is fixed in the trough of a sheet of profiled sheet decking into the supporting beam which is laid at right angles to the beam, the resistance of the connector depends upon the class of concrete used, the geometry of the ribs of the sheeting and the height of the connector. The resistance is calculated as being the product of a reducing factor K_t and the reference resistance P_0 .

$$P_{rd} = K_t \times P_0$$

$$K_t = \frac{0,7}{\sqrt{n_r}} \cdot \frac{b_0}{h_p} \left[\frac{h_{sc}}{h_p} - 1 \right] \leq 1$$

Where:

n_r is the number of stud connectors in one rib (in calculation: ≤ 2)

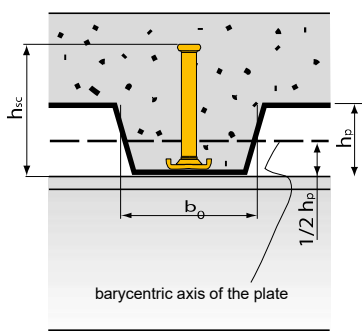
b_0 mean width of concrete rib

h_{sc} height of the connector

h_p height of the profiled sheeting ($h_p < 85$ mm and $h_p < b_0$)

$P_0 = 33.4$ kN (with concrete C30/37).

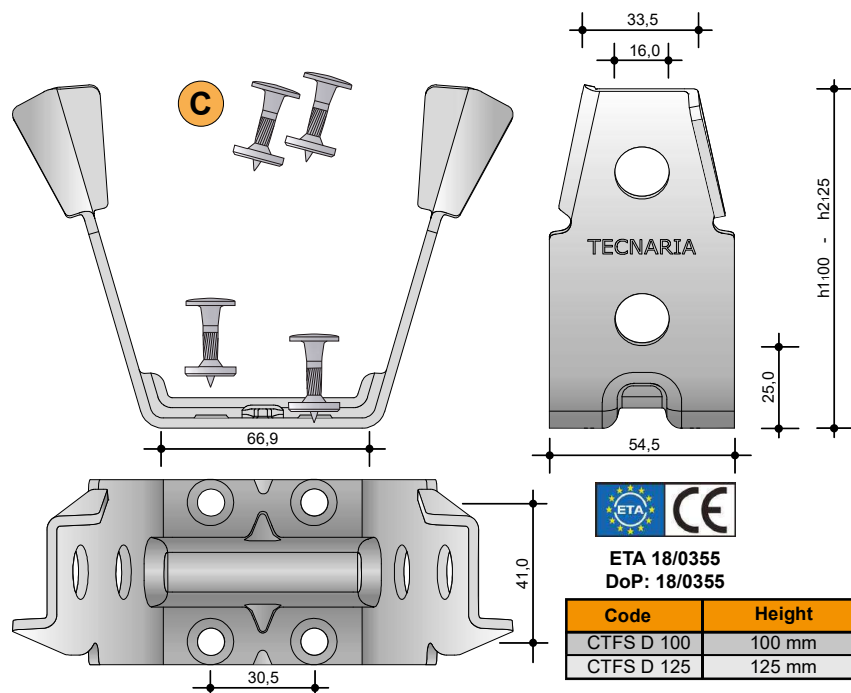
Example of the application of the formula for the shear resistance with profiled steel decking.



The best results are obtained using the longest possible connector. When it is necessary to use more than one connector in each trough, it is best to use the DIAPASON connector.

Type	Example	Connector	Shear resistance P_{Rd}	Connector behaviour
Solid slab with Hi Bond 55 metal deck 1 connector each trough		CTF090	20.9 kN	Ductile
		CTF105	28.4 kN	Ductile
		CTF125	28.4 kN	Ductile

The value of the resistance indicated refers to the example using class C30/37 concrete. Refer to the CE technical certificate or Tecnaria software for the resistance values using other classes and types of concrete.



Data Sheet

The **TECNARIA DIAPASON[®]** connector consists of a 3 mm thick galvanised steel plate with a ribbed rectangular base plate 70x55 mm, pressed into a "U" shape with two tilted wings. There are four holes in the tilted part to accommodate steel cross bars. Four high-strength steel nails go through the holes provided in the plate and fix the connector to the metal structure.

The available heights are 100 and 125 mm.

The nails used are of carbon steel \varnothing 4.5 mm, length 22.5 mm, \varnothing head 14 mm

Specifications: Pressed connection bracket in 3 mm thick galvanised plate. Dimensions of the ribbed base plate 70x55 mm with two tilted wings 55x100 mm / 55x125 mm. Shaped for use on various types of plate and designed to receive reinforcing bars. Fixed to the structure with 4 high-strength nails. CE certified.

Technical characteristics

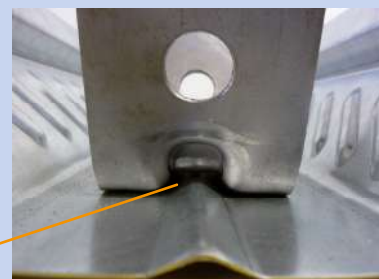
The two holes at the top allow the insertion of passing bars to increase the slip resistance due to a greater integration with the concrete. Ribbed steel bars with diameter of 10 mm and length of 600 mm must be used.

The two holes at the bottom allow the resistance to be further increased with the possible insertion of the steel bars which reinforce the profiled sheeting, a necessity in the case of fire-resistant structures.

Fixing is extremely quick as the connector is stable and the centring of the nailer is guaranteed by the form of the base plate.

The **DIAPASON[®]** connector is made of galvanised plate 3 mm thick, shaped so as to obtain a base that can be easily fixed to the steel beam and two wings at the top for the connection with the concrete.

At the top the ends of the connector are bent so as to counteract the shear stress with maximum effectiveness.



The base plate is shaped to allow the connector to be fixed even on plate that has a ribbed base or plate fixed with nails or anchoring screws.

Design shear resistance of the TECNARIA DIAPASON connector

Type	Exemple	Connector	Shear resistance P_{Rd}	Connector behaviour
Flat slab		D100	53.8 kN	Ductile
		D125	53.8 kN	Ductile
Connector with continuous profiled sheeting type HI-Bond 55		D100	40.7 kN	Ductile
		D125	43.8 kN	Ductile
		D100 + 1 rebar	40.2 kN	Ductile
		D125 + 1 rebar	48.1 kN	Ductile

The resistances shown refer to calculations using class C30/37. See the CE Technical Approval Certificate or the Tecnaria software for the resistance values with other types of concrete.

REHABILITATION OF EXISTING STRUCTURES



century until the second World War. That technology was abandoned in the early Fifties in favour of concrete and steel deck floor structures.

From the second half of the nineteenth century onwards, floors were frequently made using "double T-shaped" beams with brick arches, as an alternative to wood floors. The beams rested on the main walls with a spacing usually varying from 60 to 110 cm. The space between the beams was filled with solid or hollow brick elements.

A filling layer, often using waste material from the building site, was laid on top of the structure thus obtained, to level the surface of the floor and provide the bed for laying the floor finish.

The most frequent applications were in industrial buildings, in large public complexes, and social housing built in the period from the end of the nineteenth

These floors, designed to carry only moderate loads and not fulfilling modern construction requirements, are often in need of structural consolidation. They can be rehabilitated by connecting the steel beams to a reinforced concrete slab, using Tecnaria CTF connectors. The effectiveness of this solution has been proven by more than 20 years of operational use.



The chemical composition of the existing iron beams, also hampered by the presence of dust, rust or mortar, makes it difficult, if not impossible, to weld metal elements. Fastening with TECNARIA connectors efficiently solves the problem, since nails penetrate directly into the steel. The simplicity of installation makes this the ideal system!

Design shear resistance of the connector

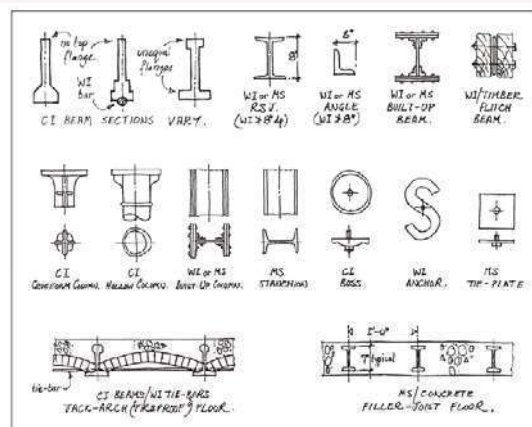
Type	Example	Connector height	Shear resistance P_{rd}
Solid slab		40 mm 60 mm 70 mm	30.9 kN
		80 mm 90 mm 105 mm 125 mm 135 mm	39.8 kN

The resistances shown refer to calculations made using class C30/37 concrete. See the Socotec Technical Approval Certificate or the Tecnaria software for the resistance values with other types of concrete.

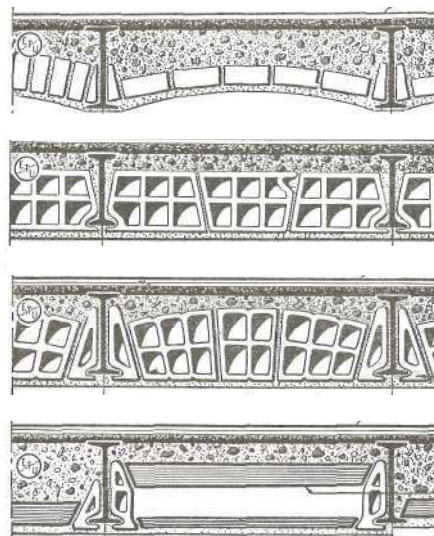
Work phases

1. If necessary, remove any existing false ceiling.
2. Demolish the flooring, the subfloor and the existing layer of mortar to expose the upper side of the existing steel beams without damaging the interposed brick elements.
3. After cleaning the surface removing major encrustations of mortar, fix the CTF connectors with the appropriate nail gun.
4. Lay the mesh reinforcement.
5. Dampen the upper surface.
6. Cast the concrete slab.

It is preferable to shore the floor before any work begins and especially before the pouring of the concrete, to improve safety on site and to give a better static result.



According to the technical manuals of the period the stress on the beams could vary from a minimum of 900 Kg/cm² to a maximum of 1600 Kg/cm².

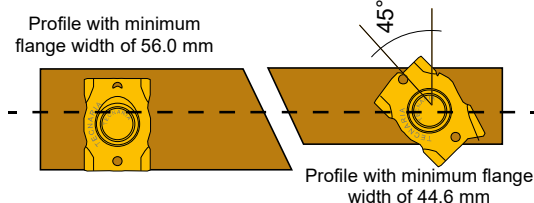


Examples of clay tile arched floors

When profiles have a flange thickness of less than 8 mm in the position where nails are fixed or when the width of the flange is less than 56 mm, it is possible to rotate the connector so that the fixing holes are nearer to the axis of the beam (greater thickness).

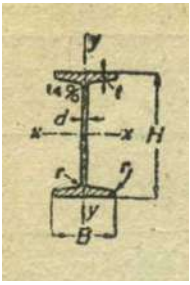
The connector can be rotated to an angle of up to 45°; this being the authorized theoretical maximum limit. A smaller angle may be used depending on site conditions, and a tolerance of a few degrees is acceptable.

Minimum thickness of the beam at the nailing point 6 mm.

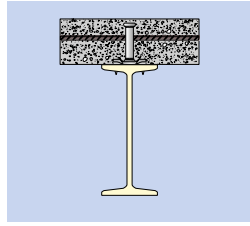


STEEL BEAMS AND BRICK ARCHES

Steel beams



In the past, it was not common to use steel profiles with a standard geometry. It is therefore necessary to measure the section of the profile and know the characteristics of the steel. Normally rolled "I" beams (e.g. BBS profiles or Universal Beams) were used. These existing beams often cannot be welded due to their chemical composition.



Tecnaria CTF connectors

Concrete

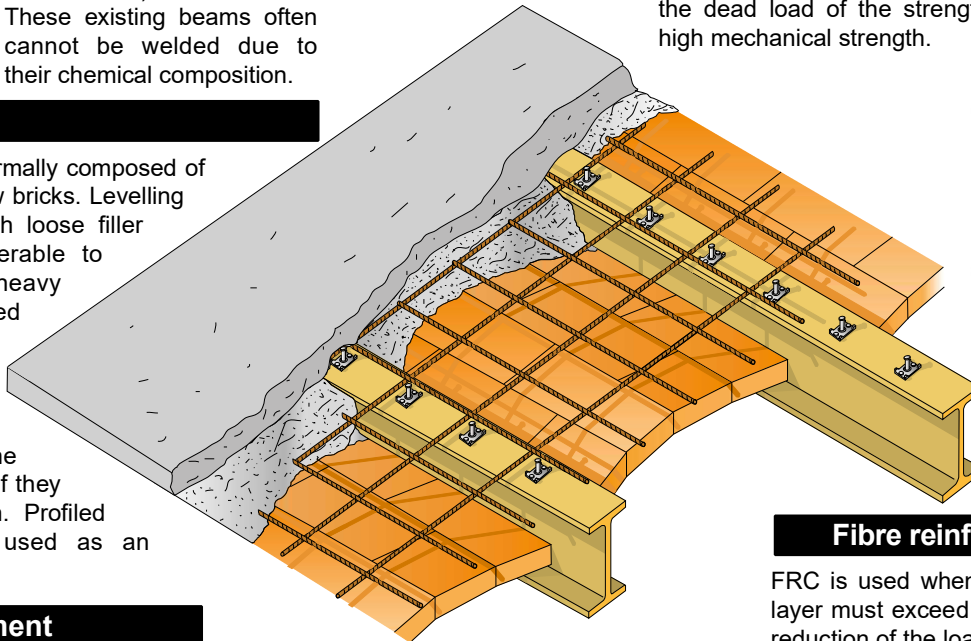
Structural concretes of minimum class C25/30 are normally used to make the load-bearing slab, with thickness no less than 5 cm. The technical installations cannot pass through the slab.

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.

Decking

The floor deck is normally composed of brick vaults or hollow bricks. Levelling was carried out with loose filler material. It is preferable to replace these heavy layers with aerated clay or polystyrene. The brick elements can be used as formwork for the subsequent casting if they are in good condition. Profiled sheeting may be used as an alternative.



Example of jack arch flooring reuse



Mesh reinforcement

A suitably sized electrowelded mesh must always be laid in the slab. Normally 8 mm diameter, 20 x 20 cm mesh is used. It is not necessary to fix the mesh to the connectors.

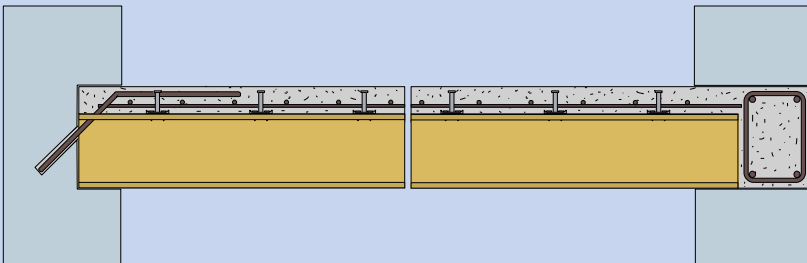
Fibre reinforced concrete

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



Connection to the walls

It is advisable to fix the slab to the bearing walls along the whole perimeter of the floor. This benefits the stiffness and seismic resistance of the floor. The operation can be undertaken in various ways depending on the type of wall.



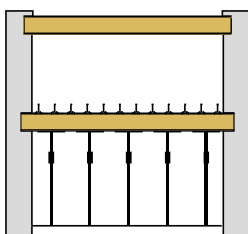
Installation



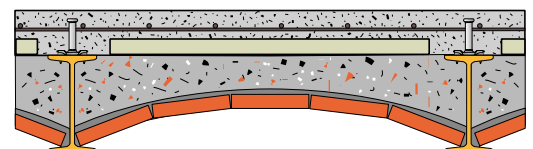
One of the main merits of the system is the rapid and safe way of fixing, carried out with a nail gun, which is available on hire. However, fixing the nail into the beam may create vibrations and this must be taken into account if there are elements that could be damaged (e.g. plaster ceilings). In these rare cases the connectors are welded.

Shoring

It is advisable to shore the floors while the concrete is setting. Where it is not possible to have access the underside of the floor slab, it will be necessary to hang the floor by means of stays.



Insulation as a structural element



By adding a panel of rigid insulating material, the section of the composite steel-concrete beam will be increased without increasing the dead weight of the floor. Advantages are obtained in terms of strength, stiffness, and partly in thermal and acoustic insulation.

TECNARIA CONNECTORS: ACCESSORIES

Tecnaria **CTF** and **DIAPASON** connectors are fixed using a Spit P560 Spitfire powder actuated fastening tool equipped with a special kit. These nailers are also available on hire and supplied in a case containing the instructions for correct use.

Spit P560 nail gun for CTF (code 014000)



Pin Drive for CTF
(code 013994)
weight 0.58 kg
Length 163 mm

Piston for CTF
(code 013997)
weight 0.21 kg
Length 235 mm

Ring Stop
(code 014136)
Diameter 22 mm



Fastening tool with kit for fixing CTF: weight 4.1 kg

Spit P560 nail gun for DIAPASON (code 014001)



Pin Drive for DIAPASON
(code 013955)
weight 0.40 kg
Length 102 mm

Piston for DIAPASON
(code 014137)
weight 0.17 kg
Length 180 mm

Ring Stop
(code 014136)
Diameter 22 mm



fastening tool with kit for fixing DIAPASON: weight 3.7 kg

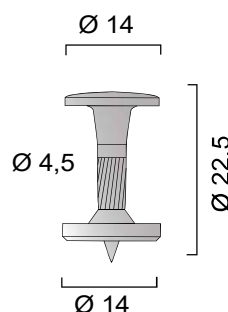
Cartridges for Spit P560



The 6,3 x 16 mm calibre cartridges, consisting of metal discs containing 10 elements, have various strengths.

- Yellow: medium (code 031240)
- Blue: strong (code 031230)
- Red: very strong (code 031220)
- Black: extra strong (code 031210)

TECNARIA HSBR14 nails (code 011390)



Special carbon steel nails for fixing on S235, S275 and S355 steel
Ultimate tensile strength: 2300 N/mm ²
Yield strength: 1600 N/mm ²
Mechanical zinc plating, minimum 10 micron
Hardness > 57 HRc
Knurled shaft
With steel washer Ø 14 mm

Chiodatrice per fissaggio lamiera (cod. 013891)



The Spit P560 nailing machine, equipped with a special "magazine" kit (code 013952), can also be used to fixing metal decking and cladding sheets to structural steel.

To speed up the installation process, the nails, which are CE certified, are supplied collated in 10-piece (code 053953).

Nailing machine with 10 nails magazine kit: weight 4.3 kg

Collated nails HSBR14 (cod.053953)



Magazine kit for collated nails (cod.013952)



Weight 0.90 kg
Length 255 mm

To be combined with:
Piston cod. 014137
Ring Stop cod. 014136

CERTIFICAZIONI

The entire range of Tecnaria connectors for steel structures is CE marked. CTF and DIAPASON shot connectors have the European Technical Assessment ETA 18/0447 and ETA 18/0355 and are subject to a continuous quality control system.



Calculation software: a precious aid for designers



Tecnaria offers professionals a useful design tool: a calculation programme for rapidly dimensioning composite steel-concrete floors with Tecnaria stud connectors according to the regulations in force.

It can be downloaded free of charge from the site www.tecnaria.com

CONCRETE AND MASONRY FLOORS

Screwed connectors



V CEM-E



MINI CEM-E



CT CEM

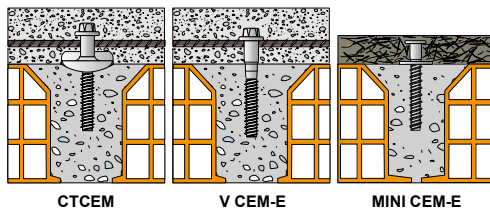
TECNARIA®

FLOOR STRENGTHENING

REINFORCEMENT OF CONCRETE AND MASONRY FLOORS

Existing beam: dimensions

The width of the beam must be such that the connector has an adequate lateral covering of concrete throughout its whole embedded depth.



Tecnaria connectors

CT CEM: screw connector with a base plate which anchors itself to the existing slab. A high performance connector offering outstanding mechanical strength properties.

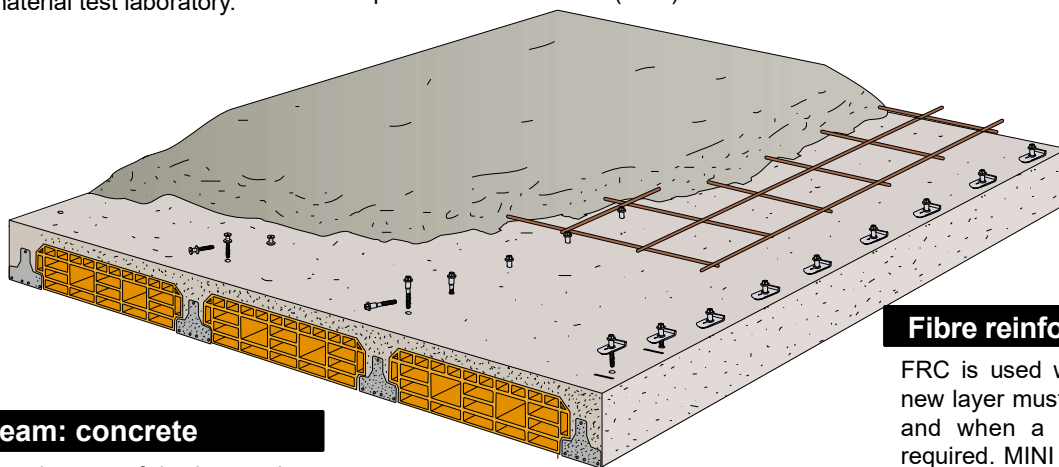
V CEM-E: screw-only connector used for less demanding applications.

MINI CEM-E: connector designed especially for connecting thin layers of high performance concrete (FRC).

Existing beam: reinforcement

The steel bars in the bottom of the beam must be checked as they are also a part of the resistant structure for the reinforced floor.

Their diameter and quantity must be carefully checked and type of steel noted. The tensile strength of the steel can be easily determined by undertaking a testing at a material test laboratory.

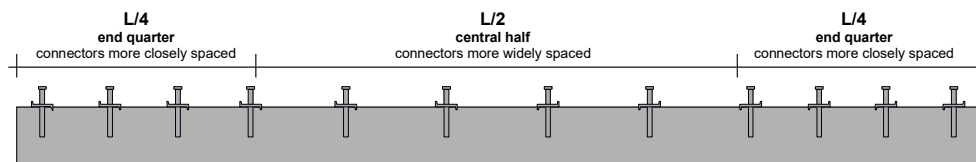


Existing beam: concrete

The bending resistance of the beam, the shear resistance and the resistance of the connector depend on the compressive strength of the existing concrete.

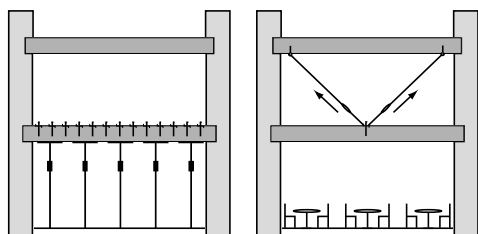
Positioning of connectors

The number of connectors to be positioned is determined by calculation (on average about 6 to 10 elements per m²). They will be fixed closely spaced near the walls and more widely spaced in the centre of the beam.



Shoring

Floors should be shored before the new casting takes place to achieve maximum efficiency of intervention. Where it is not possible to have access to the underside of the floor, the floor can be hung by means of stays.



Mesh reinforcement

A suitably dimensioned electrowelded mesh (normally Ø 6 20x20 cm) must always be placed in the middle of the slab. It is not necessary to fix the mesh to the connectors.

The mesh cannot be used with fibre reinforced concrete.

Concrete

Structural concretes of a minimum class C25/30 with a minimum thickness of no less than 5 cm are normally used. No technical installations must pass through the load-bearing slab. Dampen the floor before pouring the concrete.

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.

Fibre reinforced concrete (FRC)

FRC is used when the thickness of the new layer must not exceed 20 or 30 mm, and when a reduction of the load is required. MINI CEM connector is used in this case.

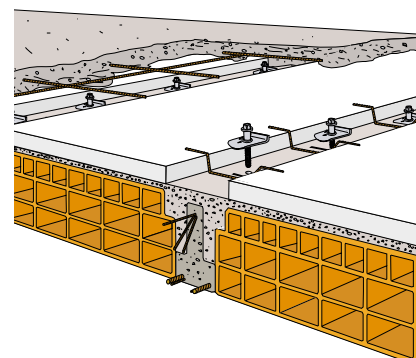


Floor thickness

It is good construction practice for the total thickness of the reinforced floor to be equal to at least 1/25 of its length (e.g.: 500 cm span=20 cm total height)

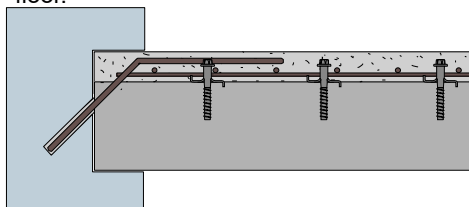
Insulation

The addition of a panel of rigid insulating material on top of the existing floor increases the section without excessively increasing the weight. The greater depth improves the reinforcement. Advantages are obtained in terms of strength, stiffness, the number of connectors used, and partly, the value of thermal and acoustic insulation.



Connection to the walls

If the existing floor does not have a perimeter beam resting on the walls, it is advisable to join the slab to the bearing walls round the perimeter of the floor. This precaution brings benefits in terms of stiffness and seismic resistance of the floor.



CTCEM connector

Plate 60x50 mm - screw Ø 14 mm

The high performance connector.

The connector consists of a toothed plate and a 10.9 steel stud threaded at the lower part and with a hexagonal head. The base plate contrasts the tendency of the stud to rotate, therefore giving a high level of resistance to any movement. The plate also prevents any crushing of the concrete and brings a large area of concrete into contact with the connector so as to give a greater shear resistance. The fixing is completely mechanical. There is no need for resins or chemical additives. The connection is quick and easy, economic and clean. The head of the connector protrudes for a height of 40mm.

Data Sheet

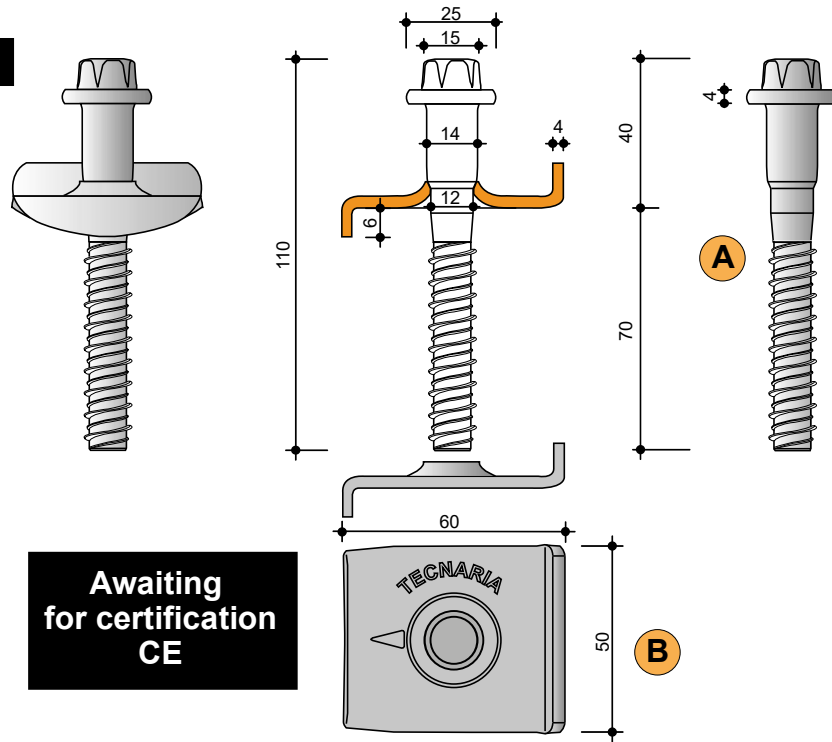
The **TECNARIA** stud connector with screw and toothed plate for integrating concrete casting consists of:

A) A Ø 14 mm shank of 10.9 hardened steel, with 15 mm hexagonal head and fake washer, and Ø 12 mm threaded body.

B) A 60x50 mm, 4 mm thick toothed steel plate with rectangular base. The stud connector and the base plate, thanks to their particular conformation, come together during the embedding process.

Specifications: Stud connector with screw and toothed plate for concrete casting integration. Element composed of a Ø14 mm shank of 10.9 hardened steel, with washer and 15 mm hexagonal head. The Ø12 mm threaded body has a truncated conical section at the lower end allowing it to be inserted into the central hole of the 60x50x4 mm stabilizing plate folded on two sides.

Code	Height connector
CT CEM 14/040	40 mm

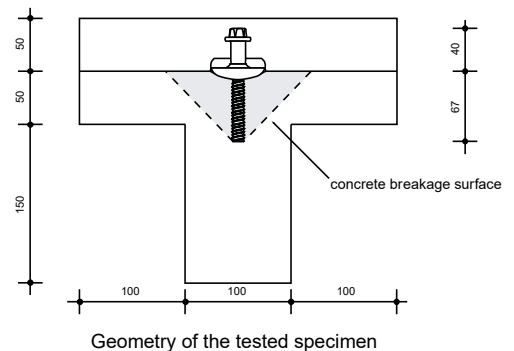


Strength of the CTCEM connector

Mean breaking load medio P_{um}	Characteristic breaking resistance P_{Rk}	Design load (S.L.U.) P_d	Allowable load (T.A.) P_{adm}
35.7 kN	26.7 kN	21.4 kN	14.2 kN

The table shows the reference values relating to the tests carried out at the Laboratory of Building Science of the University Institute of Architecture in Venice (Italy). These tests were carried out according to the procedures indicated in Eurocode 4 ENV 1994-1-1.

The results shown are for connectors connecting a C25/30 concrete structure with a C25/30 concrete slab. The geometries of the two connected parts are such that the breakage surface of the concrete is



Strength of the CTCEM connector

- When the floor has a concrete topping, locate the position of the beams.
- Mark the positions where the connectors are to be fixed.
- Make incisions in the concrete with an angle grinder to the following dimensions: width 4 mm, depth 5 mm, direction transverse to the direction of the beam (fig. 1).
- Place the base plate into the notch with the folded part facing downwards. The arrow on the top must be parallel to the beam, towards the central point (fig. 2).
- Drill a hole with an 11 mm drill bit to a depth of 75 mm (fig. 3).
- Remove the cement dust (fig. 4).
- Insert the screw in the hole and tighten it for its whole length with an impact wrench (or with a screwdriver with clutch). Take care not to keep screwing after contact between the plate and the screw has been made (fig. 5).



Connector V CEM-E

Shank Ø 14 mm - screw Ø 12 mm

This connector offers the quickest form of installation.

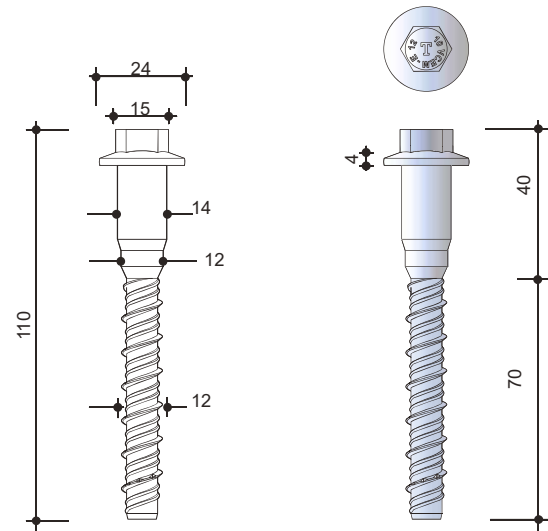
The connector comprises a carbon steel screw with hi-low thread (lower part) and hexagonal head (upper part). It is fixed by dry screwing the screw 70 mm, into a specially made hole in the concrete. The head should protrude by 40 mm. Fixing is completely mechanical, as no resins or chemical additives are required. The tip of the screw has a special heat treatment that allows it to carve the concrete in the best possible way. The connection process is therefore fast, economic and clean.

Data Sheet

The **TECNARIA** screws connector is used to integrate a new concrete layer with an existing one consists of a Ø 12 mm shank of hardened carbon steel with a 70 mm threaded part and a 15 mm hexagonal washer head, (Ø 24 mm washer), for a total length of the screw of 110 mm.

Specifications: Hardened steel screw stud connector for concrete casting integration comprising a Ø 14 mm shank of hardened carbon steel, with 15 mm hexagonal washer head and a 60 mm long, Ø 12 mm threaded body, for a total length of 110 mm.

Code	Connector height
V CEM-E 14/040	40 mm



Strength of the V CEM-E connector

The VCEM-E connector is CE marked. Its shear strength is calculated using Eurocode 2 EN 1992-4 from the data given in ETA 20/0831 (CEM 12.5).

Shear resistance in case of application on a solid slab

Strength of existing concrete	Shear resistance P_{Rd}
C20/25 non-cracked	12.30 kN
C20/25 cracked	8.61 kN
C25/30 non-cracked	13.75 kN
C25/30 cracked	9.62 kN

20
DoP: 20/0831
EAD 330232-00-0601



The values indicated are calculated using the Eurocode formulae and indicate the pry-out failure of the existing concrete. Shear strength P_{Rd} of the steel of connector V CEM-E: 28.50 kN.

Installation of the V CEM -E connector

Remove the existing flooring and strip any covering to the concrete joists. In the case of a floor with concrete topping, locate the joists through special probes. Anchor the connectors on the joists.

Mark the points where the connectors are to be fixed, following the guidelines (fig. 1).

- Drill a hole with an 10 mm bit to a depth of 85 mm (fig. 2).
- Remove the cement dust using a blowing or suction device in the hole (fig. 3).
- Insert the screw in the hole and tighten it all the way with an impulse driver or electric driver with clutch (fig. 4).
- Make sure not to over-tighten the screw (fig. 5)



MINI CEM-E connector

Shank Ø 10 mm - screw Ø 10 mm

The connector used with thin additional slabs

MINI CEM-E is the new screw connector with CE mark, designed to join a thin slab (from 20 mm) with concrete floor joists, including those with reduced dimensions. This connector is recommended in particular for joining the joists to high performance fibre reinforced concrete slabs. Thanks to the Hi-Low thread, it can be dry fixed into the support without the need for resins or other adhesives. Its free-spinning washer permits correct contact with concrete surfaces that are not perfectly level.

Data Sheet

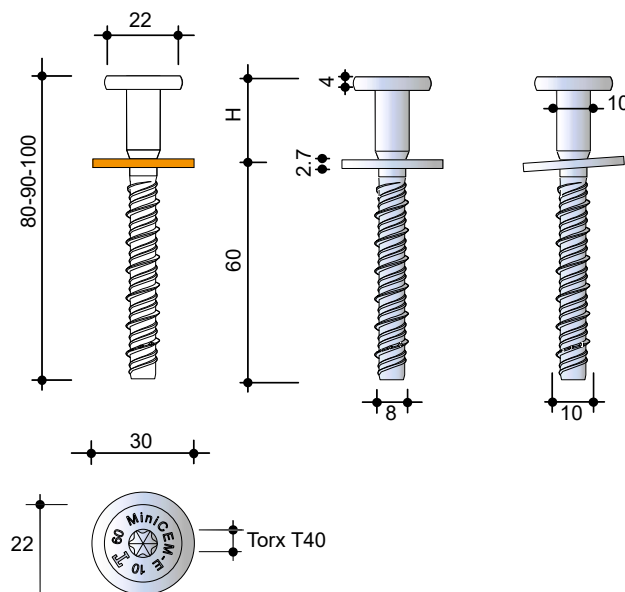
The connector comprises:

A) A shank in hardened carbon steel. The lower part has a hi-low thread for concrete that measures 10 mm in diameter and 60 mm in length. The upper part is a stud 10 mm in diameter and 20, 30 or 40 mm in length, with a 22 mm head and a T40 Torx recess.

B) A Ø 30 mm, 2,7 mm thick free-spinning washer in steel

Specifications: Stud connector with galvanised screw for concrete casting integration. Element comprising a shank in hardened carbon steel with Ø 10 mm, 60 mm threaded body; a Ø 10 mm, 20, 30 or 40 mm stud with a pre-assembled 2,7 mm thick free-spinning steel washer 30 mm in diameter and a T40 Torx recess.

Code	Connector height
MINI CEM-E 10/020	20 mm
MINI CEM-E 10/030	30 mm
MINI CEM-E 10/040	40 mm



Strength of the MINI CEM -E connector

The MiniCEM-E connector is CE marked. Its shear strength is calculated using Eurocode 2 EN 1992-4 from the data given in ETA 20/0831 (CEM 10.5).

Shear resistance in case of application on a solid slab

Strength of existing concrete	Shear resistance P_{Rd}
C20/25 non-cracked	9.90 kN
C20/25 cracked	6.93 kN
C25/30 non-cracked	11.07 kN
C25/30 cracked	7.75 kN

20
DoP: 20/0831
EAD 330232-00-0601



The values indicated are calculated using the Eurocode formulae and indicate the pry-out failure of the existing concrete. Shear strength P_{Rd} of the steel of the MINI CEM-E connector: 13.04 kN.

Installation of the MINI CEM-E connector

Remove the existing flooring and strip any extra covering of the concrete joists.
In the case of a floor with concrete topping, locate the joists through special probes.
Anchor the connectors on the joists.

- Mark the points where the connectors are to be fixed, following the guidelines (fig. 1)
- Drill a hole with an 8 mm bit to a depth of 70 mm (fig. 2)
- Remove the cement dust using a blowing or suction device in the hole (fig. 3)
- Insert the screw in the hole and tighten it all the way with an impulse driver or electric driver with clutch (fig. 4).
- Make sure not to over-tighten the screw (fig. 5)



Tecnaria Connectors: the applications

Use of metal connectors with fibre reinforced concrete (FRC)

FRC (Fibre Reinforced Concrete) is a cement based (concrete or mortar, single or multi component) composite material, with added fibres of various types and geometries. This composition gives the concrete a high level of resistance to traction and compression, significant ductility, and higher shear resistance than traditional concrete.

Regulations don't currently provide a clear view of all the possible fields of application in the structural sector, as they are not strictly classed as concretes.

They have recently been used for anti-seismic adaptation, or for the reinforcement of floors, to obtain rigid planes with smaller slab thicknesses (in the range of 25 mm) and limited weights.

In order to ensure the efficiency of the rigid plane, it is, however, still necessary to guarantee a certain level of bond with the existing structure, both when joining the beam to the slab and the beam to the masonry elements. Bearing this in mind, some FRC manufacturers recommend to carry out extremely demanding preparation works on the surface being consolidated when reinforcing hollow bricks and concrete floors, such as the roughening of the support through mechanical abrasion, followed by surface cleaning and preparation with a primer applied with a roller.

Tecnaria **MINI CEM-E** metal connectors are installed on the upper surface of concrete joists. All that is needed are simple drills.

MINI CEM-E connectors have undergone extensive laboratory tests. Thanks to the specific head conformation and reduced heights (20 mm, 30 and 40 mm), they can be used with FRC.

Resistance to slipping between two surfaces

Resistance to slipping

When two concrete layers are cast at different time, it is possible that a resistance to natural slipping movements exists, due to the irregularity of the surface being consolidated. However, in itself, the shear resistance is unable to guarantee a complete binding of the two surfaces. It will only be possible to take into account the resistance contributed by the cohesion between the materials if a headed connector is used. In simple terms, the surfaces may be classed as:

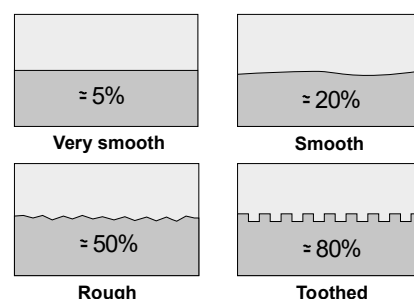
A) **Very smooth**: if cast on smooth formwork.

B) **Smooth**: in case of simple vibrated surface cap. This is the most frequent case.

C) **Rough**: roughness obtained artificially using mechanical means.

D) **Toothed**: appropriately prepared and cast using purposely shaped elements.

In the case of exposed hollow bricks or hollow bricks covered by a very thin layer of mortar, for the purpose of safety contribution must be considered as equal to zero.



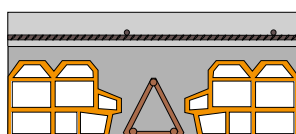
Resistance contribution shown as a %

Limitations of use

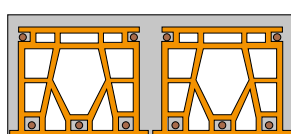
Type of floors

Reinforcement operations with the technique of the connected concrete slab are very often conditioned by the lack of reinforcement on the underside of the joist, by the poor resistance of the concrete used and by degradation of the concrete, as well as, on occasions, by flaws in design. Careful assessments on the actual condition of the floor being consolidated are therefore required.

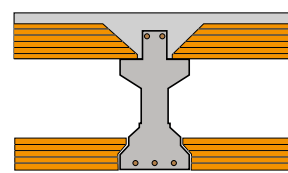
Therefore, the technique proposed is well suited to prefabricated joist floors 'Bausta type', while it is difficult for 'Sap type' or 'Varese type' floors, where the concrete joists are of a very small sizes.



"Bausta"

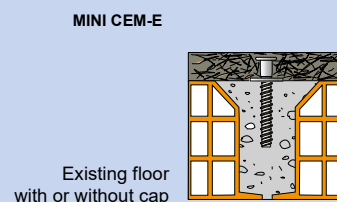
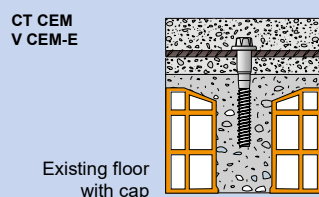
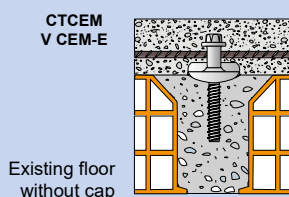


"SAP" floors



"Varese" floors

Minimum joist size



Degradation of concrete

The use of connectors is not appropriate where there is a carbonation of concrete and subsequent oxidation of the steel reinforcement. In this case, it will be necessary to assess other solutions that will not cause stress to the concrete.



Collapsed brick

Floors which have excessive sagging often have suffered a breaking of the bottom layer of the hollow bricks. The floor structures must, first of all, be made safe using an appropriate system. The connection with a new slab will then reduce the flexibility of the floor, preventing the problem of collapse from occurring again.

TECNARIA CONNECTORS: ACCESSORIES

Tecnaria proposes a series of accessories to facilitate the installation of **CTCEM**, **V CEM-E** and **MINI CEM-E** connectors.

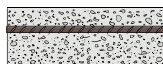
Impact wrench (code ACT-DW292)



Electric impact driver; its characteristics make it ideal for fixing the connector screws into the concrete, 1/2" fitting.
Weight: 3.2 kg
For connectors: **CTCEM**, **V CEM-E** and **MINI CEM-E**

Related item: hexagonal drive

Drill bit for concrete (code PC11160100X)



Drill bit for concrete, diameter 11 mm, working length 100 mm, SDS Plus fitting. With 4 cutting edges, extremely resistant in reinforced concrete.

Allows the hole to be made in the concrete for inserting the connector screw.

For connectors: **CTCEM**

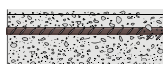


15 mm 1/2" socket (code ACT-BE15-Q)



15 mm hexagonal drive, with 1/2" square fitting.
For tightening the connector screw.
For connectors: **CTCEM** e **V CEM-E**

Drill bit for concrete (code PC10160100X)



Drill bit for concrete, diameter 10 mm, working length 100 mm, SDS Plus fitting. With 4 cutting edges, extremely resistant in reinforced concrete.

Allows the hole to be made in the concrete for inserting the connector screw.

For connectors: **VCEM-E**



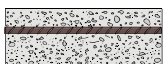
Adapter 1/2" for hex drive bits (code ACT-IE6-Q)



6 mm hexagonal drive 1/2" square fitting.
To be used in combination with Torx T40 bits.

For connectors: **MINI CEM-E**

Drill bit for concrete (code PC08160100X)



Drill bit for concrete, diameter 8 mm, working length 100 mm, SDS Plus fitting. With 4 cutting edges, extremely resistant in reinforced concrete.

Allows the hole to be made in the concrete for inserting the connector screw.

For connectors: **MINI CEM-E**



Torx T40 hexagonal drive bit (cod. BIT-T40-HEX25)



Torx T40 hexagonal drive bit

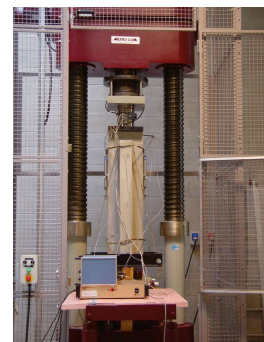
To be used with the 1/2" adapter.
Subject to wear.

For connectors: **MINI CEM-E**

CERTIFICAZIONI

The shear strength of the CTCEM connectors and the effectiveness of the connection have been experimentally verified following the test procedures given in Eurocode 4 UNI - EN1994-1-1 at the Laboratory of Building Science of the University Institute of Architecture in Venice.

The **V CEM-E** and **MINI CEM-E** connectors are CE marked according to ETA and DoP 20/00831, according to EAD 330232-00-0601.



CALCULATION SOFTWARE: a precious aid for designers

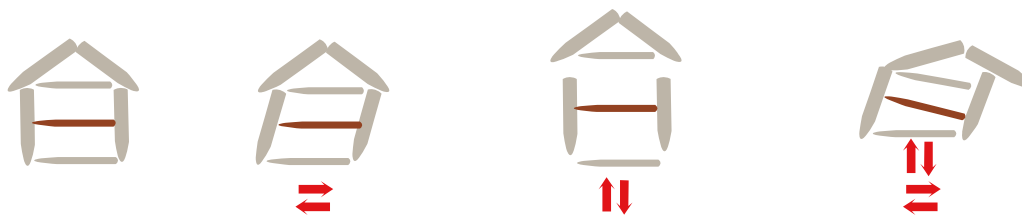


Tecnaria offers professionals a calculation programme for rapidly dimensioning reinforcement interventions on concrete and masonry floors with Tecnaria connectors.

This useful design tool can be downloaded free of charge from the site
www.tecnaria.com

ANTISEISMIC CONNECTION BETWEEN FLOORS AND WALLS

The connection between walls and floor is the most important intervention in the seismic reinforcement of existing buildings.



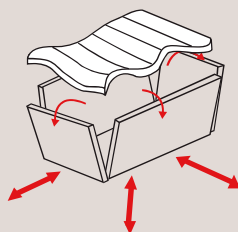
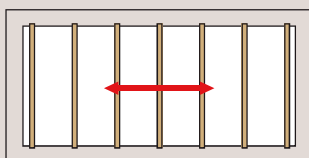
Typical shortcomings of existing masonry buildings: wall-wall / wall-floor ties

Floors are one of the most vulnerable parts of buildings constructed without any seismic criteria. The beams that form the floor are often simply resting on the supporting walls, held in place by a simple frictional force. In the event of violent seismic action there is a contemporary upward and lateral thrust; the friction force between wall and beam loses its effectiveness and the beams come away from the walls. A transversal movement causes the wall to rotate with respect to the vertical plane as they are not held together.

The remedy: box action = unity gives strength

If the walls are not connected to one another, the maximum earthquake resistance is simply that offered by the individual parts, but if they are properly connected there will be an **increased resistance** given by the box action effect. The walls remain vertically connected and develop a resistance to seismic thrust.

Before



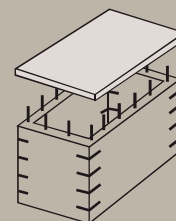
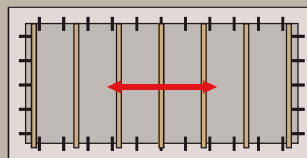
Deformable floor

Wall - wall connection: weak

Wall - floor connection: weak

Unconnected walls: great risk of collapse

After



Rigid floor

Wall - wall connections: efficient

Wall - floor connections: efficient

Tied walls: high resistance given by box action:

The walls parallel to the earthquake can exert their high resistance.

The walls placed at right-angles to the earthquake are retained by the floors and are not likely to collapse

Surface stiffness and structural continuity

The Eurocode 8 EN-1998 -1-1 provides indications for the verification for buildings subject to seismic action.

Extract from 4.2.1.5 Diaphragmatic behaviour at storey level:

(1) In buildings, floors (including the roof) play a very important role in the overall seismic behaviour of the structure. They act as horizontal diaphragms that collect and transmit the inertia forces to the vertical structural systems and ensure that those systems act together in resisting the horizontal seismic action.....

(2) Floor systems and the roof should be provided with in-plane stiffness and resistance and with effective connection to the vertical structural systems.....

(3) Diaphragms should have sufficient in-plane stiffness for the distribution of horizontal inertia forces to the vertical structural systems...

The TECNARIA solution

As regards **surface stiffness** floors having an upper reinforcing slab at least 5 cm thick, even in lightweight concrete, connected to the beams by connectors are considered to be infinitely stiff. Tecnaria proposes connectors for wood, steel and concrete and masonry floors to fulfil this requirement. It must be pointed out that in the case of existing floors the actual necessity of deformability must be assessed with care, to avoid the transmission of seismic loads to inadequate walls.

As regards structural continuity it is important that the floor slab be connected to the masonry walls. It is important that this intervention is not invasive, therefore preferable to choose interventions which avoid serious demolition of masonry at floor level. "Dovetail" joints and thick perimeter beams are therefore not advised.

The weight of the loadbearing structures and finishes (partition walls and floorings) should be reduced to the minimum possible so that the oscillation of the ground causes low entity thrusts. To achieve **structural continuity** between floors with a concrete slab and masonry walls, it is best to use the **two-component epoxy resin RTEC400** with reinforcement bars.

The intervention described is one of the primary ones to be undertaken, but others may also be necessary to comply with all the requirements of the standard.

Epoxy Resin

RTEC400

RTEC400 resin is a two-component epoxy formula with a high value of adhesion for heavy-duty fixtures on concrete, masonry and wood. Supplied in 470 ml cartridges, it is the ideal product for structural reinforcement with post-installed rebars, with very high adhesion values and a very low shrinkage coefficient.

Its consistency is dense (thixotropic), to avoid dripping and excessive dispersion of material in the voids that may be present in the walls. It is a CE certified product thanks to two ETA (European Technical Approval) approvals, valid for threaded bars and reinforcing bars inserted in concrete.

Example values of resin consumption depending on the diameter of the bar to be fixed:

Bar mm Ø	Hole diameter and depth	N° fixtures per cartridge	Bar mm Ø	Hole diameter and depth	N° fixtures per cartridge
12	16x200 mm	23	16	20x200 mm	18
12	16x300 mm	15	16	20x300 mm	12
12	16x400 mm	11	16	20x400 mm	9

Code	Description
RTEC400	470 ml two-component epoxy resin in a cartridge, with mixer
RTEGUN400	Professional hand gun for dispensing resin 470 ml "shuttle" cartridges.
RTMIXER	380 mm tubes for holes up to 380 mm deep



ETA 14/0090 e ETA 14/0091



Vinyl Ester Resin

RVINTEC400

La resina RVINTEC400 è un formulato vinilestere bi-componente senza stirene ad alto valore di aderenza per fissaggi pesanti su calcestruzzo, muratura e legno. Fornita in cartucce bicomponenti con miscelatore da 400 ml. rappresenta un ottimo prodotto per il rinforzo strutturale con ferri di ripresa post installati, con valori di aderenza elevati e ridotti coefficienti di ritiro.

La sua consistenza è densa (tixotropica), per evitare colature ed eccessive dispersioni di materiale nei vuoti che possono essere presenti nelle murature.

E' fornita di marcatura CE grazie a due omologazioni ETA (Benestare Tecnico Europeo) valide per barre filettate e per barre ad aderenza migliorata inserite in calcestruzzo.

Example values of resin consumption depending on the diameter of the bar to be fixed:

Bar mm Ø	Hole diameter and depth	N° fixtures per cartridge	Bar mm Ø	Hole diameter and depth	N° fixtures per cartridge
12	16x200 mm	19	16	20x200 mm	15
12	16x300 mm	13	16	20x300 mm	10
12	16x400 mm	10	16	20x400 mm	8

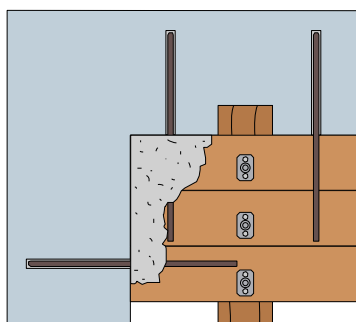
Code	Description
RVINTEC400	400 ml two-component vinyl ester resin in a cartridge, with mixer
RTEGUNVIN400	Professional hand gun for dispensing resin 400 ml cartridges..
RTMIXER	380 mm tubes for holes up to 380 mm deep



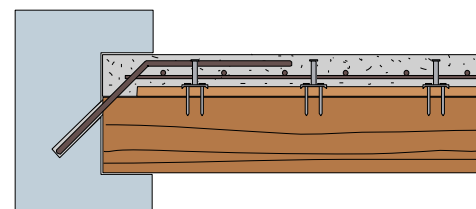
ETA 09/0246 e ETA 09/0140



Slab - masonry connection



To obtain an efficient and precise connection, a hole may be made inclined down into the perimeter walls at the height of the slab. Inject the Tecnaria Rtec400 two-component epoxy resin into the hole, insert the steel rebar, then bend the bar horizontally inside the slab. The connection must be made on all the perimeter sides, where there is load-bearing masonry. The intervention will improve the building provided that the connection is between suitable structural elements.



Example of typical dimensioning:
steel bars with diameter 12 – 16 mm at a distance of about 50 -80 cm, inserted in the wall to a depth of 30-40 cm and in the slab to about 60 cm.

Installation procedure

1. Make the hole with a drill or core drill.
2. Clean the hold by repeatedly brushing and blowing (alternatively clean with a jet of water).
3. Squeeze out the first portion of the resin that is still not mixed (thus checking the uniformity of colour of the product).
4. Fill the hole uniformly starting from the bottom, moving back gradually. Fill up to 2/3 the depth of the hole.
5. Insert the bar slowly, with a light rotating movement. Respect the application times in the table below.
6. Remove the excess resin from around the bar.
7. Before loading, wait for the maturation times indicated in the instructions.



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