CONCRETE AND MASONRY FLOORS

CTCEM screw connectors and toothed plate

TECNARIA®

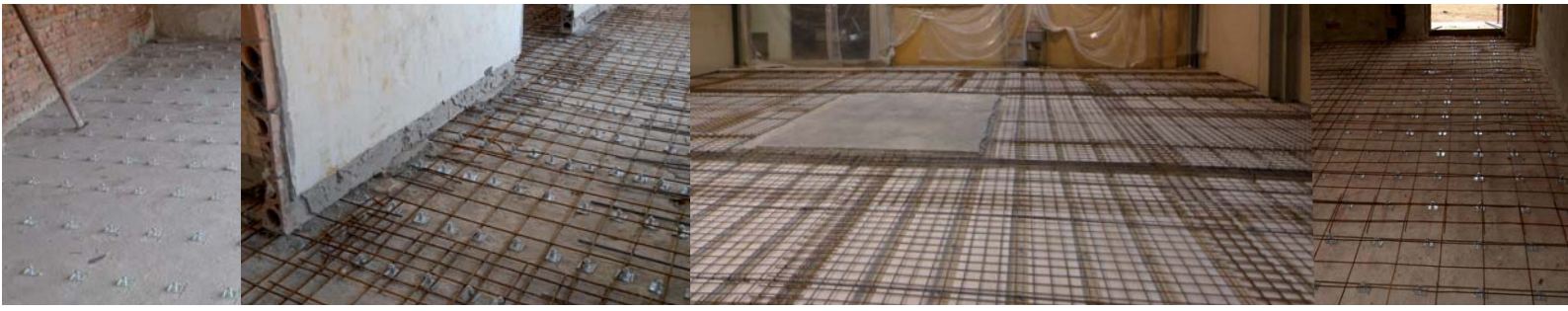
FLOOR STRENGTHENING

THE SOLUTION TO A PROBLEM

Concrete and masonry element floors were widely used from the Thirties onward, becoming even more widespread in the Fifties, during the "boom" in the building industry, due to the need to build housing as quickly as possible and with the lowest possible cost. Due to the shortage of raw materials (especially steel) and a lack of care in design and building construction, at times, these floors manifest deficits in terms of structural performance.

They are often deficient compared to current requirements, having a low bearing capacity or void of a reinforced concrete slab which ties together the whole slab and distributes the loading.

Tecnaria stud and plate connectors have been specifically designed to upgrade these floor structures. The creation of a new slab to collaborate with the existing one is often the cheapest and most logical solution.



Possible uses

Formation of a binding layer – low loadbearing capacity floor

Many floors do not have a concrete cap over the flooring blocks, or have slabs without any reinforcement of limited thickness. In these cases it is advisable to provide a suitably connected reinforced top slab which will distribute applied loads and bring the structure up to seismic standards.

Increased stiffness - deformed floors

When the concrete slab is slender, when its thickness is small compared to its length, the floor is deformable and may be subject to sagging and cracking. In these cases it is convenient to increase the thickness by forming an integrated load-bearing slab.

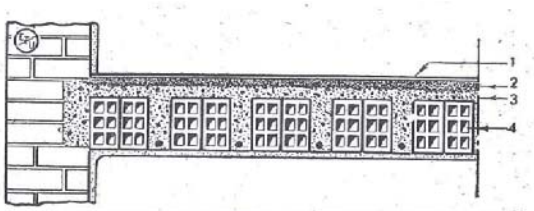
Increased strength - change of use

When design loads need to be increased, an additional load-bearing slab will increase the lever arm within the structure thus making an increase in the bending strength of the section.

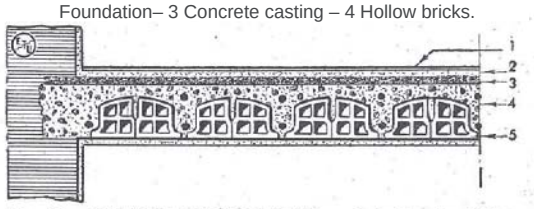
The increase in strength is proportional to the increase in section height.

It is useful to know that the strength increases directly in proportion to the increase in height, unlike in the case of wood or steel beams. It is therefore apparent that the use of the composite slab technique is statistically less viable in existing concrete and masonry floors than in wood or steel ones.

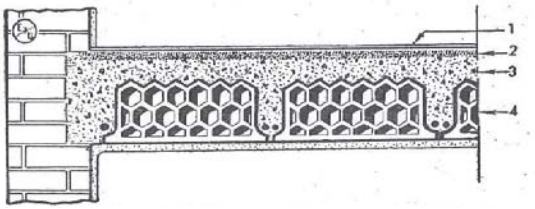
It is advisable **to limit the applied loads as much as possible** by using lightweight concrete, light finishes, screeds with a small thickness and light internal partition walls.



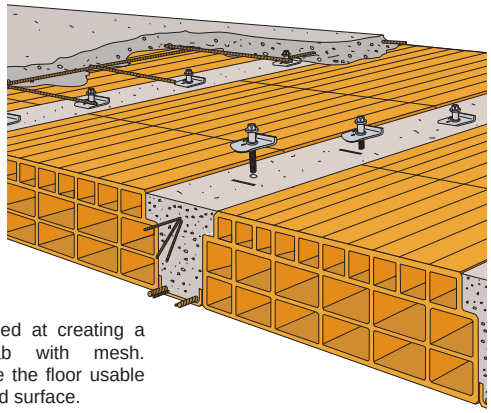
FLOOR WITH REINFORCED CONCRETE AND ORDINARY HOLLOW BRICKS – 1 Floor– 2 Foundation– 3 Concrete casting – 4 Hollow bricks.



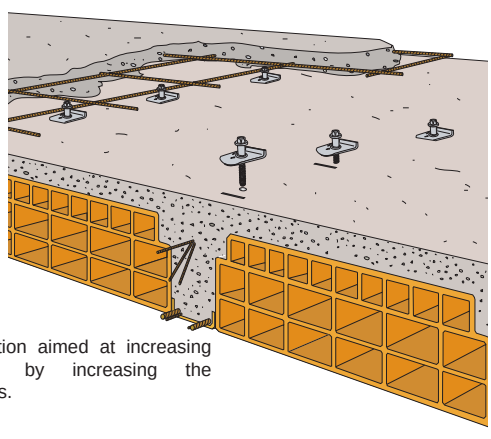
1 Floor – 2 Insulating slabs – 3 Foundation– 4 Concrete casting – 5 Hollow bricks



1 Floor – 2 Foundation – 3 Concrete casting – 4 Honeycomb hollow bricks



Intervention aimed at creating a distribution slab with mesh. Needed to make the floor usable and create a hard surface.

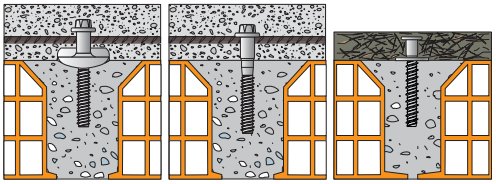


Intervention aimed at increasing strength by increasing the thickness.

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: screw-only connector used for less demanding applications.
MINI CEM: connector designed especially for connecting thin layers of high performance concrete (FRC).

Concrete

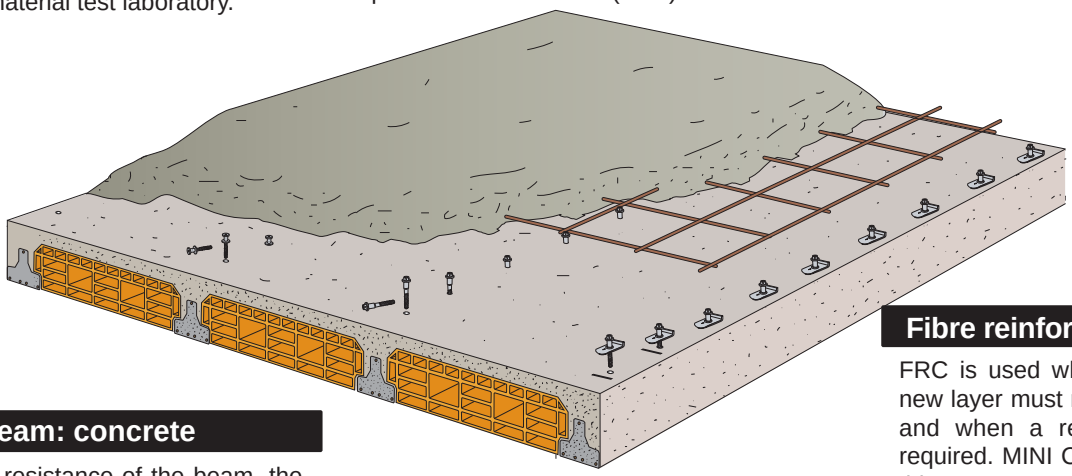
Structural concretes of a minimum class C25/30 with a minimum thickness of no less than 5 cm are normally used. No technical installations must pass through the load-bearing slab. Dampen the floor before pouring the concrete.

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.

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.

Existing beam: concrete

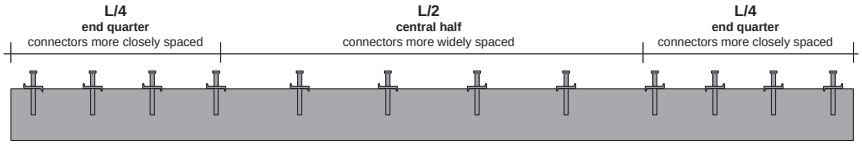
The bending resistance of the beam, the shear resistance and the resistance of the connector depend on the compressive strength of the existing concrete.
It must be at least C16/20.

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.

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.

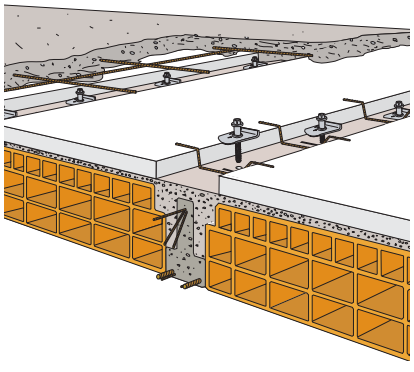


Floor thickness

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)

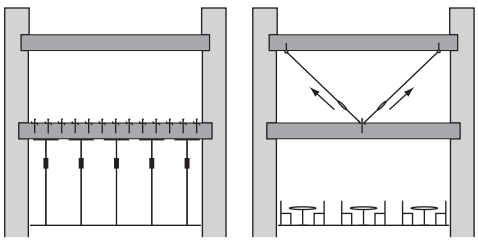
Insulation

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.



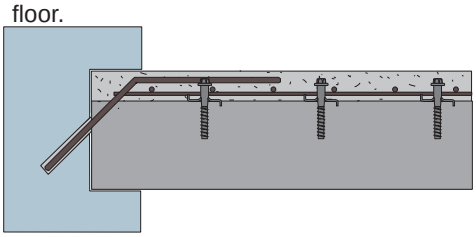
Shoring

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.



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.

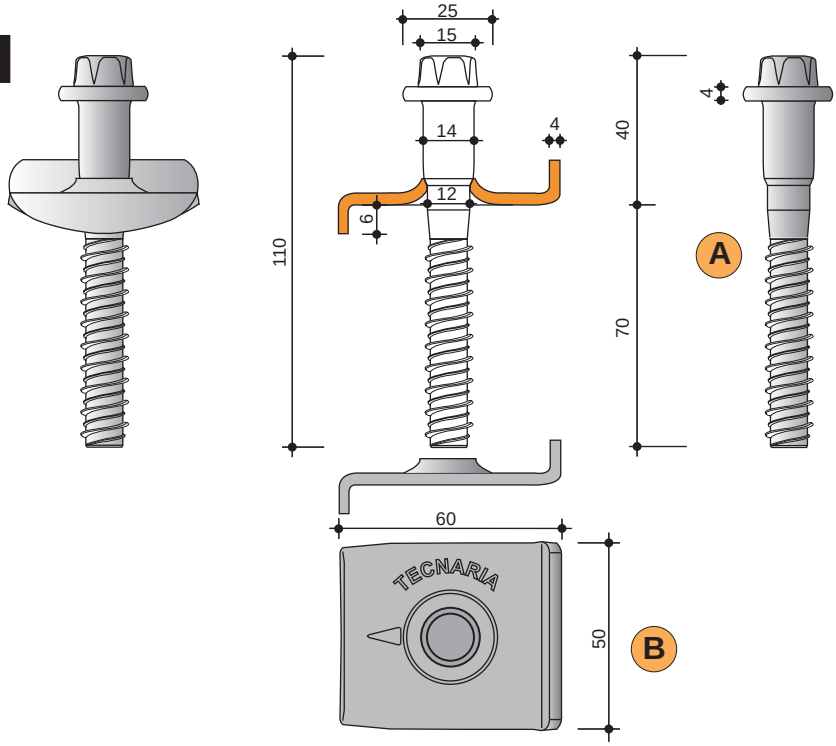
Data Sheet

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.

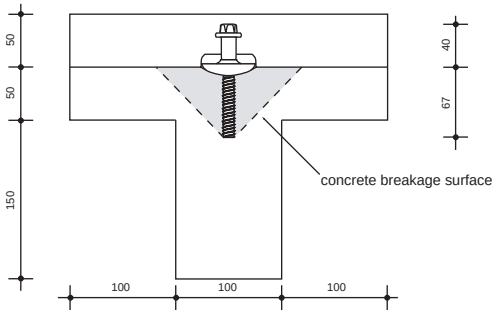
Code	Height connector
CT CEM 14/040	40 mm



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

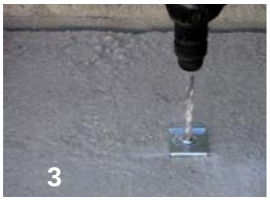
The table shows the reference values relating to the tests carried out at the Laboratory of Building Science of the University Institute of Architecture in Venice (Italy). These tests were carried out according to the procedures indicated in Eurocode 4 ENV 1994-1-1.
The results shown are for connectors 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 not reduced due to thin sections.

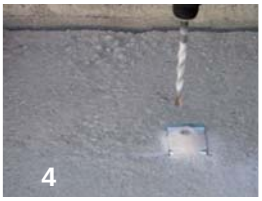


Geometry of the tested specimen

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

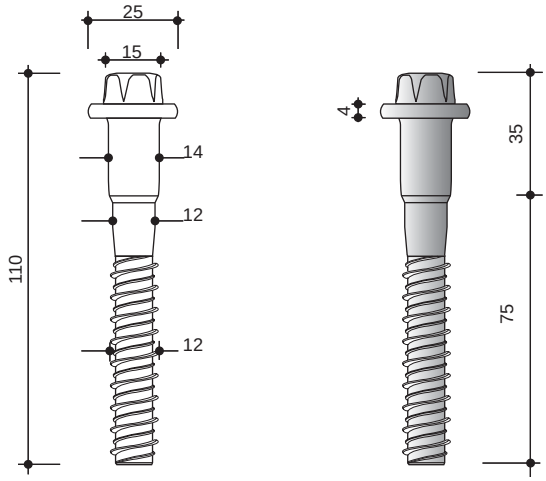
Shank Ø 14 mm - screw Ø 12 mm

This connector offers the quickest form of installation.

The connector comprises a 10.9 steel screw with hi-low thread (lower part) and hexagonal head (upper part).
It is fixed by dry screwing the screw 75 mm, into a specially made hole in the concrete. The head should protrude by 35 mm. Fixing is completely mechanical, as no resins or chemical additives are required. The connection process is therefore fast, economic and clean.

Data Sheet

The **TECNARIA** screws connector used to integrate a new concrete layer with an existing one consists of a Ø 12 mm shank of 10.9 tempered steel with a 60 mm threaded part and a 15 mm hexagonal head with a Ø 25 mm fake washer, for a total lenght of the screw of 110 mm



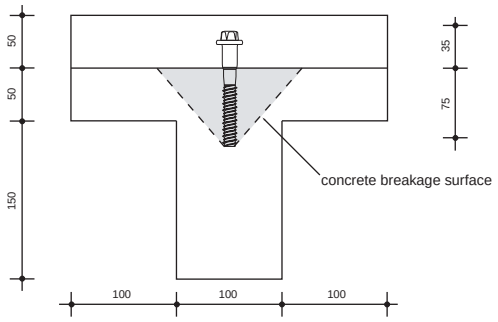
Specifications: Galvanised screw stud connector for concrete casting integration comprising a Ø14 mm shank of 10.9 tempered steel, with 15 mm washer and hexagonal head, and a 60 mm long, Ø 12 mm threaded body, for a total lenght of 110 mm.

Code	Connector height
V CEM 14/035	35 mm

Strength of the V CEM connector

Breaking load mean P_{um}	Breaking load characteristic P_{Rk}	Design load (S.L.U.) P_d	Allowable load (T.A.) P_{adm}
24.7 kN	16.75 kN	13.40 kN	8.93 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. These tests were carried out according to the procedures indicated in Eurocode 4 EN 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 not reduced due to thin sections.



Geometry of the tested sample

Installation of the V CEM 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 11 mm bit to a depth of 80 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)


1


2


3


4


5

MINI CEM connector

Shank Ø 10 mm - screw Ø 10 mm

The connector used with thin additional slabs

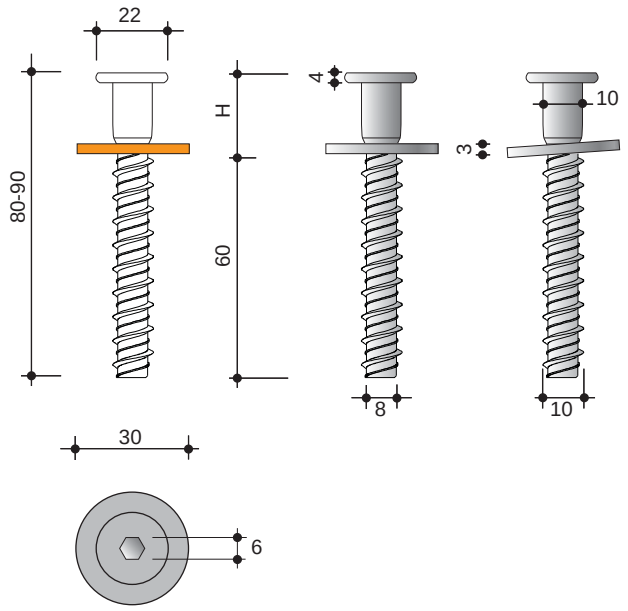
MINI CEM is the screw connector designed to join a thin slab (from 20 mm) with concrete floor joists, including those with reduced dimensions (from 60 mm wide). This connector is recommended in particular for joining the joists to high performance fibre reinforced concrete slabs.
Thanks to the Hi-Low 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 or 30 mm in length, with a 22 mm head and a 6 mm hexagonal hollow.
B) A Ø 30 mm, 3 mm thick free-spinning washer in steel

Specifications: Stud connector with galvanised screw for concrete casting integration. Element comprising a shank in hardened steel with Ø 10mm, 60 mm threaded body; a Ø 10 mm, 20 or 30 mm stud with pre-assembled 3 mm thick free-spinning steel washer 30 mm in diameter and a 6 mm hexagonal head.

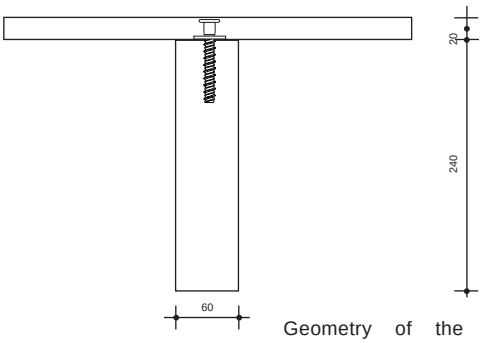
Code	Connector height
MINI CEM 10/020	20 mm
MINI CEM 10/030	30 mm



Strength of the MINI CEM connector

Breaking load mean P_{um}	Breaking load characteristic P_{Rk}	Design load (S.L.U.) P_d	Allowable load (T.A.) P_{adm}
18.6 kN	14.5 kN	9.66 kN	6.45 kN

The reference values of the tests carried out at Tecnaria's test and measurement laboratory are given in the table. These tests were carried out according to the procedures indicated in Eurocode 4 EN 1994-1-1. The results are for connectors that connect a C25/30 type concrete structure – joist to a new concrete slab.
The concrete slab used for the tests is 60 mm wide.



Geometry of the tested sample

Installation of the MINI CEM 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 65 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)

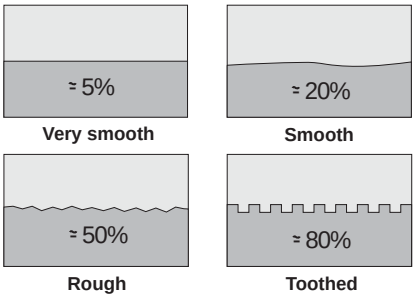
FRC (Fibre Reinforced Concrete) is a cement based (concrete or mortar, single or multi component) composite material, with added fibres of various types and geometries. This composition gives the concrete a high level of resistance to traction and compression, significant ductility, and higher shear 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** metal connectors are installed on the upper surface of concrete joists. All that is needed are simple drills.
MINI CEM connectors have undergone extensive laboratory tests. Thanks to the specific head conformation and reduced heights (20 mm and 30 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.



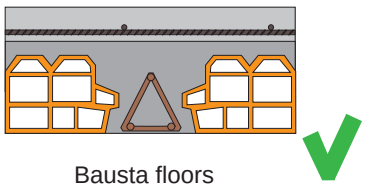
Resistance contribution shown as a %

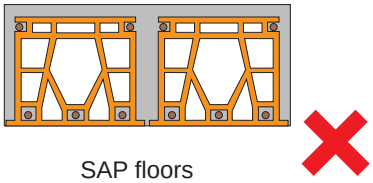
Limitations of use

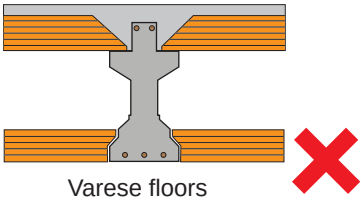
Type of floors

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.

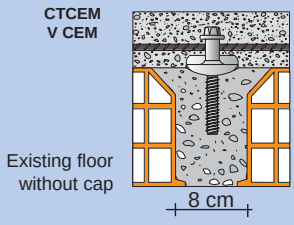
Therefore, the technique proposed is well suited to prefabricated joist floors ‘Bausta type’, while it is difficult for ’Sap type’ or ‘Varese type’ floors, where the concrete joists are of a very small sizes.

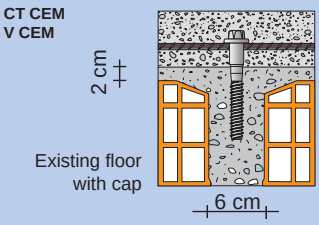

Bausta floors

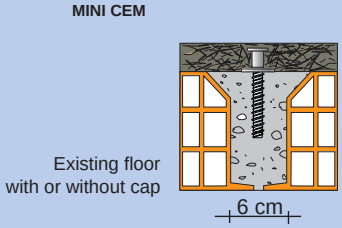

SAP floors


Varese floors

Minimum joist size







Degradation of concrete

The use of connectors is not appropriate where there is a carbonatation 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** and **MINI CEM** connectors.

Angle grinder (code ACT- DW 28113)

900 Watt angle grinder allows cuts to be made in the concrete to insert the connector plate.
Weight: 1.7 kg
Maximum disc diameter 115 mm.

For connectors: **CTCEM**
Related item: 115 mm disc (code DC-DW270XJ)

Abrasive disc Ø 115 mm (code ACT-DW270XJ)

Abrasive disc for stone, 3 mm thick, diameter 115 mm
For connectors: **CTCEM**

Hammer drill (code ACT-DW25123K)

Hammer drill for making holes in concrete, power 800 watt, SDS fitting.

For connectors: **CTCEM, V CEM e MINI CEM**

Related item: drill bit for concrete (code PC11160100)

Drill bit for concrete (code PC11160100)

Drill bit for concrete, diameter 11 mm, working length 100 mm, SDS Plus fitting.

Allows the hole to be made in the concrete for inserting the connector screw.
For connectors: **CTCEM** e **V CEM**

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 **MINI CEM**

Related item: hexagonal drive

Drill bit for concrete (code PC08160100)

Drill bit for concrete, diameter 8 mm, working length 100 mm, SDS Plus fitting.

Allows the hole to be made in the concrete for inserting the connector screw.
For connectors: **MINI CEM**

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**

6 mm hexagonal drive 1/2" square fitting (code ACT-IE6-Q)

6 mm hexagonal drive, with 1/2" square fitting. For tightening the connector screw.
For connector: **MINI CEM**

Laboratory tests

The shear strength of the CTCEM and V CEM 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 strength of the MINI CEM connectors was tested at the TECNARIA test and measurement laboratory following the same procedures.

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 CTCEM connectors.

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

AD Carlo Guazzo - ed. Oct. 2016

Tecnaria S.p.a. Viale Pecori Giraldi 55 - 36061 Bassano del Grappa (VI) - Italy
Tel. +39 (0)424 502029 - Fax +39 (0)424 502386 - info@tecnaria.com - www.tecnaria.com