COMPOSITE STEEL-CONCRETE FLOORS

CTF stud connectors

ETA 18/0447
DoP: 18/0447

DIAPASON
plate connectors

ETA 18/0355
DoP: 18/0355

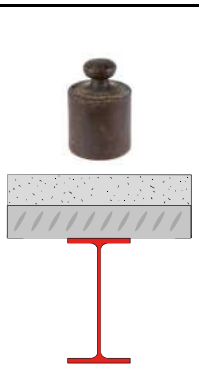
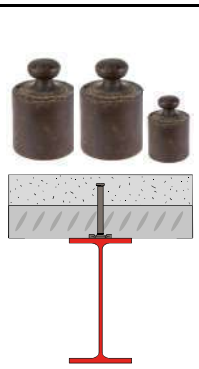
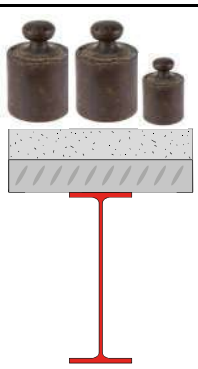
TECNARIA®

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/m²	**IPE 240** connected bearing capacity 1050 kg/m²	**IPE 330** not connected bearing capacity 1050 kg/m²
		
	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.

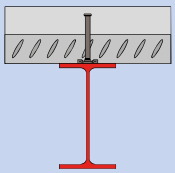
The diagrams on the left demonstrate the advantages of the composite structure. 600 cm long S275JR steel beams are spaced at intervals of 180 cm, with Hi-Bond 55 profiled sheet decking and a 6 cm thick slab of C25/30 concrete covering the sheeting. Props are to be used in the transitional phase and deformations 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

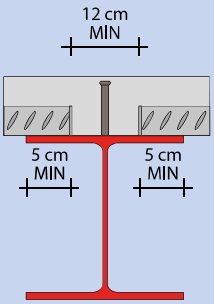
TECNARIA offers special **connectors, simply fastened to the beams with high-strength nails using a special nail gun**, avoiding any need for welding. This simplifies the construction procedures with consequent low costs.
- The **continuity of the profiled sheeting** on top of the beams can be maintained 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.



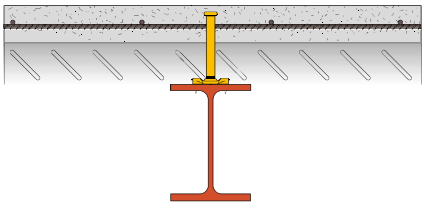
Examples of connection with a welded stud

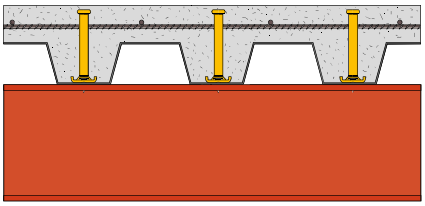
- Connector welded directly onto the beam with interrupted plate. A minimum profile HEA 240 is required and shuttering at the head of the decking to contain the casting.
- Connector welded onto the beam and plate pre-drilled locally in the points where the connectors are to be positioned
- The connector 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



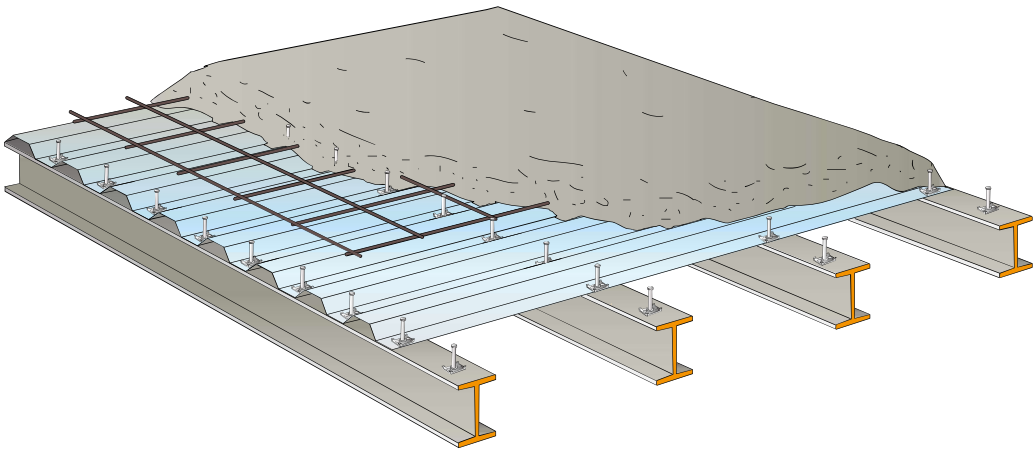


Concrete

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.

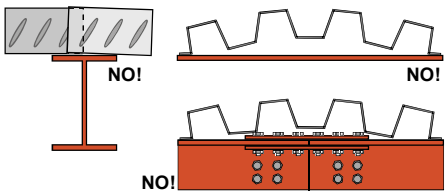
P560 Nail Gun

The nails are fastened with a **SPIT P560 nail gun** which can be **hired** from Tecnaria. 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 Ø 8 mm, mesh 20x20 cm is placed in the middle of the slab. It is not necessary to fix the mesh to the connectors



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.

Steel profiles

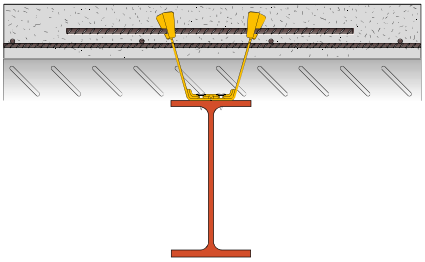
S235, S275 and S355 steel beams can be used, even when painted or hot-galvanised. The connectors can be fixed to profiles with a minimum flange thickness of 8 mm. The nails can also be fixed into solid steel.

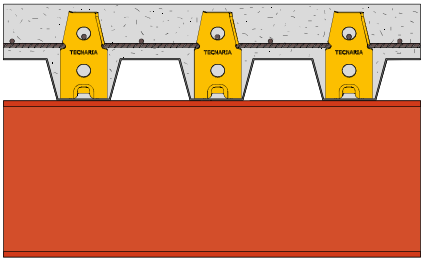
Profiled sheeting

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.

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.





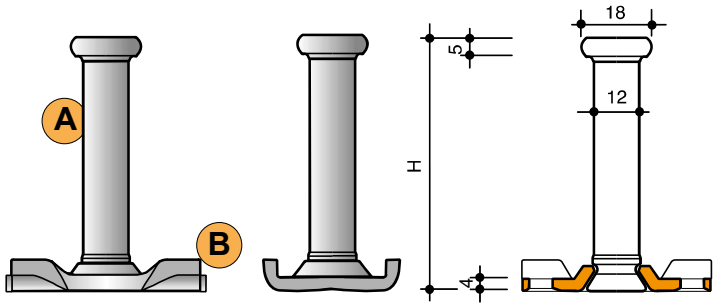
The DIAPASON connector is used whenever it is necessary to fix 2 CTF connectors side by side.

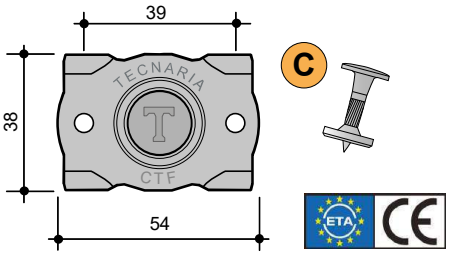
CTF Connector

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.





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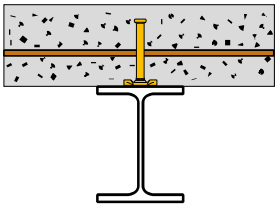
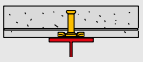
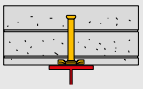
Code	Height shank
CTF020	20 mm
CTF025	25 mm
CTF030	30 mm
CTF040	40 mm
CTF060	60 mm
CTF070	70 mm
CTF080	80 mm
CTF090	90 mm
CTF105	105 mm
CTF125	125 mm
CTF135	135 mm

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

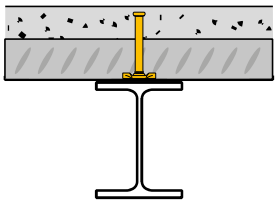


Solid slab

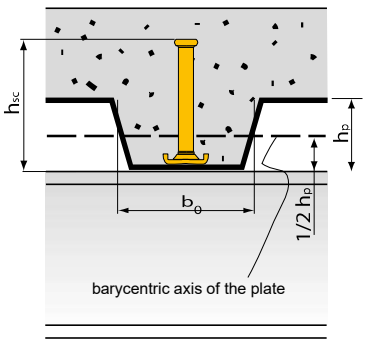
Type	Example	Connector	Shear resistance P_{Rd}	Connector behaviour
Solid slab		CTF040 CTF060 CTF070	30.9 kN	Rigid
		CTF080 CTF090 CTF105 CTF125 CTF135	39.8 kN	Ductile

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



Metal 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.

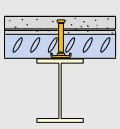
When a connector is fixed in the trough of a sheet of profiled sheet decking into the supporting beam which is laid at right angles to the beam, the resistance of the connector depends upon the class of concrete used, the geometry of the ribs of the sheeting and the height of the connector. The resistance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

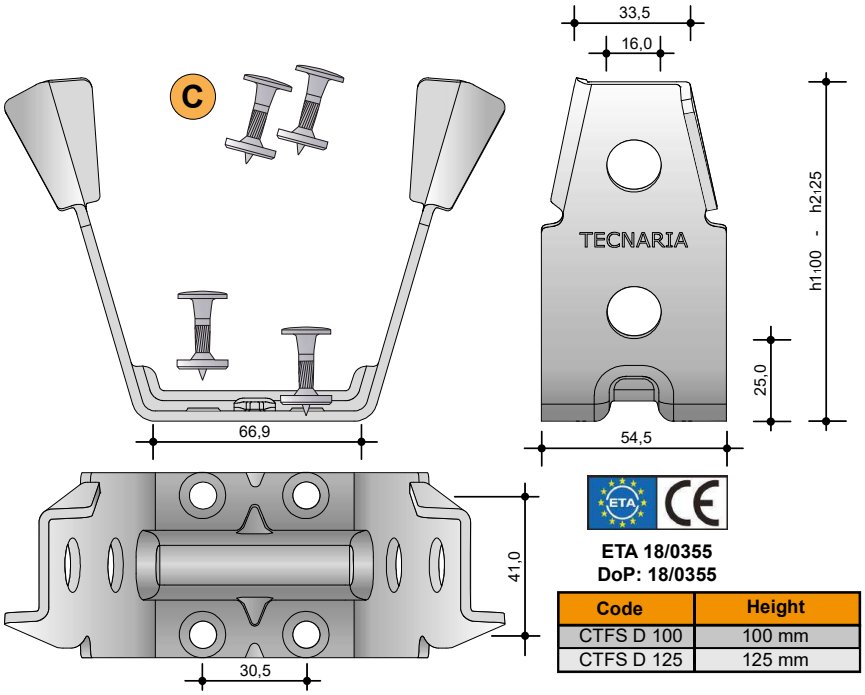
Example of the application of the formula for the sheer resistance with profiled steel decking.

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.

DIAPASON® connector

Base 55x70 mm fixed with 4 nails



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Code	Height
CTFS D 100	100 mm
CTFS D 125	125 mm

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 Ø 4.5 mm, length 22.5 mm, Ø head 14 mm

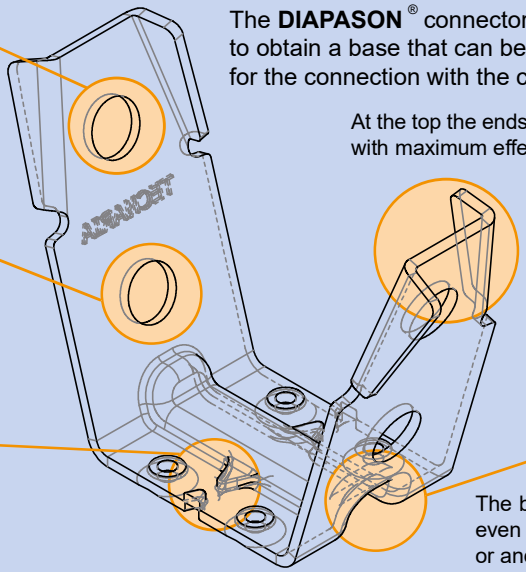
Specifications: Pressed connection bracket in 3 mm thick galvanised plate. Dimensions of the ribbed base plate 70x55 mm with two tilted wings 55x100 mm / 55x125 mm.
Shaped for use on various types of plate and designed to receive reinforcing bars. Fixed to the structure with 4 high-strength nails. CE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

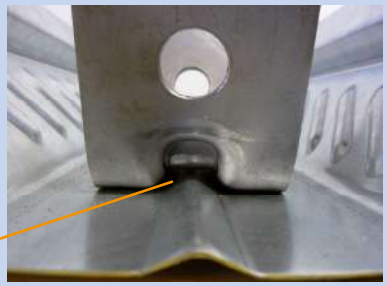
The two holes at the bottom allow the resistance to be further increased with the possible insertion of the steel bars which reinforce the profiled sheeting, a necessity in the case of fire-resistant structures.

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



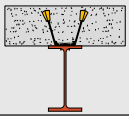
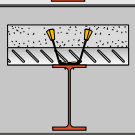
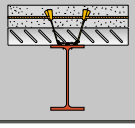
The **DIAPASON®** connector is made of galvanised plate 3 mm thick, shaped so as to obtain a base that can be easily fixed to the steel beam and two wings at the top for the connection with the concrete.

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 **1 connector each trough**		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.

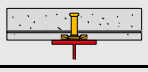
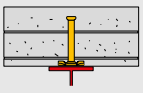
REHABILITATION OF EXISTING STRUCTURES

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

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

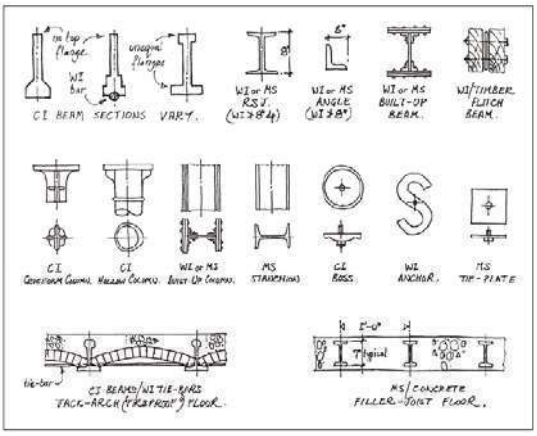
Type	Example	Connector height	Shear resistance P_{Rd}
Solid slab		40 mm 60 mm 70 mm	30.9 kN
		80 mm 90 mm 105 mm 125 mm 135 mm	39.8 kN

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.

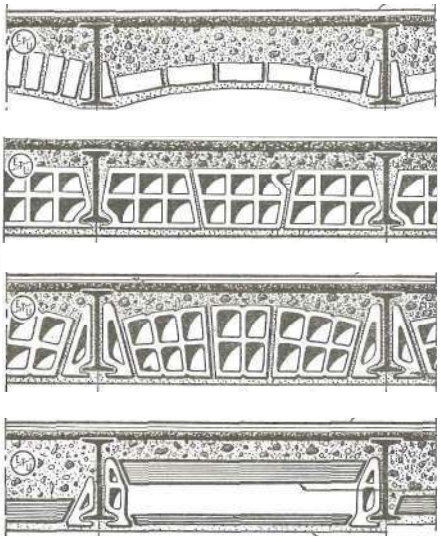
Work phases

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.



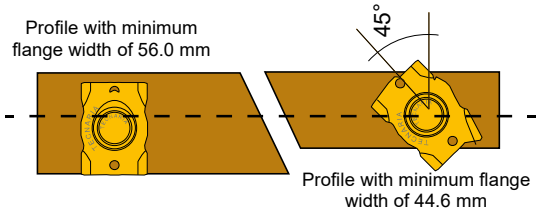
According to the technical manuals of the period the stress on the beams could vary from a minimum of 900 Kg/cm² to a maximum of 1600 Kg/cm².



Examples of clay tile arched floors

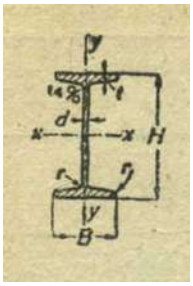
When profiles have a flange thickness of less than 8 mm in the position where nails are fixed or when the width of the flange is less than 56 mm, it is possible to rotate the connector so that the fixing holes are nearer to the axis of the beam (greater thickness).
The connector can be rotated to an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

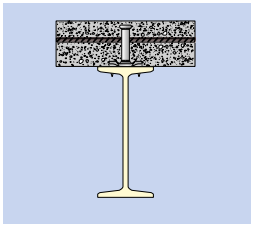


STEEL BEAMS AND BRICK ARCHES

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

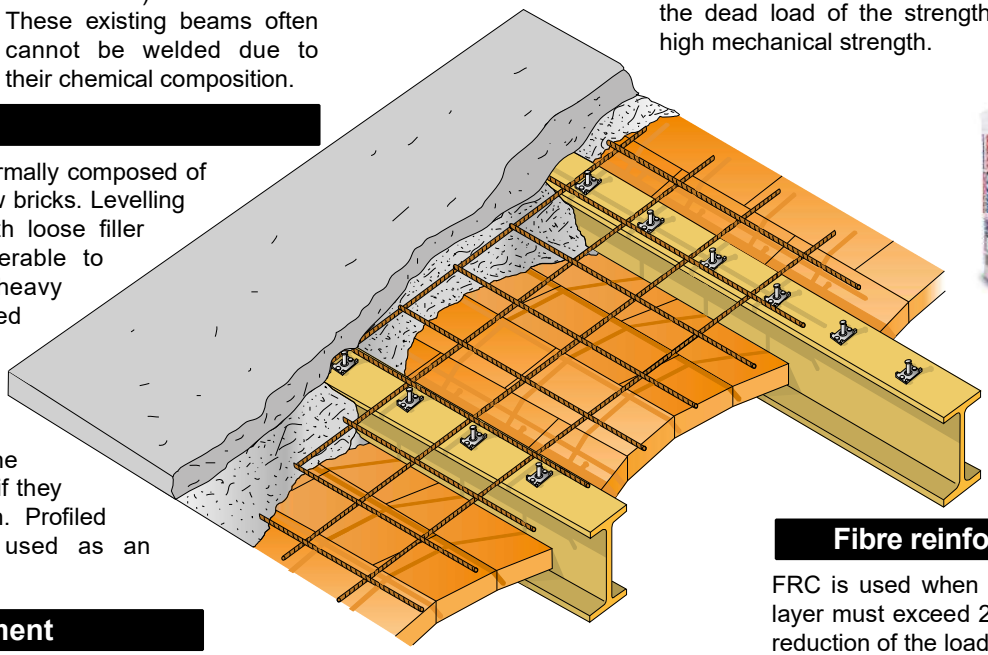
Structural concretes of minimum class C25/30 are normally used to make the load-bearing slab, with thickness no less than 5 cm. The technical installations cannot pass through the slab.

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

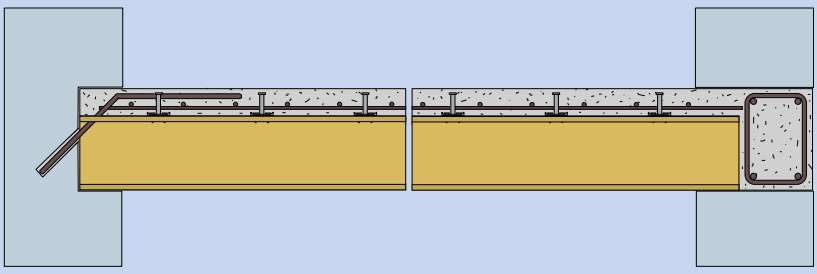
A suitably sized electrowelded mesh must always be laid in the slab. Normally 8 mm diameter, 20 x 20 cm mesh is used. It is not necessary to fix the mesh to the connectors.

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.

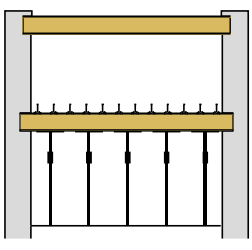


Installation

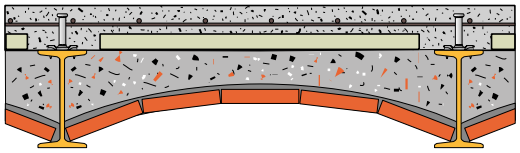
One of the main merits of the system is the rapid and safe way of fixing, carried out with a nail gun, which is available on hire. However, fixing the nail into the beam may create vibrations and this must be taken into account if there are elements that could be damaged (e.g. plaster ceilings). In these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

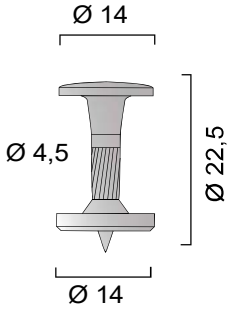
fastening tool with kit for fixing DIAPASON: weight 3.7 kg

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/mm2
Yield strength:1600 n/mm2
Mechanical zinc plating, minimum 10 micron
Hardness > 57 HRc
Knurled shaft
With steel washer Ø 14 mm

Chiodatrice per fissaggio lamiere (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