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Design of peripheral ties with connection system for easier and faster building

The design and execution of the floors is often an important factor when building with precast concrete elements. As a frequently preferred solution, floors are executed in complex in-situ concrete or with semi-precast elements, since in these construction methods it is easy to provide a load-transmitting diaphragm effect with load-transmitting peripheral ties. However, new connection systems offer an attractive alternative for easier and faster building.

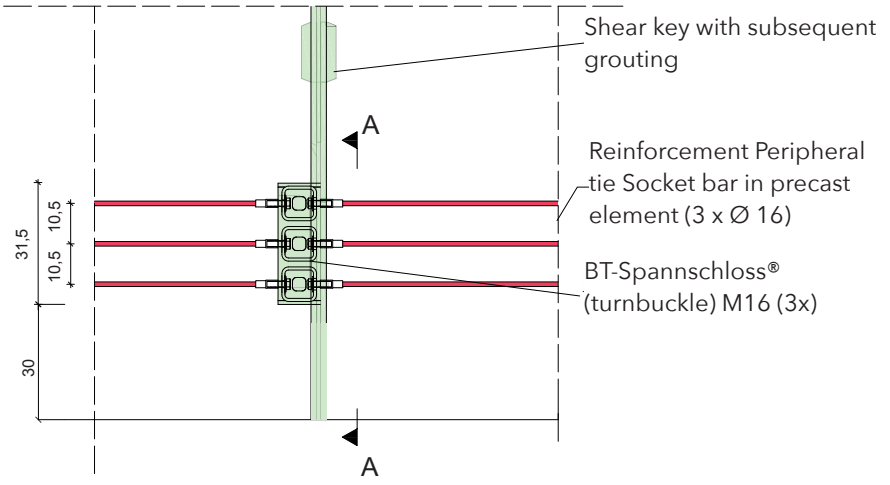
For the erection of floor elements, whether weight-reduced prestressed hollow-core slabs or solid concrete floors, a peripheral tie is usually required. The common procedure is to execute the peripheral tie in the joints between the floor element and the wall and/or edge formwork. This is provided with reinforcing bars in the required number and diameter and with the appropriate lapping lengths, which are installed and cast with concrete. With higher tensile loads, the peripheral tie is executed with welded joints.

However, subsequent installation of the reinforcement and grouting slows the construction progress and - owing to the required curing times to establish the necessary concrete strength - may even lead to standstills. By using the BT-Spannschloss® system from BT innovation, this delay can be prevented. The peripheral tie is already integrated during precasting of the floor elements. The principle can be seen in Figure 2 and is based in the concrete example on socket or double socket bars. In the case of double socket bars, these must be made to measure for the length of structural element. In the case of simple socket bars, these are coupled with an overlap into the reinforcement of the precast concrete element. Additional recesses for the BT turnbuckles are incorporated in the precast concrete plant.

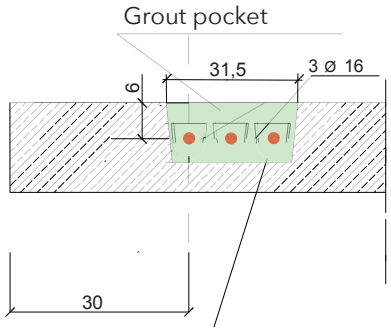
The suitable turnbuckle size is selected depending on the resulting loads and in accordance with the usable floor height. The application is possible from a floor thickness of 10 cm. The number and diameter of the peripheral tie reinforcement bars are dimensioned according to the resulting forces.

The peripheral tie, according to EN 1992-1-1 and the national annex, must have a tensile force of $F_{tie,per} = l_i \times q_1$ or higher, or equal to 70 kN. As a rule, the peripheral tie should be arranged within an edge distance of 1.2 m.
For the tensile force of a peripheral tie of 70 kN, for example, 3 BT turnbuckles M12 or alternatively 2 BT turnbuckles M16 are required (Fig. 1). For a peripheral tie with a load capacity of up to 130 kN, 3 BT turnbuckles M16 are required. The loads are transmitted through the socket bars and the BT turnbuckles.

Fig. 1: Perspective representation of the design of the peripheral tie with the BT-Spannschloss® (turnbuckle).



Section A - A



3x BT-Spannschloss® (turnbuckle) M16

Fig. 2: Schematic representation of the formation of a peripheral tie with the BT-Spannschloss® (turnbuckle) M16.

It is also possible to combine different sized turnbuckles for one peripheral tie, but this should only be used in exceptional cases for ease of installation. Depending on the size of the turnbuckles and the number of connections, the maximum tensile forces that can be transmitted in the peripheral tie vary (see Table 1).

The above also applies analogously to the formation of internal prestressing anchors.

The diaphragm action of the floors is achieved constructively by the formation of the joint with shear key, mortar application, roughness of the joint, etc.
The complete system of the peripheral tie thus consists of the peripheral tie reinforcement of socket bars or double socket bars, the BT-Spannschloss® (turnbuckle) and the two bolts with washers. The quality of the bolts and washers is specified in the general building authority approval for the BT-Spannschloss® (turnbuckle) Z-14.4-599 (valid until 02 May 2025).
It is currently assumed that the socket bars have the same reinforcement diameter as the turnbuckle screws. Depending on the application and static calculation, it is also possible to use socket bars with pressed-on sleeves where the reinforcement diameter is reduced.

Tab. 1: Maximum tensile load bearing capacity of the peripheral tie in kN when designed with the BT-Spannschloss® (turnbuckle)

	Number of connections					
Turnbuckle size	1	2	3	4	5	6
M12	33.7	67.4	101.1	134.8	168.5	202.2
M16	43.5	87.0	130.5	174.0	217.5	261.0
M20	52.5	105.0	157.5	210.0	262.5	315.0

Fig. 3: Lateral view of the connections of socket bars on a disposable recess body

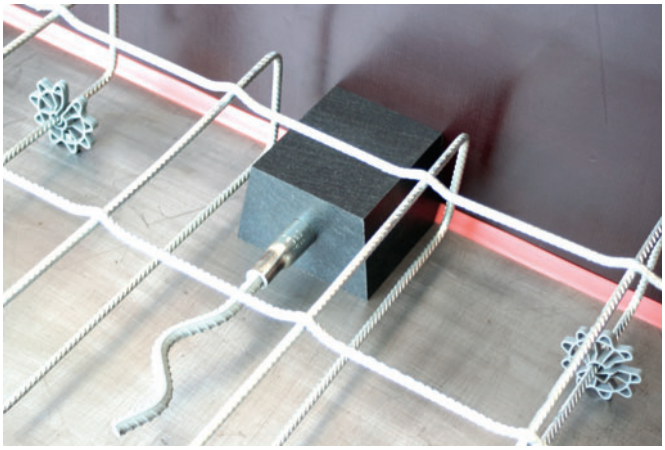


Fig. 4: Single PE recess body installed in the formwork

Position sockets are available as standard on the market, with which the socket bars in the two floor elements could alternatively be screwed together, but the smallest manufacturing and installation tolerances lead to a deviation of the reinforcement axes and thus to problems and time-consuming reworking. The design of the BT turnbuckles with two-axis slot holes allows tolerances and dimensional inaccuracies to be compensated without any problems.

Prefabrication in the precast plant

During the prefabrication of the floor elements, the socket bars are attached to the recess bodies. This ensures the exact position of the reinforcement. Fig. 3 shows a temporary disposable recess body with screwed-on reinforcing bars. PE recess bodies are used for repeated production of the same type (Fig. 4). These can optionally be equipped with clamping magnets.

The design of the recess bodies ensures not only the exact lateral position of the reinforcement but also the required concrete cover. This is an important criterion for fire prevention requirements.

Work steps on the building site

On the building site, the precast concrete elements are deposited at their destination and the BT turnbuckles are just inserted into the recesses and connected to the socket bars by means of screws (Figs. 1 and 2). The load-bearing capacity of the peripheral tie is already guaranteed immediately after bolting. The small grout pockets are subsequently filled with concrete.

Compared to the classic methods such as welded joints, the quality is noticeably increased and the time required for work and coordination is reduced. It is possible to compensate for tolerances and reduce the risk of fire.

This solution is currently being used in the construction of a large office building. A classic welded peripheral tie is replaced by the BT-Spannschloss® (turnbuckle) solution. It is assumed that costs will be significantly reduced across all subsectors of production and assembly and that assembly will be accelerated. Added to this is the reduction of weather dependency and increased cleanliness on the floor.

Fig. 5: Turnbuckle sizes M12 – M16 – M20

This means that the BT-Spannschloss® (turnbuckle) has found a further area of application for optimising construction work, in addition to the structural connections of floor elements that have already been frequently used. ■

FURTHER INFORMATION

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