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Innovative turnbuckle system used in major project with timber-hybrid construction method

The design and layout of the floors is often an important part of 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 achieve a load-transmitting diaphragm effect with load-transmitting peripheral ties. However, new connection systems offer an attractive alternative for easier and faster building.

In most larger buildings, peripheral ties in the floor area are an absolutely necessary structural element. The more the development moves towards largely prefabricated wall and floor elements, the more important a similarly prefabricated peripheral tie system becomes, the execution of which can keep up with the ever faster assembly progress.

However, the traditional production of a peripheral tie with the installation of reinforcing bars with appropriate covering lengths and subsequent grouting with concrete slows down construction progress and may even lead to downtimes, as a required minimum strength of the grouted concrete must be achieved before the floor is fully load-bearing.

By using BT-Innovation's BT-Spannschloss® turnbuckle system in combination with socket bars, most of the peripheral tie production is transferred to the prefabrication and integrated into the production of the floor elements. At the construction site, only the pure screw connection of the floor elements takes place. The full load-bearing capacity of the peripheral tie is reached immediately on completion of the screw connection.

This system has now been successfully used for the first time for timber-hybrid floors on what is currently the largest construction site in Germany, the Siemens Campus in Erlangen, Germany.

CREE Buildings – new buildings using the sustainable timber-hybrid construction method

CREE Deutschland GmbH, a subsidiary of the Zech Group, erects buildings using the innovative timber-hybrid construction method. The first buildings erected still had a peripheral tie formed by means of large grouting zones in which the reinforcement was connected with usual overlapping joints, e.g. Handwerkerhaus Bremen, see Fig. 1.

The production of the peripheral tie connection by means of overlap joints in grouting zones has undesirable effects on the construction process, as the peripheral tie is only load-bear-

Fig. 1: Timber-hybrid construction: Handwerkerhaus in Bremen, Germany

Fig. 2: Wall installation at Siemens Campus Erlangen, connection of the walls with the BT-Spannschloss® turnbuckle

ing after the grouting material has hardened, which means that waiting times are always a problem. In addition, moisture is introduced into the building, which is generally undesirable and therefore all grouting work should be minimised.

In a current project, the Siemens Campus II in Erlangen, the peripheral ties are therefore manufactured using the BT-Spannschloss® turnbuckle. Siemens Campus II comprises five buildings with a gross storey area of around 70,000 m². The buildings have five to seven storeys, where groups with five M12 BT-Spannschloss® turnbuckles are used throughout for the peripheral tie, see Fig. 11.

The chosen arrangement of five BT-Spannschloss® turnbuckles has procedural, design and structural advantages that convinced CREE:

Process engineering

The production of the prefabricated floor elements is simplified, thus saving on labour costs: The recess body is attached to the formwork and no additional work is required during concreting to shutter the casting zone and remove concrete.

Construction

The dimensions of the BT-Spannschloss® turnbuckle allow it to be installed in the 10 cm thick concrete plate while maintaining the necessary concrete cover to prove the 90-minute fire protection without any further measures.

Construction technology

The BT-Spannschloss® turnbuckle is connected by means of standard metric screws and is immediately load-bearing. In addition, it is possible to absorb production and installation tolerances between the prefabricated elements.

The amount of grouting per floor element is reduced by about 50% compared to the connection by means of an overlap joint.

BWE-Bau Fertigteilwerk GmbH – High quality precast concrete elements

The BWE-Bau Fertigteilwerk (Weser Ems concrete plant), which has been successful on the market for 68 years, produces high-quality concrete in all its variations at its Lemwerder site and is one of the most efficient plants in the region. The high quality of the products is guaranteed by qualified and highly trained employees who manufacture architectural concrete components for very high design requirements for representative building construction elements. As a new product, the timber-hybrid floors will also be manufactured in fair-faced concrete quality. BWE-Bau is producing 2,350 floor slabs for the current Siemens Campus Erlangen project. The maximum production capacity is 90,000 m² / year.

Peripheral tie with the BT-Spannschloss® turnbuckle for easier and faster construction

With timber-hybrid floors, the upper concrete layer of the floor is reduced. In this case, the concrete was 10 cm thick. For this reason, the BT-Spannschloss® turnbuckle M12 was foreseen for this application, as it has a construction height of only 51.5 mm, thus maintaining the necessary concrete cover for the required fire protection. The number of BT-Spannschloss® turnbuckles and socket bars to be used was selected according to the forces acting on the structure. The peripheral tie, according to EN 1992-1-1 and the national annex, must have a tensile force $F_{tie,\,per} = l_i \times q_1$ and be greater than or equal to 70 kN. The outer peripheral tie of the timber-hybrid floors on the Siemens Campus Erlangen building project was dimensioned for a tensile force of 160 KN. As a result, 5 socket bars were installed at a distance of less than 1.20 m from the outer edge of the floor and the con-

Fig. 3: Perspective representation of the design of the peripheral tie with the BT-Spannschloss® turnbuckle.

nection of the floor slabs to each other was carried out with 5 BT-Spannschloss® turnbuckles.

For the tensile force of a peripheral tie of 70 kN, for example, three BT-Spannschloss® turnbuckles M12 or alternatively 2 BT-Spannschloss® turnbuckles M16 are required (Fig. 3). Three BT-Spannschloss® turnbuckles M16 are required for a peripheral tie with a load capacity of up to 130 kN. The loads are transmitted continuously via the socket bars and the BT-Spannschloss® turnbuckles.

In principle it is possible to combine different BT-Spannschloss® turnbuckle sizes and socket bars with different diameters in order to optimally dimension the tensile load-bearing capacity of the peripheral ties, e.g. a BT-Spannschloss® turnbuckle M16 and a BT-Spannschloss® turnbuckle M12.

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).

Table 1: Maximum tensile load capacity of peripheral ties in kN with the BT-Spannschloss® turnbuckle

Turnbuckle size	Number of connections					
	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

In addition to outer tie rods, many structures also require inner tie rods. These can be executed in the same way with the BT-Spannschloss® turnbuckle and socket bars. Preferably, the structural joints can be used to guide the socket bars. Depending on the construction of the floor, the so-called 3-point connection of the BT-Spannschloss® turnbuckle according to ETA-19/0013 can also be used to connect the rectangular inner tie rod directly to the outer peripheral tie.

The diaphragm action of the timber-hybrid floors is achieved constructively by the formation of the joints with shear key, subsequent mortaring and the roughness of the joint.

The BT-Spannschloss® turnbuckles are connected to the double socket bars with bolts and washers of a specified quality in accordance with the building authority approval Z-14.4-599. This means that the entire system consisting of socket bars or double socket bars, the BT-Spannschloss® turnbuckle and the connecting means is designed to be consistently quality-assured.

Socket bars with the same reinforcement diameter as the turnbuckle bolts are used for the floors in the buildings on the Siemens Campus Erlangen construction project. For other applications, it may be sufficient to use socket bars with pressed-on sleeves whose reinforcement diameter is reduced.

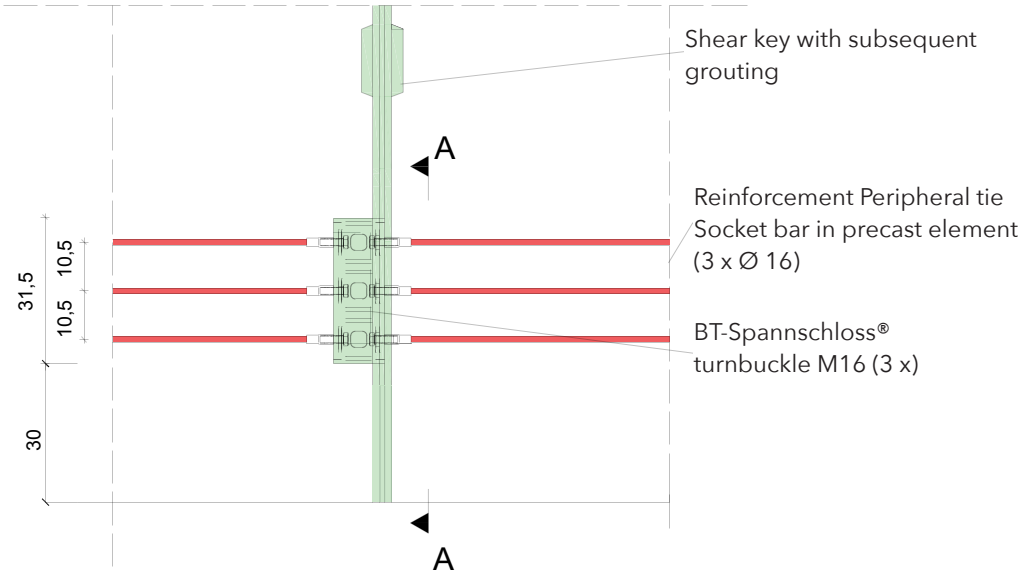

Fig. 4: Schematic representation of the formation of a peripheral tie with the BT-Spannschloss® turnbuckle M16.

Position sleeves that are commonly used on the market to screw socket bars together have the decisive disadvantage that the reinforcement axes must lie exactly in line. Each BT-Spannschloss® turnbuckle has biaxially arranged slots, which allow production and assembly tolerances to be easily compensated. This saves problems and time-consuming rework.

Prefabrication in the precast plant

In prefabrication, the production of the peripheral tie connection requires only a little additional reinforcement work.

The double socket bars are fixed to the formwork and on the other side to a special recess body. Fig. 4 shows the design of the body. Fig. 5 shows a temporary recess body. The recess bodies made of polyethylene, which are intended for the serial production of floors, can optionally be equipped with holding magnets, which greatly simplify the attachment to steel formwork.

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.

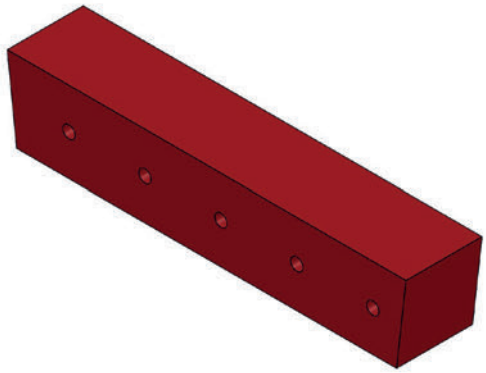

Fig. 5: Drawing of a reusable PE recess body for 5 connection points

Fig. 6: Lateral view of the connections of socket bars on a disposable recess body

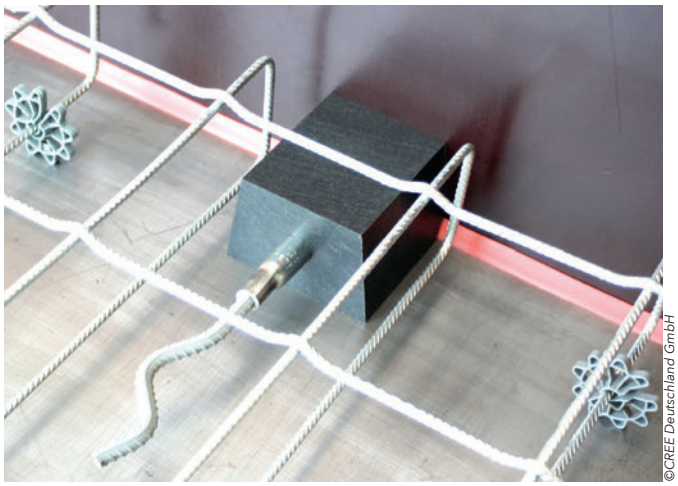

Fig. 7: Single magnetic PE recess body installed in the formwork

Work steps on the building site

The timber-hybrid floor slabs are laid on the construction site with the intended joint spacing. Then only the BT-Spannschloss® turnbuckles have to be inserted into the recesses and screwed to the socket bars on both sides (Fig. 9 and 10). To relieve the mechanics, Fig. 11 shows a special electric screwdriver which shortens the screwing process and relieves the workers. Different joint widths can be achieved with screws of different lengths, provided that the prescribed minimum and maximum screw-in depths in the socket bars are observed.

The load bearing capacity of the peripheral tie is guaranteed immediately after screwing the BT-Spannschloss® turnbuckles. The grouting pockets and joints are subsequently grouted. This work can be carried out independently of further assembly work.

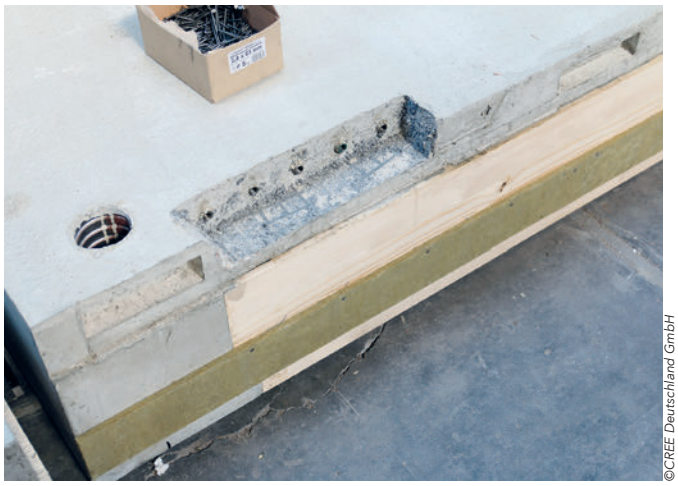

Fig. 8: Demoulded floor slab from fig. 4 with recess for the BT-Spannschloss® turnbuckles

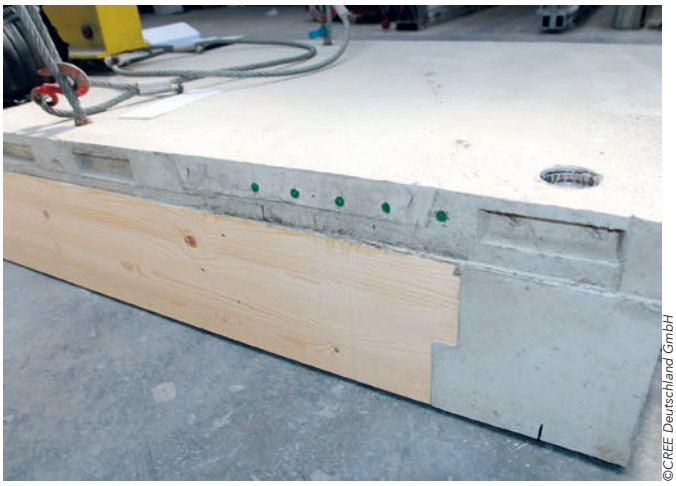

Fig. 9: Floor slab to be connected with flush screw sleeves of the socket bars

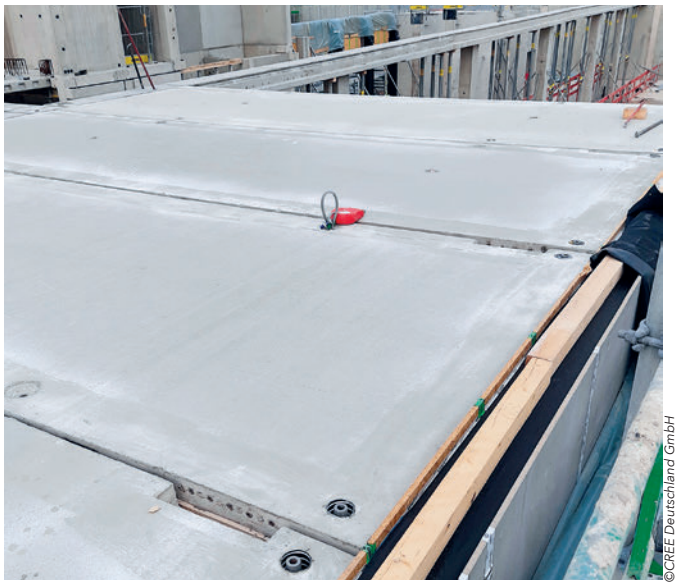

Fig. 10: Installed floor slabs

Fig. 11: Inserting and screwing the BT-Spannschloss® turnbuckles

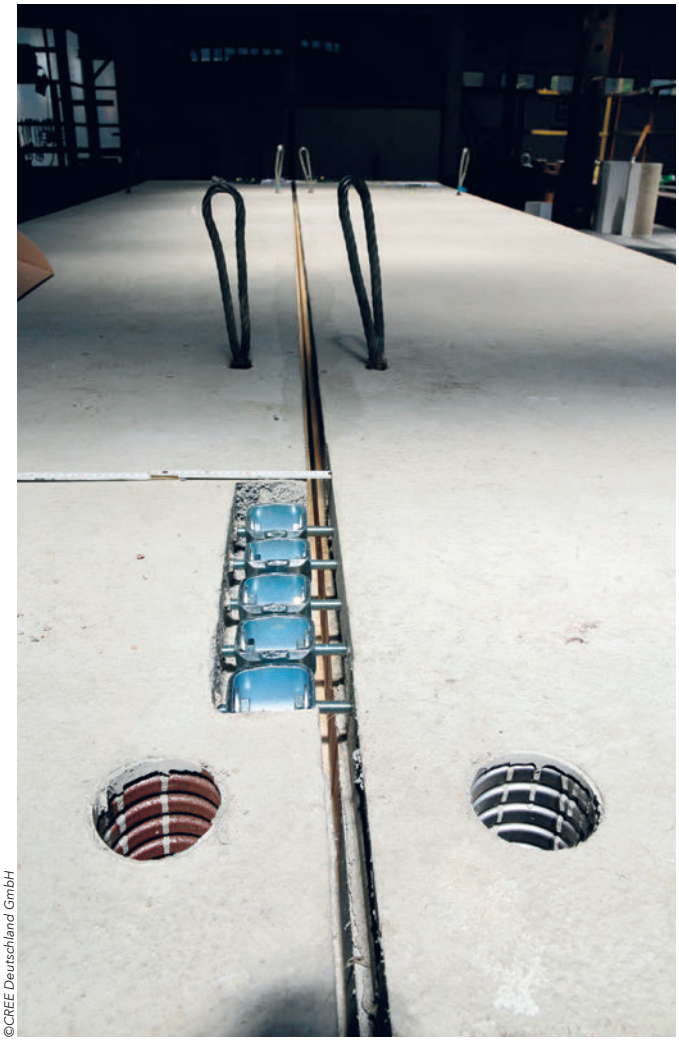

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Fig. 12: Tie point ready for filling with grouted concrete

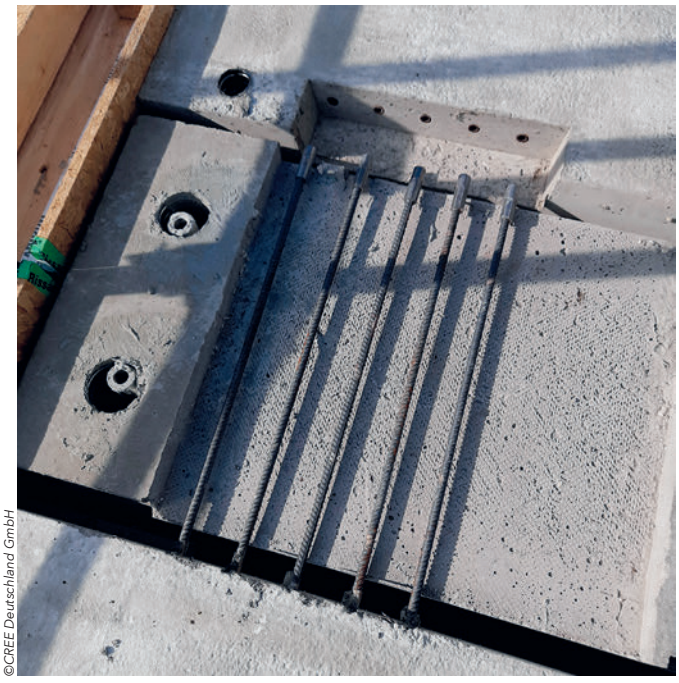

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Fig. 13: Installation of the socket bars over a downstand beam, BT-Spannschloss® turnbuckles not yet inserted

The system of BT-Spannschloss® turnbuckle and socket bars also allows easy execution of connections to rising walls, bridging of downstand beams (Fig. 12) and other connections to ensure the continuity of the peripheral tie.

Conclusions

The use of BT-Spannschloss® turnbuckles for peripheral ties opens up a new field of application. The interaction of the innovative timber-hybrid construction method of CREE Deutschland GmbH with the BT-Spannschloss® turnbuckle will noticeably increase the effectiveness during installation. 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. ■

FURTHER INFORMATION

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