Use reinforced concrete supports as natural conductors in a lightning protection system

White paper

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Nowadays, buildings of almost any size are built with precast components. Extraordinary geometries, high horizontal loads and large span lengths are no obstacle here. Prefabricated parts such as reinforced concrete supports make a crucial contribution to the structure and statics of buildings. Additionally, the steel components / reinforcing bars contained in them are like "natural down conductors".
Simultaneously using the existing building structure as an effective component of a lightning protection system is therefore an economically sensible action.
It is necessary to factor in these actions early on in the planning stage and to specify the connecting points (**Figure 1** – yellow points) to the prefabricated part manufacturer.

Normative references

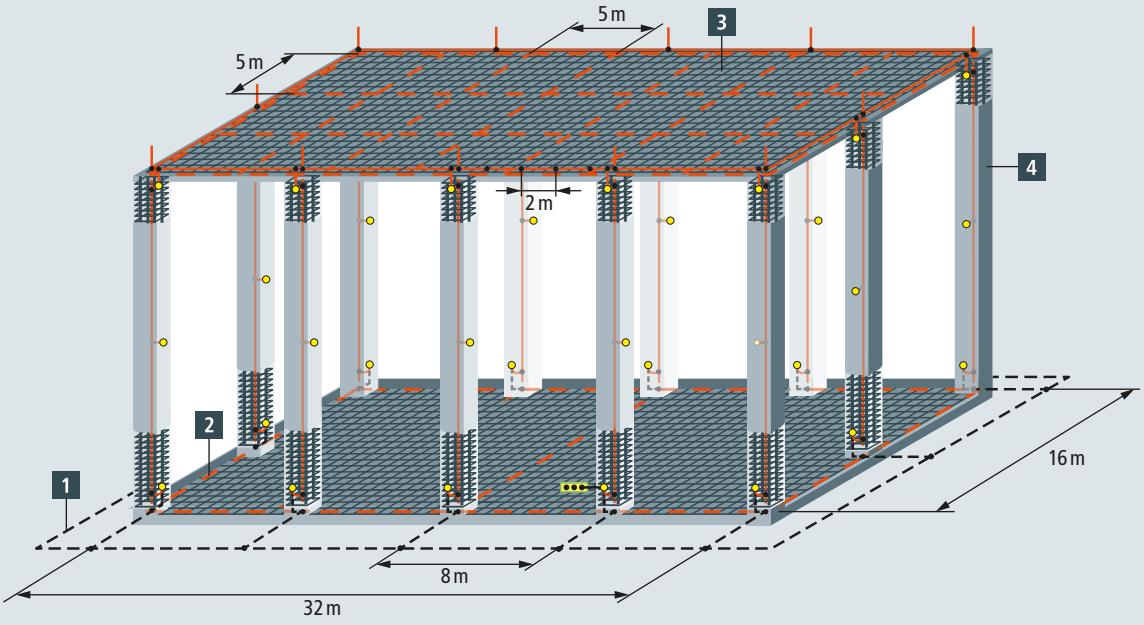
The following parts of a structure can be used as natural down conductors:

- the metal of the electrically connected reinforced concrete framework of the structure.
- the interconnected reinforcement of the structure.

The corresponding minimum dimensions provided in Table 6 of IEC 62305-3 for standard down conductors must be complied with here. For galvanised steel (St/tZn) and for non-galvanised steel (black steel) in concrete, this is a minimum cross-section of 50 mm^2. This equates to a nominal diameter of ≥ 8 mm.
For structures made of reinforced concrete, including precast components, the electrical continuity of the reinforcing bars must be checked between the highest part (e.g. the top) and ground level (e.g. the base). The total electrical resistance must not be greater than 0.2 Ω during the measurement.

Reinforced precast concrete parts

The position and form of the connecting points / termination points should be designated early on when planning the precast components. These connecting points (yellow points) should be arranged so that a continuous reinforcing bar runs through the precast component, from one equipotential bonding connection to the next.
Subsequent, safe electrical interconnection of the reinforcement of these prefabricated parts with the reinforcement of the structure is therefore possible. The individual components should be interconnected on site during installation.



1 Ring earth electrode mesh size as per DIN 18014, max. 10 x 10 m (each down conductor must be connected to the ring earth electrode)
2 Functional bonding conductor mesh size as per DIN 18014, max. 20 x 20 m
3 Equipotential surface in the reinforced concrete slab
4 Reinforced concrete support with connections (yellow points)

Figure 1 Schematic diagram of the building structure

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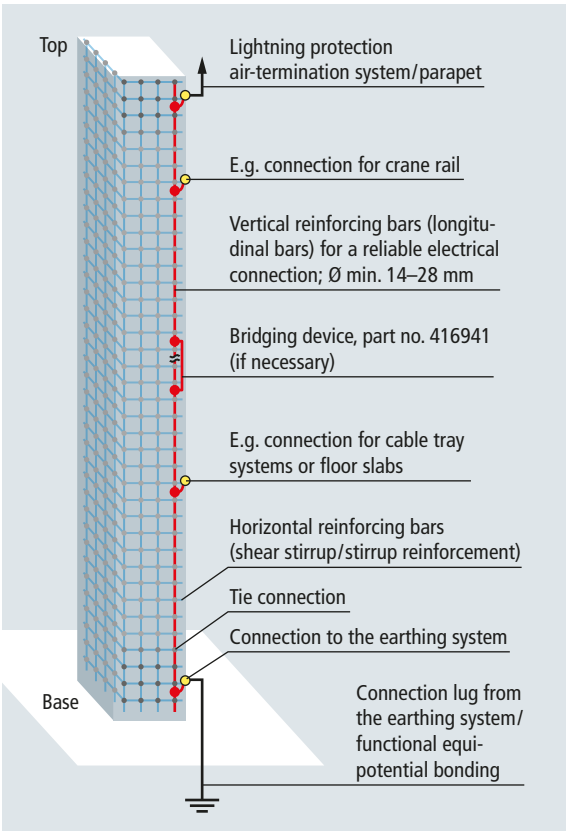

Figure 2 Schematic layout of a reinforced concrete support

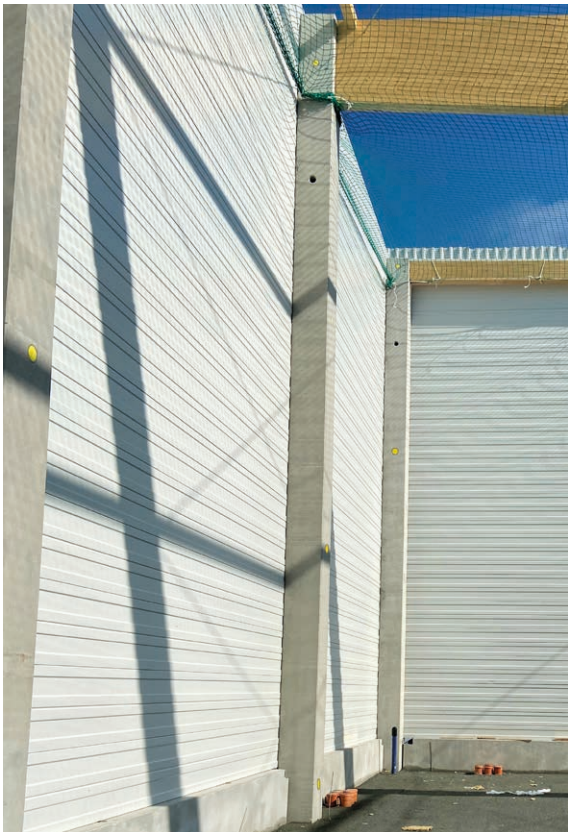

Figure 3 Reinforced concrete supports with connecting points

Lightning protection and separation distance

The air-termination system on the roof surface must be planned and set up so that electrical equipment (e.g. domelights, roof-mounted fans, PV systems) are protected against direct lightning strikes (e.g. using air-termination rods) and the roof surface is protected by a meshed air-termination network by means of round wires. Depending on the intermeshing and the number of connections to the reinforcement, separation distances on the roof surface must be calculated and taken into account where necessary. To comply with this, high-voltage-resistant insulated conductors (HVI Conductors) can also be used. The connection of the air-termination system to the down conductor in the reinforced concrete supports is usually established through the conductive parapet.

Each reinforced concrete support is to be connected at the base to the earthing system / functional equipotential bonding, and at the top (highest point) to the parapet, the mesh of the equipotential surface in the reinforced concrete slab or to the trapezoidal sheet structure (**Figure 1**).

With continuously reinforced concrete supports (**Figure 4** – cage with reinforcing bars) it is assumed that the lightning impulse current not only flows through the continuous reinforcing bars defined as down conductors, but is divided over a large number of parallel paths. The impedance of the network resulting from this is reduced and the voltage drop generated by the "divided" lightning impulse current is smaller.

The resulting electromagnetic field is thus also reduced and internal electrical conductors and systems are thus burdened significantly less.

Due to the multiple and balanced division of the lightning current, the inward separation distances, with natural down conductors in the form of reinforced concrete supports, are reduced so that it is usually adequate to connect the electrical equipment installed there – such as lighting or motors – with surge protective devices (SPD type 2) (lightning equipotential bonding).

Connection device for using the building structures

The reinforcing bars of precast parts in concrete supports or walls are used as natural down conductors. By using a continuous, lightning-current-carrying, connected reinforcing bar in the reinforced concrete support, the additional installation

of round conductors (St/tZn) for lightning protection / earthing / equipotential bonding can be omitted.
The electrically relevant connection is established across the entire length of the reinforced concrete support by a vertical reinforcing bar. Connections to, for example, crane rails or cable tray systems are made here via connection devices (yellow points) (**Figure 2**).
Depending on the structure, the connecting clamp can be connected to reinforcing bars with a diameter of 14 – 28 mm. These vertical reinforcing bars can be supplied and installed uncut in lengths of over 20 metres. If the relevant reinforcing bar is shorter than the reinforced concrete support (overlapping), a flexible bridging device (part no. 416 941) must be used.
A connecting point (connection device) to the earthing system / equipotential bonding system in the floor slab (protective / functional equipotential bonding) is necessary at the base of the reinforced concrete support.
Additional connections must be planned and laid out in detail (quantity, height and position) for the equipotential bonding of:

- Façade elements or metal façades
- Metal cable tray systems
- Technical equipment rooms
- Floor slabs
- Crane rails or
- Other metal parts (e.g. sprinkler piping)

At the top (highest point of the reinforced concrete support), a connection is necessary for the air-termination system of the lightning protection system. How this is performed in practice is shown in **Figure 3**.

Installation

The connection device is designed with a flexible connecting cable, so that simple installation of the fixed earthing terminal in the formwork of the prefabricated element is possible (**Figure 4**). All the positions in the formwork (left and right on the insides) can usually be reached due to the length of the connecting cable (60 cm).
The individual installation steps are described precisely in the accompanying installation instructions. The specified tightening torques must be complied with.

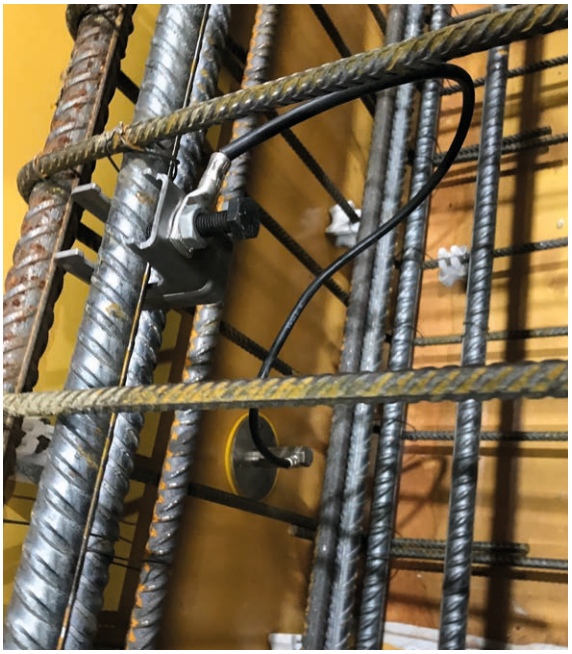

Figure 4 Installation in the formwork

If the necessary connection devices are installed properly as per the specifications in the installation instructions, a lightning current carrying capability of 100 kA (10/350 µs) is ensured.
In addition, after installation, the safe electrical connection of the respective connecting points/devices must be checked and measured. In practice, this is performed with a continuity measurement (2-conductor process; as per DIN 18014*) and documented accordingly. The total electrical resistance / the volume resistance must not exceed a value of 0.2 Ω. Plans or system drawings must be created for the documentation that show all relevant connections and terminals.
The position of the connecting points must be designated early on when planning the precast components. In accordance with these specifications, the flexible connection devices can be installed in the formwork, and natural building structures can thus be used for discharging lightning currents in a technically correct and economically sensible manner.

* An English translation of DIN 18014 can be downloaded for a fee from the following link: https://www.beuth.de/en/standard/din-18014/197068219

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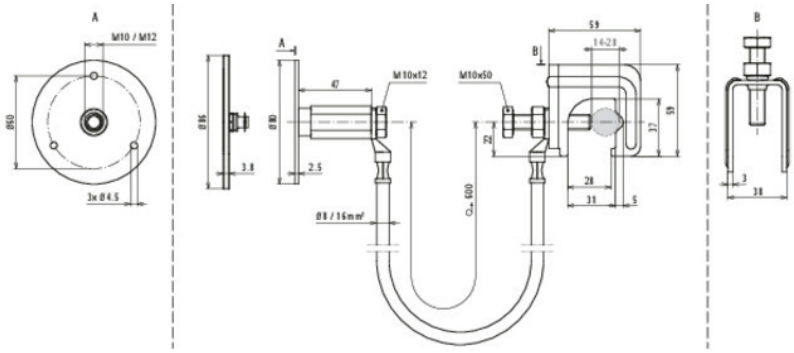
Bridging device

UES 16 L600 VK RD14 28 EFP (416 940)

Figure without obligation



Connection device consisting of connecting cable with connected connecting clamp and fixed earthing terminal.

Arrangement:

Type Part No.	UES 16 L600 VK RD14 28 EFP 416 940
Connecting clamp material	St/bare
Clamping range Connecting clamp	14-28 mm
Screw Connecting clamp	M10 x 50 mm
Fixed earthing terminal material	StSt (V4A)
Fixed earthing point terminal thread	M10 / M12
Bridging cable material	Flexible copper conductor, frost-resistant
Bridging cable cable length	600 mm
Bridging cable cable cross section	16 mm²
Cable lug Bridging cable	M10 / Cu/galSn
Lightning current carrying capability (10/350 µs)	N *)
Standard	EN 62561-1
Short-circuit current (AC 50 Hz / DC) (1 s; ≤ 300°C)	3.1 kA
Weight	513 g
Customs tariff number (Comb. Nomenclature EU)	85389099
GTIN	4013364360280
PU	25 pc(s)

Special lengths possible on request.

*) For exact assignment, see test certificate.

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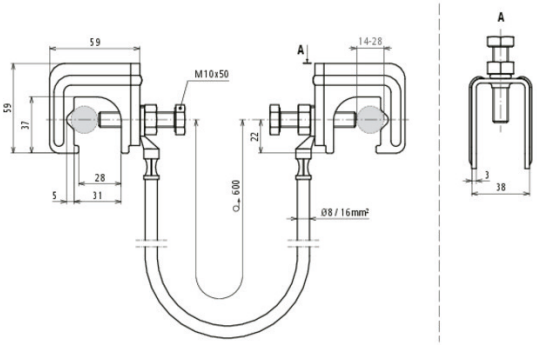
Bridging device

UES 16 L600 2VK RD14 28 (416 941)

Figure without obligation



Bridging device consisting of connecting cable with two connected connecting clamps.

Arrangement:

Type Part No.	UES 16 L600 2VK RD14 28 416 941
Connecting clamp material	St/bare
Clamping range Connecting clamp	14-28 mm
Screw Connecting clamp	M10 x 50 mm
Bridging cable material	Flexible copper conductor, frost-resistant
Bridging cable cable length	600 mm
Bridging cable cable cross section	16 mm^2
Cable lug Bridging cable	M10 / Cu/galSn
Lightning current carrying capability (10/350 µs)	N *)
Standard	EN 62561-1
Short-circuit current (AC 50 Hz / DC) (1 s; ≤ 300°C)	3.1 kA
Weight	497 g
Customs tariff number (Comb. Nomenclature EU)	85389099
GTIN	4013364360273
PU	25 pc(s)

Special lengths possible on request.

*) For exact assignment, see test certificate.

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Surge Protection
Lightning Protection / Earthing
Safety Equipment
DEHN protects.

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