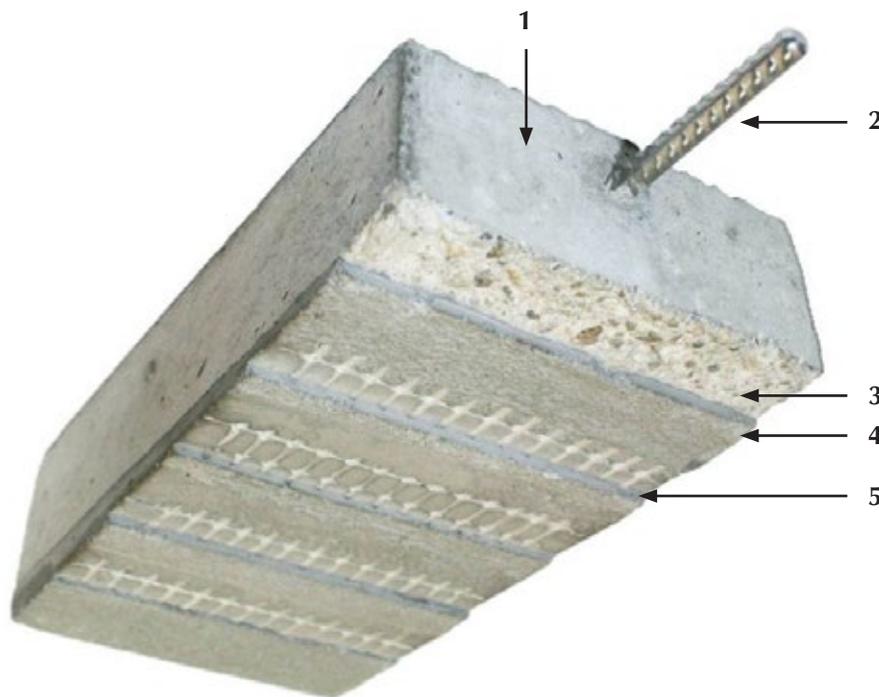


## 4. Construction and process for reinforcements with textile concrete as per abZ [General Building Inspectorate Approval]

### 4.1 Construction

The construction of reinforcement with textile carbon reinforcements is displayed below with the help of schematic diagrams. The requirements regarding the execution of reinforcement are given in detail in 4.2; a dimensioning model is given in section 5.



1. Existing component
  2. Steel reinforcement of existing component
  3. Prepared old concrete surfaces
  4. Fine-concrete layer
  5. Textile reinforcement (max. 4 layers )
- Note: Figure shows AR-glass reinforcement

Fig. 4.1 Bottom view of a 4-layered textile-concrete reinforced ferroconcrete component (main execution; here: AR glass reinforcement)  
Photo: IMB/TU Dresden

#### Explanations

- |  |  |
|--|--|
| <ol style="list-style-type: none"> <li>1 Existing component           <ul style="list-style-type: none"> <li><input type="checkbox"/> Recording of actual status</li> <li><input type="checkbox"/> Requirements regarding component to be</li> </ul> </li> </ol>   | <p>as per section 4.2 of AbZ<br/>as per section 4.3 of AbZ</p>   |
| <ol style="list-style-type: none"> <li>2 Concrete cover of steel reinforcement of existing component</li> </ol>  | <p>at least 10 mm</p>  |
| <ol style="list-style-type: none"> <li>3 Surface preparation of old concrete</li> </ol>  | <p>as per section 4.5 of AbZ</p>   |
| <ol style="list-style-type: none"> <li>4 Fine-concrete           <ul style="list-style-type: none"> <li><input type="checkbox"/> General information</li> <li><input type="checkbox"/> Detailed information</li> </ul> </li> </ol>   | <p>as per section 4.4 of AbZ<br/>as per section 4.6 of AbZ</p>   |
| <ol style="list-style-type: none"> <li>6 Textile reinforcement of carbon yarns           <ul style="list-style-type: none"> <li><input type="checkbox"/> General information</li> <li><input type="checkbox"/> Detailed information</li> <li><input type="checkbox"/> End-anchorage</li> </ul> </li> </ol> | <p>as per section 4.4 of AbZ<br/>as per section 4.6 of AbZ<br/>as per section 5, point 2<br/>available planner portfolio</p> |

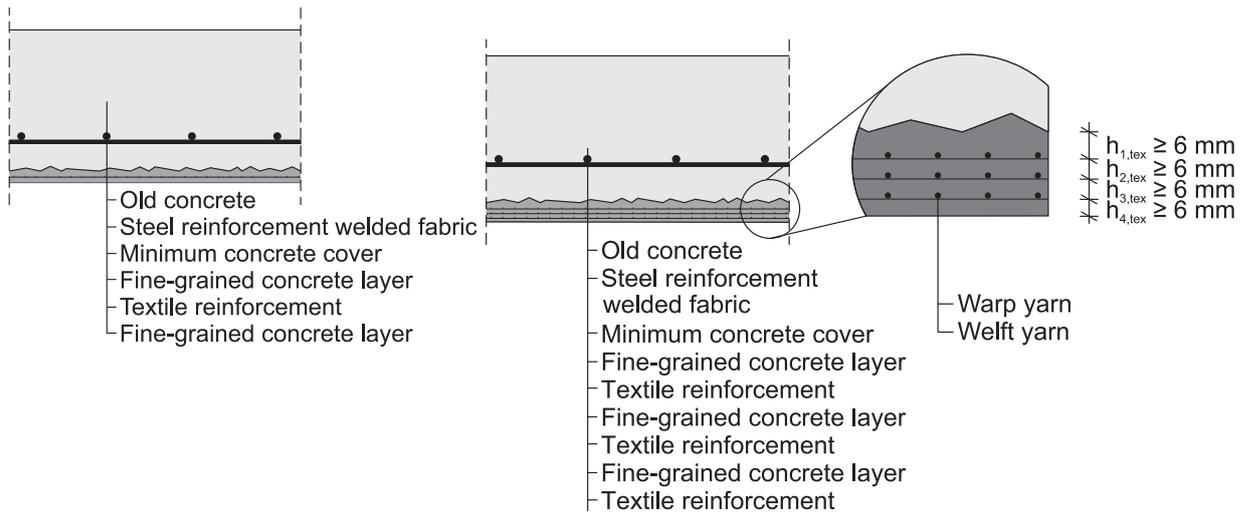
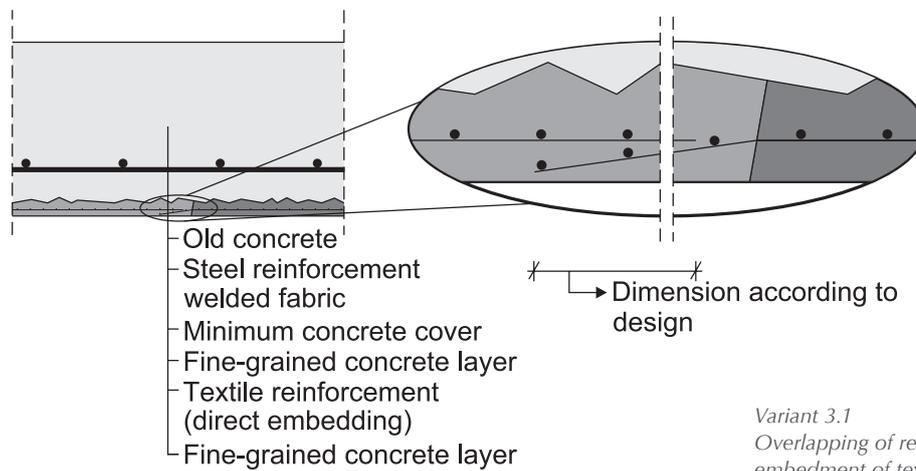


Figure 4.2 Layer structure of a one-layered and a multi-layered carbon reinforced concrete structure – Overview (up to four layers possible)

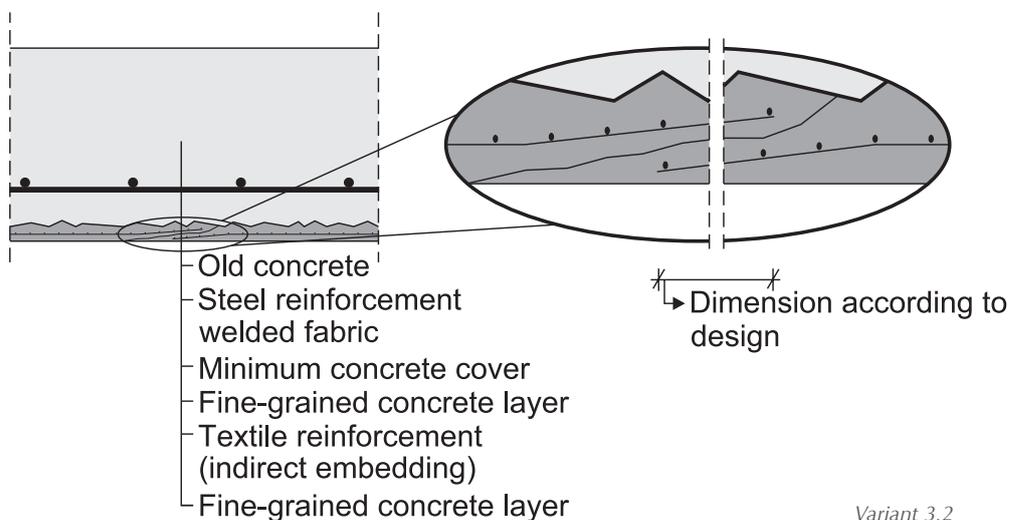
Graphic: Egbert Müller



Variant 3.1  
Overlapping of reinforcement in case of direct embedding of textile reinforcement in a new layer

Figure 4.3 Layer structure in case of overlapping of carbon reinforcement layers – one-layered and multi-layered (Shall include legends, cutting and installation plan)

Graphic: Egbert Müller



Variant 3.2  
Overlapping of reinforcement in case of indirect embedding of textile reinforcement in a new layer

Figure 4.4 Layer structure in case of overlapping of carbon reinforcement layers – one-layered and multi-layered (Shall include legends, cutting and installation plan)

Graphic: Egbert Müller

The following drawings (Figures 4.5 to 4.11) show the process to strengthen a structure with carbon concrete reinforcement for the design example shown in detail, in section 5.

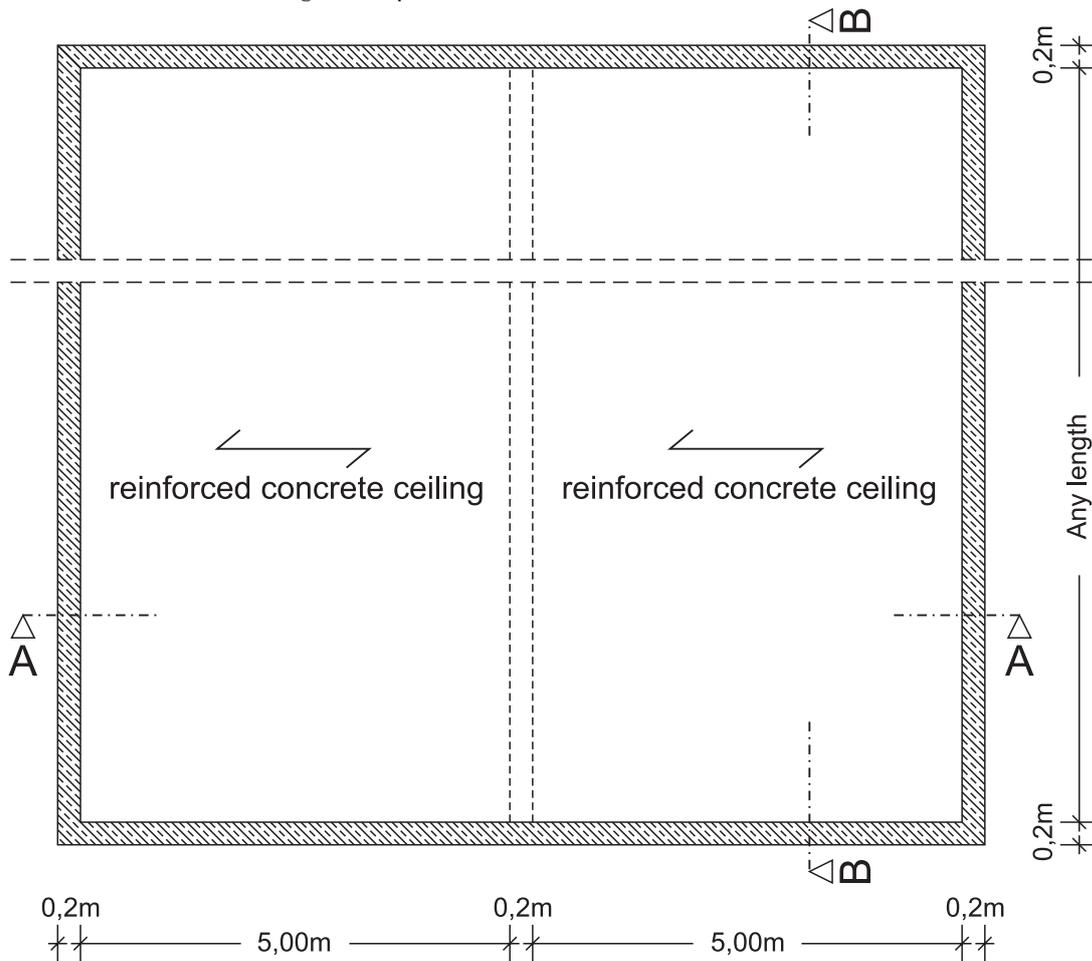


Figure 4.5 Plan view of a section of the structure used in the design example

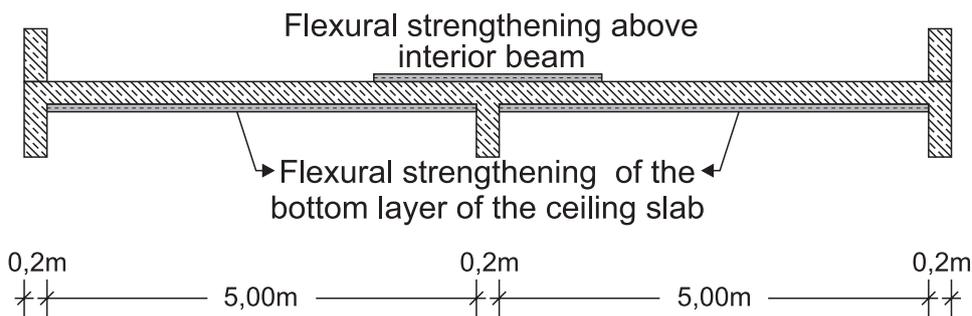


Figure 4.6 Section A-A of proposed strengthening (see also figure 4.8)

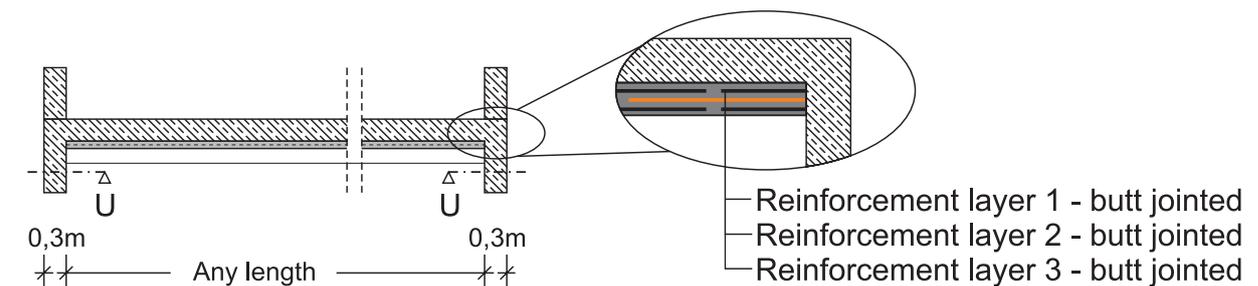


Figure 4.7 Section B-B of proposed strengthening with detailed edge connection (see also figure 4.8)

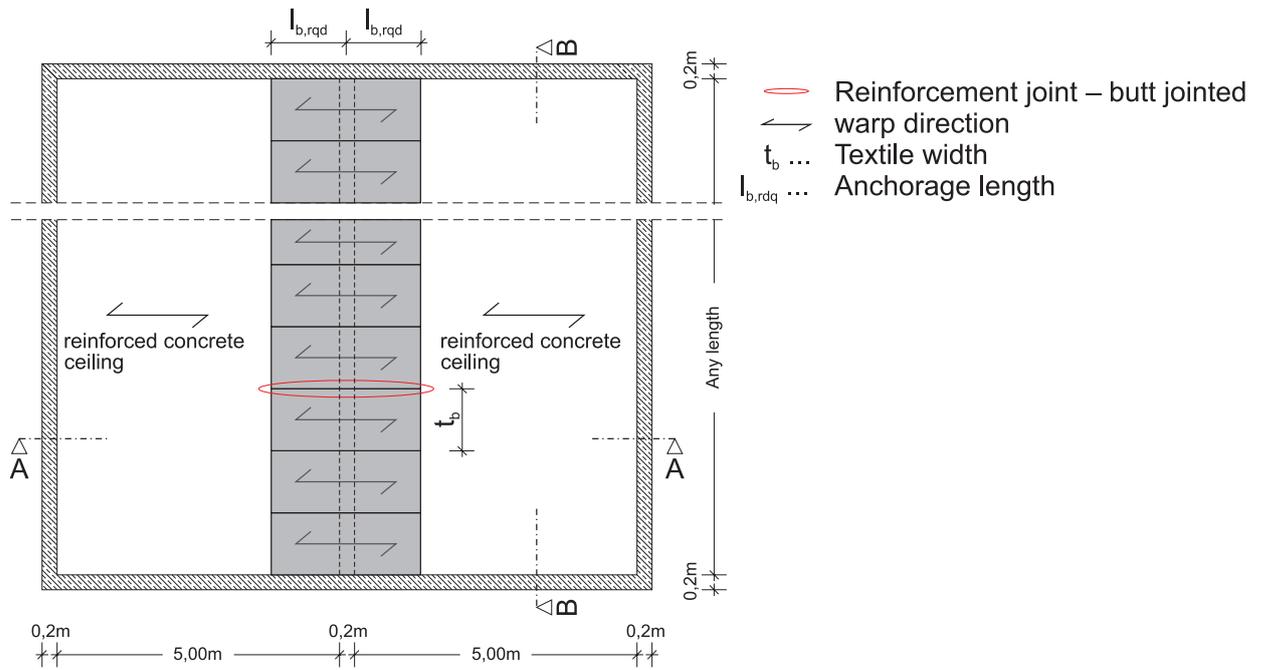


Figure 4.8 Installation plan of strengthening layer above beam

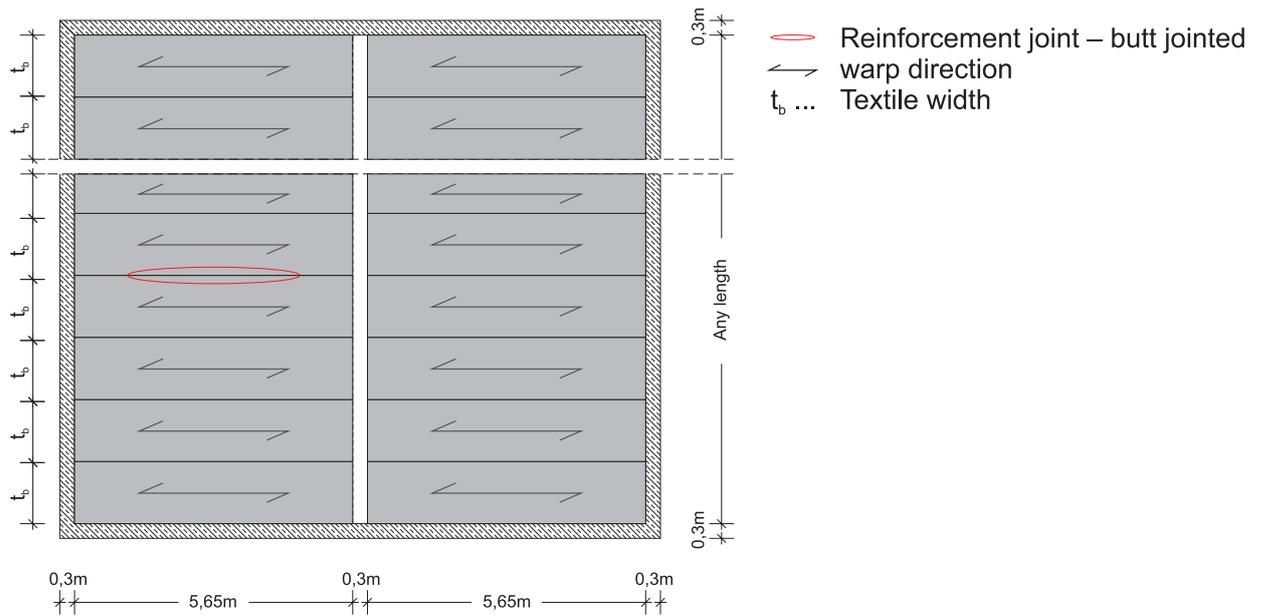


Figure 4.9 Section U-U, bottom view of ceiling slab showing installation plan for strengthening layer 1 (see also figure 4.7)

as on: 15. November 2017

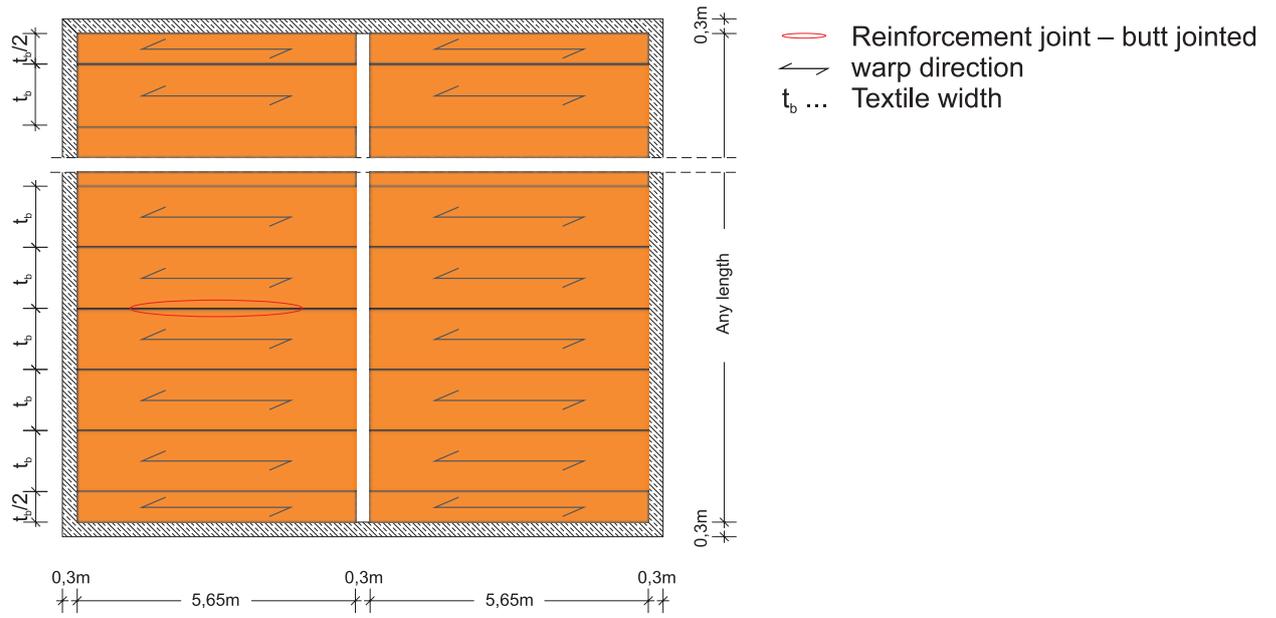


Figure 4.10 Section U-U, bottom view of ceiling slab showing installation plan for strengthening layer 2

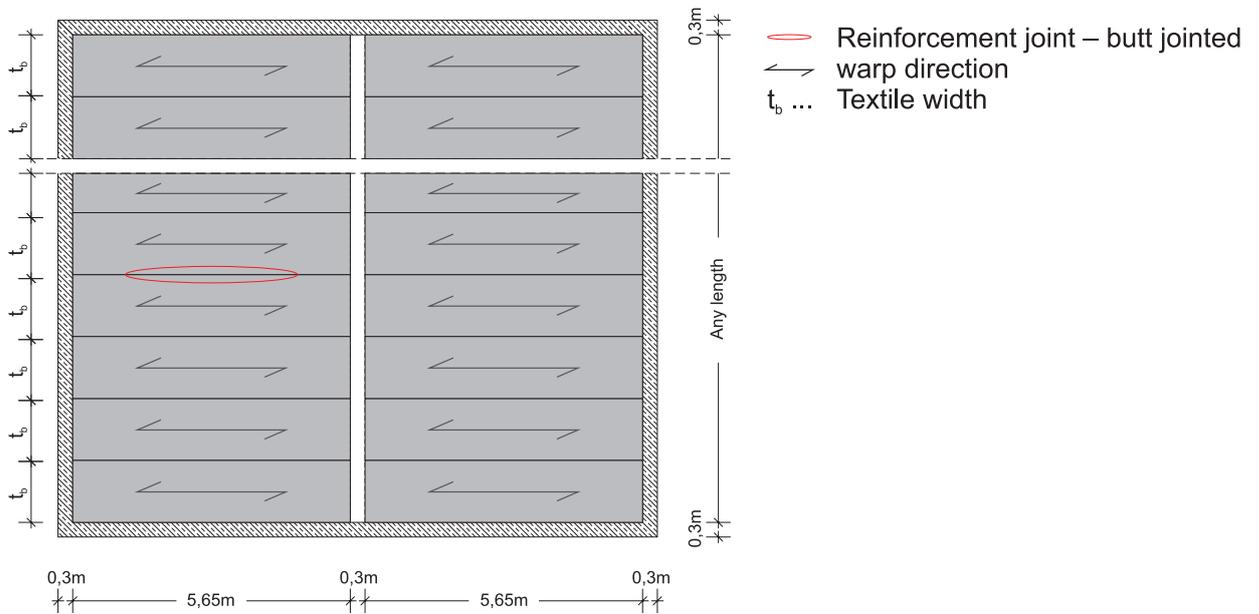


Figure 4.11 Section U-U, bottom view of ceiling slab showing installation plan for strengthening layer 3 (due to end anchoring)

as on: 15. November 2017

## 4.2 Process

The reinforcement measure comprises the following substeps:

- ❑ Manufacturing of a reinforceable old concrete surface after the prior actual status recording of portfolio,
- ❑ Substrate preparation,
- ❑ Applying the textile reinforcement layers by spraying and lamination,
- ❑ Subsequent treatment.

During the execution, tests should be conducted as per sections 4.7.1 to 4.7.3 of abZ. After the execution, the checks specified in section 4.7.4 of abZ should be conducted.

The reinforcement measure should be monitored and documented according to section 4.8 of abZ by the executing company. Besides the monitoring by executing company, there is an external monitoring obligation (IMA Materialforschung und Anwendungstechnik GmbH, Dresden, PÜZ-Stelle [testing inspection and certification body] SAC 08 for the textile reinforcement and GÜB, Berlin, PÜZ-Stelle ÜG 010) for monitoring the execution.

### Assessment of the strengthening feasibility of the existing concrete structure – according to section 4.5 of abZ

In order to have the aspired success with respect to type, quality and duration for reinforcement activities with textile concrete on concrete components, the related concrete on their surface must have specific properties.

- ❑ Cracks in the strengthening area, which could lead to corrosion of the steel reinforcement or provide a passage for liquids, must be treated as per “DAfStb-Richtlinie - Schutz und Instandsetzung von Betonbauteilen” (Technical guidelines by DAfStb, in German).
- ❑ The strengthening area must not have any loose parts.
- ❑ There should not be any cracks running parallel to the surface or cupped in the area near the surface.
- ❑ Likewise, there should not be any delamination.
- ❑ There should not be any foreign substances, such as abrasion residues, release agents, old coatings, efflorescence, oil, spalling and so on, which can affect the bond. Such things should be removed completely before the strengthening measure.
- ❑ The old concrete surface to be strengthened must be prepared for applying the first fine-grained concrete layer until aggregate with a diameter of  $\geq 4$  mm is visible. The average roughness of old concrete surface must be at least 1.0 mm.
- ❑ Unevenness in old concrete cross section larger than 3 mm and up to 30 mm must be re-profiled with fine-grained concrete. In case of irregularities in the old concrete cross section that are larger than 30 mm, a separate evaluation by the designer is necessary. A few concrete spalling or gravel pockets are irregularities that can be excluded from this requirement.
- ❑ After the surface preparation is complete, the surface tensile strength should be demonstrated as per DIN EN 1542 (BS EN 1542:1999) with a ring groove.  
The expected average value of surface tensile strength must be at least  $\geq 1.00$  N/mm<sup>2</sup>. If a higher value is recorded, a structural analysis shall be completed to check the section. At least 5 tests should be conducted. If the surface tensile strength is not attained, the competent designer must be informed accordingly (where appropriate, additional tests will be necessary)

### Surface preparation – as per section 4.5 of abZ

For the application of textile reinforced concrete layer, the surface of old concrete structure must be “moist” as defined by DAfStb guideline “DAfStb-Richtlinie – Schutz und Instandsetzung von Betonbauteilen” (Technical guidelines, in German) (October 2001 and 2nd Amendment December 2005), Part 2, section 2.3.5 (2). This can be attained through the following preparation regime:

- ❑ Intensively pre-wet the old concrete surface at least 24 hours before the reinforcement measure,
- ❑ Subsequently, wet every two hours during the day and cover with foil during night,
- ❑ Pre-wet the old concrete surface lastly approximately 20 minutes before applying the reinforcement.

### Execution of spraying and lamination works – as per section 4.6 of abZ

The General Building Inspectorate Approval specifies detailed rules for the production of reinforcement:

- ❑ The air and component temperature must be between + 5 °C and + 30 °C during the strengthening works.
- ❑ The textile reinforcement must not have any dirt and grease during installation. They should not be trimmed or exposed to a sharp traverse compression. The handling of textile reinforcement should not exceed the mandrel diameter of 30 mm.
- ❑ The specifications of the manufacturer should be taken into account while mixing the fine-grained concrete.
- ❑ The spray works are carried out in dense phase with the MAWO jacket air stream nozzle (for this, see attachment 4 of abZ).
- ❑ The strengthening measure begins with the application of first fine-grained concrete layers on the prepared old concrete structure. In this measure, the first textile reinforced concrete layer is incorporated. If the components have to be strengthened with multiple layers of textile reinforcement, then always one layer of fine-grained concrete should be laminated or sprayed first before the next application of textile reinforcement layer. Then, the freshly applied textile reinforcement should again be covered with a layer of fine-grained concrete. Maximum of four layers of textile reinforcement should be applied. A sprayed or hand-laminated textile reinforced concrete layer should be at least 6mm on average. The textile layers should be in hardened state according to section 4.7.4 of abZ.
- ❑ The processing time of fine-grained concrete should not be exceeded.
- ❑ In case of interruption during the strengthening works or planned work sections/-construction joints, the last fine-grained concrete layer to be cast prior to the interruption should be roughened with a broom finish before the processing time is exceeded, otherwise the surface preparation for a joint shall be completed accordingly.
- ❑ During the strengthening measure, the components should not be subject to vibration or movement.

### Post-treatment – as per section 4.6 of AbZ