Transport anchor - type KE

Assessment report

for use in water-impermeable structural components

Client: H-Bau Technik GmbH
Am Güterbahnhof 20
79771 Klettgau

The report comprises 7 pages and 4 annexes

File ref.: 07-G-019-Rev. 1
Lauterbach, 26.06.07

Contents

1 Commission and purpose

The company H-Bau Technik manufactures transport anchors of type KE. We were commissioned by H-Bau Technik to assess the use of the anchors in water-impermeable structural components with regard to impermeability.

Tests were carried out at the Institut für Massivbau der Technischen Universität (TU) Darmstadt [Institute for Solid Structures at the Technical University of Darmstadt] in order to ascertain the swell tendency of the compressed wood and any possible effect on the enclosing concrete.

2 Documentation

[D1] DAfStb* guidelines, water-permeable structures made from concrete (guidelines on water-impermeability), German committee for reinforced concrete, 07/2004

[D2] Die Technik zu Decke und Wand [Technology for floor and wall], SysproGruppe Betonbauteile e.V., Dr.-Ing. H. Kahmer, 2006

[D3] Bonzel, J.; Manns, W.: Beton mit besonderen Eigenschaften [Concrete with special characteristics], in: Zementtaschenbuch [Cement pocket book] 1984 (48th edition) Bauverlag Wiesbaden-Berlin

3 Description of the transport anchor and the installation situation

The type KE transport anchor is illustrated in Fig. 1. The distinctive feature of this anchor is that there is no welded steel cross-bolt to provide stabilisation, but rather a cross-bolt made of an exact-fit integrated compressed wood. The compressed wood comprises a special laminated veneer lumber.

* German committee for reinforced concrete

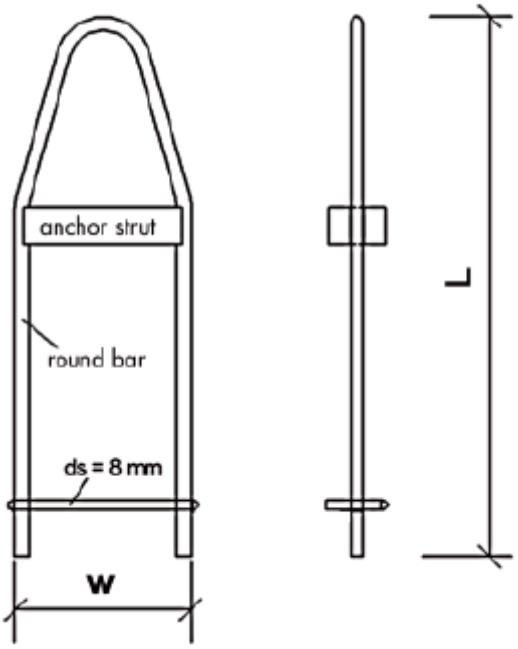

Fig. 1 Type KE transport anchor

The installation situation of the anchor is illustrated in Fig. 2.

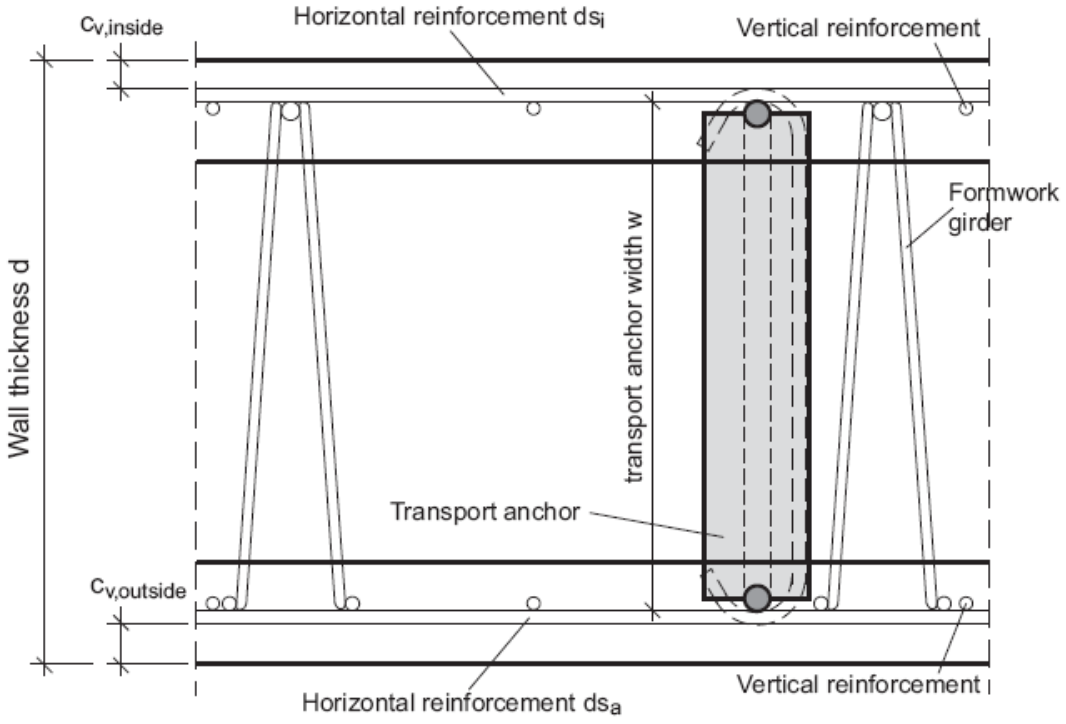

Fig. 2 Transport anchor installation situation

In accordance with the designs of DIN 1045-1:2001-07, Table 4, at least one concrete cover of $c_{nom} \geq 30$ mm must be maintained for water-impermeable pre-cast elements. Taking the arrangement of a transverse reinforcement with diameter ds = 6 mm as a starting point results in a calculated concrete cover of $c_{nom,wood} \geq 45$ mm based on the laminated veneer lumber.

4 Structural component tests

Structural component tests were carried out at the Institut für Massivbau at the TU Darmstadt in order to ascertain the swell tendency of the wood in pre-fabricated wall elements. The tests should provide information on whether the concrete shell is damaged by the swelling of the wood. A summary of the tests on the structural components is given in Annex 1.

The wood moisture content measured on the test specimens (test specimen B) lying horizontally corresponds to the equilibrium wood moisture content for the existing climatic conditions. The wood moisture content of 50% measured on test specimen A is considerably higher than the fibre saturation moisture content for the wood. This value is approx. 28% to 32%. The maximum degree of swelling is reached for the fibre saturation moisture content. There is no increase in the swelling associated with an increase of the wood moisture content beyond the fibre saturation moisture content. The degree of swelling remains almost constant above the fibre saturation moisture content, so that no further stresses are transmitted to the concrete. Furthermore, it must be borne in mind that the modulus of elasticity for the wood perpendicular to the fibre is only $E_{\perp} = 300$ N/mm^2 and that this tends downwards with increasing wood moisture content. Due to the small modulus of elasticity $E_{\perp}$ of the wood, no large restraint stresses are transmitted to the concrete as a result of the swelling. No chipping or cracking could be observed in the area of the transport anchor on the outer shell of the pre-fabricated wall elements for any of the tests.

5 Assessment of the impermeability

The requirements on the fitness for purpose of water-impermeable structures are regulated in the guidelines [D1]. In these a fundamental differentiation is made between two strength classes (strength class 1 - component in contact with standing water / strength class 2 – component in contact with moisture or water seeping downwards).

The concrete used must meet the requirements for concrete with high resistance to water penetration in accordance with DIN EN 206-1. Fundamentally, in order to fulfil these requirements, a w/z [water/cement] value of w/z ≤ 0.6 must be maintained. If the thickness of the components is reduced to the minimum component thickness regulated in [D1], a w/z value of w/z ≤ 0.55 must be maintained.

Fig. 1 illustrates the dependence of the water penetration depth on the w/z value. As can be seen in the diagram, the maximum penetration depth for a w/z value of w/z = 0.55 is between t [depth] = 15 mm and a maximum of t = 30 mm.
For a concrete cover of c_{nom} = 30 mm in accordance with DIN 1045, the concrete cover of the wood is $c_{nom,wood}$ ≥ 45 mm (cf. Section 3). This ensures that for technically-correct installation of the concrete no water penetrates as far as the laminated veneer lumber of the transport anchor as a result of hydraulic pressure. From experience, the water penetration depth of t = 30 mm included in the calculation is not reached by quality pre-fabricated wall elements. So, for example, a penetration depth for the Syspro-Part type pre-fabricated wall elements (see [D2]) is given as only 18 mm approximately.

In summary, it can be assumed that the transport anchor has no bearing on the water penetration depth of pre-fabricated wall element.

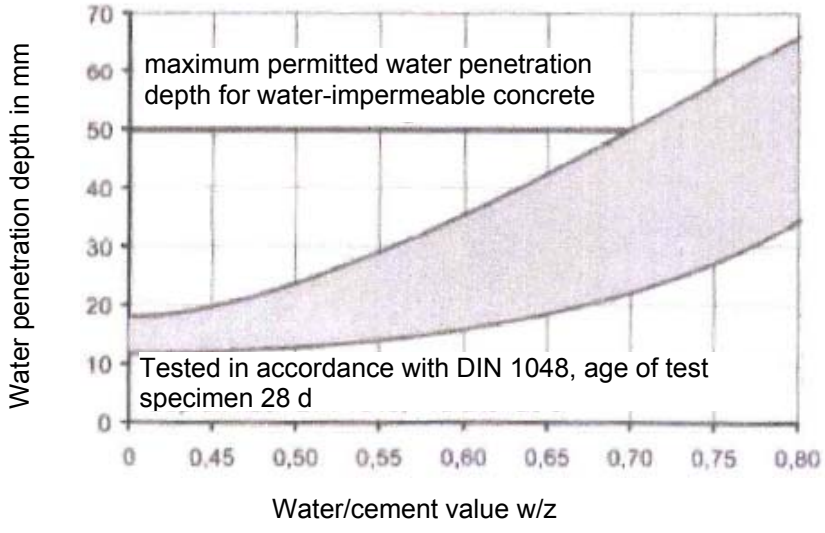

Fig. 1 Dependence of water penetration depth on the w/z value for concrete according to [D3]

6 Summary

The structural component tests have shown that no damage whatsoever is done to the concrete shells due to the swelling of the wood, e.g. as a result of chips or other types of crack.

For a concrete cover in accordance with DIN 1045-1 of c_{nom} = 30 mm, the concrete cover above the wood is $c_{min,wood} \geq 45$ mm as a result of the defined installation situation of the transport anchor. For structural components that meet the requirements of the water-impermeable guidelines and have a w/z value of w/z ≤ 0.55, the water penetration depth is less than 30 mm. This ensures that no water penetrates directly as far as the laminated veneer lumber of the transport anchor as a result of hydraulic pressure.

In summary it can be stated that, on the basis of the tests carried out, the installation of the transport anchor in pre-fabricated wall elements in accordance with the water-impermeable guidelines is quite safe with regard to the water penetration depth.

Lauterbach, 26.06.07

Dr.-Ing. Heinz Pape

Summary of structural component tests
(The tests were carried out within the framework of load-bearing tests at the TU Darmstadt)

Table 1 Slab geometry

Transport anchor type	Slab thickness [mm]	Manufacture		Shell thickness/concrete cover of the transverse reinforcement c_v [mm]		Strength of concrete on 16.11.2005 $ß_{w200}$ [N/mm²]	
		shell 1	shell 2	shell 1	shell 2	shell 1	shell 2
KE 300	360m	14.11.2005	15.11.2005	52/25	51/25	16.2	9.5

Table 2 Measured wood moisture contents in [%] – mean values from 6 measurements

Test specimen	for installation before concreting on 14.11.2005	after concreting on 16.11.2005	on 30.05.2006
A since 21.11.2005 - pre-fabricated wall element section stored vertically in open air	12.3	13.9	52
B since 21.11.2005 - pre-fabricated wall element section stored horizontally in open air			16

Notes: The measurement of the wood moisture content was made in the middle of the compressed wood using a GANN Hydromette RTU 600. The measurement electrodes of the measuring device were driven vertically into the layers of veneer to a depth of approx. 15 mm.

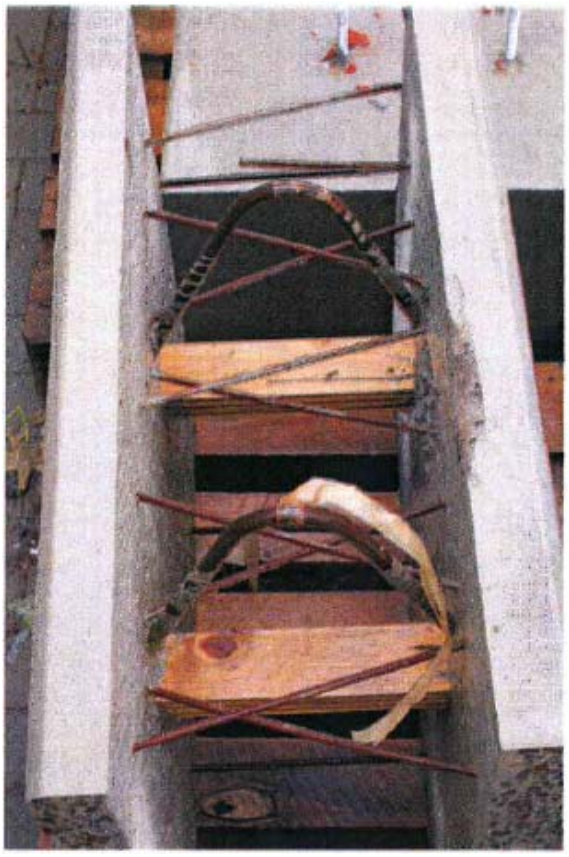

Fig. 1 Test specimen A - stored in a vertical position

Fig. 2 Detail of test specimen A

Fig. 3 Outside surface of test specimen A

Fig. 4 Detail – undamaged outside surface of test specimen A – anchor 2

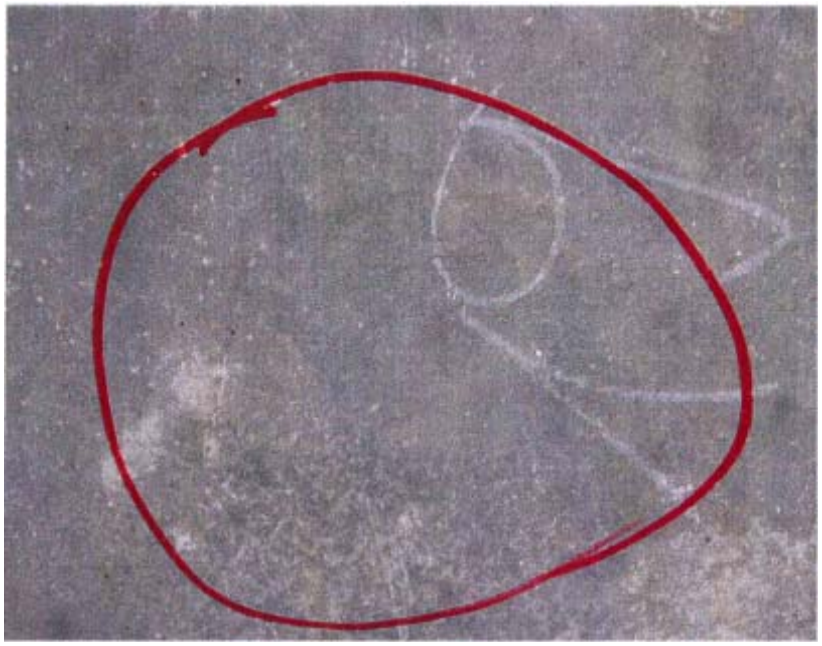

Fig. 5 Detail – undamaged outside surface of test specimen A – anchor 1