

Patent Application

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Tunnel lining

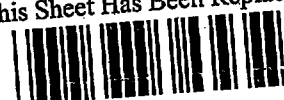
Description

The invention relates to a tunnel lining comprising tubbing rings disposed successively in the longitudinal direction of the tunnel and each being constructed from reinforced concrete segmental tubbings disposed successively in the peripheral direction of the tunnel.

A tunnel lining of this kind in the form of a tubbing lining generally known in practice has its advantages in difficult foundation soil conditions, particularly in connection with groundwater where the NÖT (Neue Österreichische Tunnelbauweise) (= New Austrian Tunnel Construction Method) has its limits: the tubbing lining is suitable both for cohesive and for non-cohesive soils provided they do not have too fluid a consistency. In loose rock and in the presence of groundwater the tubbings are installed behind a tunnel drilling machine operating on the shield tunnelling principle. On the advance of the tunnel, the rock support and the shutting-off of the groundwater by the shield must immediately be taken over by the tubbing lining. Tubbings must accordingly have an immediate load bearing action and, in some cases, an immediate sealing action. In solid rock, tubbings can be installed as an alternative to the gunite process behind full or part cutting machines. In either case, a one-shell tunnel lining which is simultaneously a lining and securing means can be obtained by the use of tubbings.

Tubbings are prefabricated elements which are today usually made from reinforced concrete. The tunnel tube consists of individual tubbing bricks, the number of

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which depends, inter alia, on the tunnel diameter. The tubbing rings are installed with a half brick length offset from one another in order to obviate joint intersections which are difficult in terms of sealing. The conventional type of tubbing configuration today is the block or cassette tubbing. In the case of the cassette tubbing, in contrast to block tubbing, in order to save weight and facilitate the bolting of the bricks together, the cross-section is greatly reduced in the middle zone of the brick. The tunnel lining is required to take loads without appreciable deformation, i.e. it must be capable of being dimensioned for all load cases corresponding to tunnel construction. The finished structure has to take soil loads, groundwater, dead weight and operating loads or traffic loads. In the constructional state, there are transport modes, advancing loads, injection pressure and compressed air influences. The above enumeration of the loads clearly shows that the lining must be dimensioned predominantly for pressure normal forces and bending moments. Only in the case of the compressed air load can the compressed air in the tunnel result in the pressure normal forces being cancelled out in the case of small roof overlaps; in some cases this may be decisive for the dimensions. Any tensile stresses in the tunnel lining occur only in the constructional state. Longitudinal joints can be sealed in these areas by means of prestressed screw connections. The pressure normal forces present in the tubbing ring and the advancing pressure forces guarantee that the longitudinal and ring joints will be compressed. In this way the seals inserted in the joints are fully operative. In the case of components with water pressure from inside, e.g. pressure water tunnels, high



tensile normal forces may occur depending on the soil stiffness. Sealing, particularly of the longitudinal joints, cannot then be obtained with conventional lubbing linings. High tensile stresses in the tunnel lining cannot be controlled with the present conventional reinforced concrete tubing systems since the sealing properties cannot be guaranteed in the longitudinal joints.

Similarly, very soft, cohesive or fluid soils give rise to considerable problems with a tubing lining since the assumed elastic bedding of the soil no longer applies due to approximately hydrostatic soil conditions.

The object of the invention is to provide a tunnel lining which in addition to the above-described possible uses also allows use in very soft cohesive soils and which can be used in cases of considerable tensile stress of the tunnel shell.

To solve this problem, according to the invention, each tubing ring is provided, on its inside surface, with at least one peripheral undercut recess and the recesses are filled with in situ concrete.

As already stated, it is primarily pressure normal forces and bending moments resulting from deformation-dependent soil loads and possibly present groundwater that act on the securing means or the lining during the building phase. For this purpose, the tubings are installed with the recesses and with a structure similar to a T-beam. They are then in a position to support the excavated cross-section and to secure it.

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The reinforced beam zone guarantees a perfect transmission of the ring forces, since the longitudinal joint can be constructed in a constructionally rational manner by means of the brick thickness of, for example, about 40 cm. The in situ concrete rings in the correspondingly dimensioned recesses in any case take over the transmission of the tensile normal forces occurring and prevent gaping of the longitudinal joints.

There are a number of possibilities for the further configuration in the context of the invention. For example, according to a preferred embodiment, each tubbing ring is provided with an undercut recess in the region of each of its two inner ring edges and the neighbouring recesses of the adjacent tubbing rings complement one another to form a recess groove; this is particularly advisable when the recesses or recess grooves have a dovetailed cross-section. In this embodiment the ring joints are also particularly well sealed. As a result of the dovetailed construction of the recesses, any external water pressure which may build up in the region of the bond joint can be taken by the complete cross-section and dissipated. If the tunnel is driven in very soft cohesive soil, sheet-metal profile sections can be placed in the recesses at the level of the longitudinal joints during the building of the tubbing ring in order to ensure immediate flexural stiffness of the tubbing ring. The sheet-metal profile sections are bolted to the tubbing rings and, if required, one another. The recesses are then reinforced and concreted in a subsequent operation in accordance with static requirements.



According to another preferred embodiment of the invention, advantageously, the concrete filling the recesses is constructed in the form of outer ribs of an inner lining shell of in situ concrete extending continuously in the longitudinal direction of the tunnel. The inner lining shell may have an additional reinforcement. Since the tubbing ring joints are subsequently concreted, the offset installation of the tubbing rings relative to one another can be dispensed with since the in situ concrete of the inner lining shell takes over sealing in the regions of the longitudinal joints; the installation of the tubbings is thus facilitated for the site.

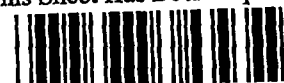
The invention is explained in detail below with reference to a drawing illustrating one exemplified embodiment and wherein:

Fig. 1 is a cross-section and a longitudinal section through an inner lining.

Fig. 2 is detail A of Fig. 1 in a modified embodiment.

Figs. 3 to 6 show different embodiments of the detail B in Fig. 1.

The tunnel linings shown in the drawings initially each comprise tubbing rings 1 which are disposed successively in the longitudinal direction of the tunnel and which are each constructed from segmental tubbings 2 of reinforced concrete, said tubbings being disposed successively in the peripheral direction of the tunnel. The inside surface of each tubbing ring 1 is provided with at least one peripheral undercut

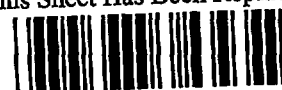


recess 3 and the recesses 3 are filled with in situ concrete. In the embodiments shown in Figs. 3 and 4, the undercut dovetailed recesses 3 are disposed in the middle of a tubing ring 1. In the embodiments shown in Figs. 1, 5 and 6, on the other hand, each tubing ring 1 is provided with an undercut recess 3 in the region of each of its two inner ring edges, in such manner that the neighbouring recesses 3 of the adjacent tubing rings 1 complement one another to form a recess groove 4 of dovetailed cross-section.

Fig. 2 shows that neighbouring tubings 2 of a tubing ring 1 can be bolted together by means of sheet-metal profile sections 5 introduced into the recesses 3 before the in situ concreting.

The drawings do not show that the in situ concrete in the recesses 3 can be reinforced. Nor do the drawings show that there can be an annular space between the rock and the tubing rings and this can be filled with mortar, concrete or artificial soil after or before the assembly of the tubings.

Finally, Figs. 4 and 6 show an embodiment which can be subjected to particularly high loading and which is characterised in that the concrete filling the recesses 3 is in the form of outer ribs 6 of an inner lining shell 7 of in situ concrete extending continuously in the longitudinal direction of the tunnel. In addition, the continuously concreted inner lining shell 7 guarantees a particularly high degree of sealing of the reinforced concrete bonding construction method, particularly with the use of tubings having a central



recess. Although this is not shown either, this inner lining shell 7 can have an additional reinforcement.

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C l a i m s

1. A tunnel lining comprising tubbing rings disposed successively in the longitudinal direction of the tunnel and each being constructed from reinforced concrete segmental tubbings disposed successively in the peripheral direction of the tunnel, characterised in that each tubbing ring (1) is provided, on its inside surface, with at least one peripheral undercut recess (3) and the recesses (3) are filled with in situ concrete.

2. A tunnel lining according to claim 1, characterised in that each tubbing ring (1) is provided with an undercut recess (3) in the region of each of its two inner ring edges and the neighbouring recesses (3) of the adjacent tubbing rings (1) complement one another to form a recess groove (4).

3. A tunnel lining according to claim 2, characterised in that the recess groove (4) has a dovetailed cross-section.

4. A tunnel lining according to any one of claims 1 to 3, characterised in that neighbouring tubbings (2) of a tubbing ring (1) are bolted together by sheet-metal profile sections (5) introduced into the recesses (3) before the in situ concreting.

5. A tunnel lining according to any one of claims 1 to 4, characterised in that the concrete filling the recesses (3) is reinforced.

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6. A tunnel lining according to any one of claims 1 to 5, characterised in that the concrete filling the recesses (3) is constructed in the form of outer ribs (6) of an inner lining shell (7) of in situ concrete extending continuously in the longitudinal direction of the tunnel.

7. A tunnel lining according to claim 6, characterised in that the inner lining shell (7) has an additional reinforcement.

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