Process for pressure injection with mortar the annular space between tubbing and rock

The invention relates to a method during shield driving of a tunnel lined with tubbing for injecting under pressure the annular space between tubbing and rock with a mortar mixture which is introduced into the interspace from a mortar container installed on the trailer via hosing and ~~reinforcing strips~~ pipes preferably disposed in the shield casing.

During shield driving of a tunnel lined with tubbing a larger hollow space is generated than is required for the tubbing shell such that an annular space is formed between the tubbing and the rock which must be pressure injected with mortar which embeds the tunnel in the rock and which absorbs the pressure and thrusting force transmission between tubbing ring and rock.

Three fundamental requirements are made of the mortar. The first requirement is rapid stiffening so that the purpose of the pressure- and thrust-resistant embedding of the tubbing tube can be fulfilled. The liquid property of the mortar must disappear rapidly and a shear~~ing~~ strength must be formed since liquid mortar loses the capability for load absorption of the deadweight of the tubbing and the loading of the transport mechanism of a trailer, on which, among other installations, also the mortar reserve container and pumps are disposed, and the load can lead to deformation of the tubbing ring.

The second requirement is good flowability in order to fill out completely the hollow space. The third requirement is longer processibility of the mortar. The mortar is mixed and pumped into the supply container, therein kept in motion through an agitator mechanism and pressure injected from there into the annular space through hosing lines and ~~reinforcing strips~~ pipes. The ~~reinforcing strips are specially developed pipes which~~ pipes are welded flush all-around in the shield tail comprising, as a rule, solid

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steel.

The pressure injection is carried out continuously during the driving for the width of a tubbing ring (approximately 1 to 2 m). Even after a moderately long interruption of up to approximately 1.5 hours, it must still be possible to start pumping the mortar again without too high a pumping pressure needing to be generated.

In order to fulfil these mutually contradictory requirements, the most diverse mortar mixtures with different cement content have been used. Sufficient flowability and pumpability could be attained therewith. Only the consistency, i.e. the flowability, was reduced within the first hour due to the binding agent adhesive becoming stiff. Shearing strength did not develop thereby. Strengths only developed gradually after approximately 2 to 3 hours up to several months through hydration of the binding agent. The shearing strengths required after thirty minutes cannot be attained in this way. Depending on the quantity of the cement content, a stiffening of greater or lesser degree occurs. All normally used mixtures age slightly during the processing time but they do not require high pressures when pumping is started again because shearing strength has not yet been developed. Attempts have been made through additives, such as, for example, water glass, to accelerate the hardening whereby, however, again the problem of the ability to start pumping again occurs after a relatively long standstill.

The invention is therefore based on the task of developing the above stated pressure-injection process such that the mortar is pumpable over several hours and thus is processible, but yet reaches a minimum shearing strength within a short time.

The task posed is solved with the above described process according to the invention thereby that to the mortar mixture is added an agent imparting thixotropy and sandy limestone powder in such quantities that a rapid initial shearing strength through thixotropy, good flowability and, after operational standstill, pumping start with low

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pressure are ensured.

Due to the effect of thixotropy, the mortar does not harden but is only stiffened, and, if, after an interruption, pumping is started again, it is possible, due to the lubricating effect of the sandy limestone powder, to liquify again the entire content of the pump lines and the reinforcing strips. Through the invention the pressure peak during the pumping start is decreased and therewith difficulties, occurring due to the thixotroping, are buffered again.

The high lubricating capability of the sandy limestone even permits adding to the mortar mixture as further additive substances crushed sand and stone chips whereby the initial shearing strength can be further increased, but yet starting the pumping again after approximately one hour becomes possible with manageable pressures.

The additive substances to the mortar are preferably selected such that after approximately 30 minutes a shearing strength of 5 to 10 kN/m^2 is attained. This ensures that with advancing driving the mortar is sufficiently capable of being loaded if the ring has completely exited the shield tail and the lifting force is fully effective.

The mortar mixture is preferably composed as follows: up to 500 kg/m^3 cement, up to 900 kg/m^3 flue ash, up to 400 kg/m^3 water, up to 20 kg/m^3 thixotroping agent, up to 400 kg/m^3 sandy limestone powder, up to 1500 kg/m^3 crushed sand, up to 5 kg/m^3 ~~flux means~~ plasticizer.

In the following the invention will be explained in further detail with reference to the drawings. In the drawings depict:

Fig. 1 schematically a cross section through a tunnel lined with tubbing, and

Fig. 2 schematically a longitudinal section through a shield driving arrangement in use during pressure injection of the annular space between tubbing and rock.

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Figure 1 shows that through shield driving into the rock 1 an approximately circular hollow space 2 is driven in, into which tubbings 3 are installed wherein between the soffit of the hollow space 2 and the tubbing an annular space 4 remains whose diameter is greater than the outer diameter of the tubbings, which [space] must be filled with mortar.

The way in which this is carried out is shown schematically in Figure 2. This Figure shows that the cutter head 5 disposed in the shield driving arrangement progressively generates in the rock a hollow space into which, during the advancing of the shield driving, tubbing rings 6 are installed. The last tubbing ring 6a remains yoked in the shield casing 7 so that during the advancing shield driving it remains at a distance from the limit of the dug-out annular space. During the progression of the shield driving, via a so-called trailer 8 which runs on the inner floor of the already processed tubbings, mortar is pressure injected from a container 9 disposed on the trailer via a pressure-injection line 10 and ~~reinforcing strips~~ pipes 11, welded into the shield casing, into the annular space 12 which has been formed between the installed tubbing 6a and the rock. This pressure-injected mortar adjoins the already hardened mortar in the annular space 13 between the rock and the already installed tubbings 6.

Through the additives according to the invention to the pressure-injected mortar, it is ensured that the tubbing ring 6a, which has just been pressure-injected [with mortar], is sufficiently supported and, subsequently, after the installation of the succeeding tubbing ring, the start of the pumping is possible with manageable pumping pressure.

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Patent Claims

1. Process during shield driving of a tunnel lined with tubbings for pressure injecting the annular space between tubbings and the rock with a mortar mixture introduced from a mortar container installed on a trailer through pumping via hosing and ~~reinforcing strips~~ pipes disposed in the shield casing into the interspace, characterized in that to the mortar mixture a thixotroping agent and sandy limestone powder is added in such quantities that through thixotropy a rapid initial shearing strength, good flowability and, after an operational standstill, starting the pumping with low pressure are ensured.

2. Process as claimed in claim 1, characterized in that to the mortar mixture as further additives crushed sand and stone chips are added.

3. Process as claimed in claim 1 and 2, characterized in that the additives to the mortar are selected such that after 30 minutes a shearing strength of 5 to 10 KN/m^2 is attained and a pumping pressure of 8 bars is not exceeded when starting pumping again.

4. Process as claimed in one of the preceding claims, characterized in that the crushed sand has a grain size of 0 to 2 mm and the stone chips a grain size of 2 to 5 mm.

5. Mortar mixture for a process as claimed in one of the preceding claims, characterized in that the mortar mixture is composed as follows: up to 500 kg/m^3 cement, up to 900 kg/m^3 flue ash, up to 400 kg/m^3 water, up to 20 kg/m^3 thixotroping agent, up to 400 kg/m^3 sandy limestone powder, up to 1500 kg/m^3 crushed sand, up to 5 kg/m^3 ~~flux means~~, plasticizer.

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