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Protecting tree roots and subterranean infrastructure in urban areas by developing self-compacting flowable fills with root growth impeding properties

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In urban areas, the installation of cables and disposal lines is still done by open building method. Here, a ditch is being excavated, pipes and lines are laid and subsequently it is filled with and covered by bulk material (e.g. sand or gravel), which is then compacted. Due to the often times limited space that the roots have in the ground and the better supply of water and oxygen in the poorly compacted bulk material, these refilled ditches are areas of preferential root growth of urban trees. The entangling of the pipes and supply lines by these roots leads to severe damage of the tree when maintenance work on the lines is carried out and roots have to be cut. In order to reduce this competition between urban trees and urban subterranean infrastructure, the development of a self-compacting flowable fill with root growth resistance is mandatory. Physico-chemical properties, such as a very high pH-value and a low cation-exchange-capacity, a low root-penetrability, a high packing density and a low porosity, with a poorly connected pore system that impedes gas and water exchange are the characteristic aspects of this flowable fills that could help avoid undesired root penetration into supply lines. The flowable fills are supposed to sheath pipes and lines void-free and without any tension, in order to restrain the root growth in these areas.

Trees are of crucial importance for urban ecosystems and are comprising 3% of the total stock of trees in the Federal Republic of Germany, which is why it is fundamental to conserve them. This work therefore targets not only at enabling a balanced coexistence of urban trees and subterranean infrastructure, but also at avoiding costly re-opening of ditches, tree harming cutting of roots and time consuming maintenance work. Further positive side effects are reduced costs for network providers and local municipalities, as well as reduced noise and dust emissions for passersby and local residents. To guarantee the root growth restricting properties, the self-compacting fill has to have less porosity than the adjacent soil (40 – 60%). Theoretically a porosity of 30% is possible with a homogeneous compaction of sand. In urban areas, however, because of the limited spaces and crossing pipes, a mechanical and homogenous compacting is often impossible. Porosities of 60 to 70% are the result. Self-compacting flowable fills have a porosity of about 40% while the first optimized materials can even have a porosity of 28%.

We present the first results of the hydro-mechanical properties of the different materials under development that highlight the influence of the mixture of the fills (i.e. maximal grain size) on the root growth impeding properties, while still ensuring mechanical workability of the material (in spite of the low porosity, strengths less than 0.8 N mm^{-2} must be ensured at all times).