Movements induced by the installation of diaphragm walls: observations and modelling using Code_Bright.

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Deep excavations are required for the construction of high-rise buildings, underground parking lots and mass transport systems. In dense urban areas, diaphragm walls are commonly used to limit movements of existing structures induced by such deep excavations. A typical diaphragm wall installation scheme is as follows. A trench is excavated mechanically between the existing structure that requires protection and the future excavation work. During excavation, the trench is filled with a bentonite-water mixture to protect it against collapse. When the design depth is reached (this may be as much as 60m deep), concrete is injected at the bottom of the trench, expulsing the less dense bentonite-water mixture and a reinforcing metallic structure is introduced. The walls are excavated and concreted in individual panels. Typically, a panel of length between 3 and 8m is executed daily.

Although diaphragm walls are designed to minimize soil movements during excavation, their own execution can cause important settlement in the near field. In Barcelona, the execution of diaphragm walls in a station of the new metro line 9, was accompanied by a 5.5cm settlement on a nearby building. That case prompted the present study.

Settlement during the execution of a field test diaphragm wall in soft clay is shown in Figure 1 (a). Settlement during the excavation (under bentonite support) reaches 0.5mm. After that, the slurry in the trench is diluted and settlement increases slightly. The motion accelerates when the supporting fluid is replaced by water reaching then 5 mm. Concrete pouring is accompanied by ground heave, explained by the higher density of concrete. Afterwards, settlement resumes during the hardening of the concrete.

The different steps of the execution of a diaphragm wall have been modelled in 3D with Code_Bright using an especially designed boundary condition for taking into account the hydrostatic profile in the bentonite and the fresh concrete. Typical results are shown in Figure 1 (b): the settlement induced by the excavation, the heave caused by the injection of fresh concrete and the second settlement phase induced by concrete hardening.