

Tunnels and deep excavations in historical urban centres: when engineers dialogue with the past, imagining the future

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The major metropolises in the world live a dynamic development of buildings and infrastructures: this work is unstoppable and tunnels or deep excavations are frequently necessary. This worldwide frenetic activity often involves urban historical centres, rich of unique masterpieces: new structures have to coexist with ancient ones, without depriving future generations from this priceless heritage.

Engineers have the responsibility to make this coexistence possible: they are aware that - in any epoch - whatever unites, connects, reduces distances is a drive for development and welfare and is a heritage for future generations. At the same time, they are aware of the challenging task assigned to them.

Sometimes this challenge can be “extreme”, as for the Oudayas Tunnel in Rabat (Morocco): this tunnel was considered crucial to divert traffic by the city centre, undercrossing the so called Oudayas Complex, catalogued among the UNESCO World Heritage Sites. The safeguard of the historical buildings was not the unique trouble to face: other problems concerned the presence of underground water table and the closeness between the twin tunnels to be excavated.



The Fortress fully suspended on underpinning piles
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The new skyline after tunnel completion
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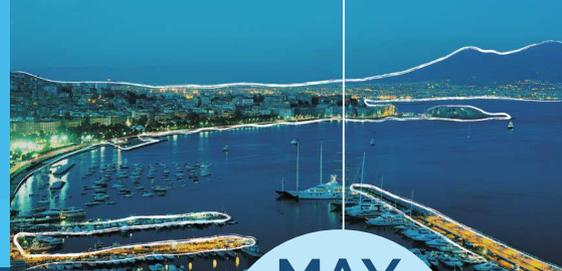
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Engineers solved all these problems, underpinning - in a first stage - the ancient buildings by means of special micro-piles and adopting countermeasures to ensure safety during construction, without invasive works. In a second stage, the weight of the buildings was distributed to a foundation slab which also served as the roof slab of the tunnel. On-site testing and sophisticated 3D numerical analysis, combined with monitoring, made possible to control the different execution phases.

Deep excavation in urban centres are also quite common for Metro Line construction: in this case the interferences between new structures and existing ones can involve whole urban districts: this is the case of the new Cityringen, an expansion of the Copenhagen Metro: the 15,5 km City Circle Line will serve 17 stations. Copenhagen is a completely different city from Rabat: a flagship of North Europe new "green" lifestyle, thus a great challenge for Engineers.



Excavation completed inside the stations

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The cutterhead of the TBM machine is lowered into the station

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The excavation depth of the stations - placed all around the city centre, close to existing buildings - is approximately 25 m below ground level. Excavation impacts are generally minimized by means of the so called "top down" construction method. Normally buildings are

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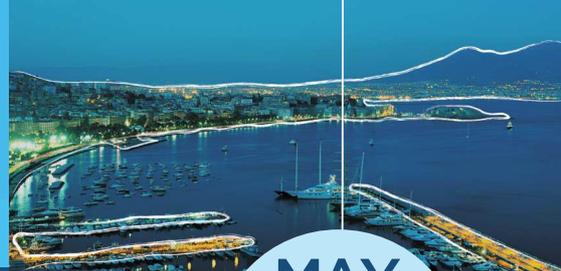
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built from the foundation to the roof; in the “top-down” procedure the order is subverted: at first the roof is build and then excavation is done, underneath the roof, up to the foundation level.

Once the box of the station is completed, a tunnel boring machine (TBM) can be lowered up to the metro line tunnel level, ready for tunnels excavation. All these different kinds of tunnels and excavation techniques can be used and combined together to create infrastructures, undercrossing urban centres and their historical masterpieces: they are really modern works of art, “a bridge” between past and future.

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