

Technological solutions for the design and management of construction infrastructure

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During the past decade, a wide range of digital solutions have emerged, with the ambition of improving productivity and quality in the construction processes. The engineering and construction sectors are now on the cusp of change, with cutting-edge products increasingly being used in many areas of the project life cycle – from design and cost estimation, to quality control, contract management, health and safety, and to operations, and building management.

This industry 4.0 is already incorporated on ACCIONA's DNA: Digital Platform for earthworks control, drones in tunnels, circular economy solutions, the use of new materials, among others. These technologies complement the design of processes and systems in our facilities in a natural way.

Innovation is an inseparable part of how we interpret progress. It is an idea that leads to an applied solution for ensuring sustainability, thus representing a key element in generating value in our current and future businesses. In ACCIONA we firmly believe that the digitation of construction processes is not just a new way of working: it is our heartbeat.

Our Construction Technology Centre is the landmark for ACCIONA in the design of resilient and sustainable infrastructures prepared to deal with the worst effects of the climate emergency. Our people design solutions to optimize construction processes, as well as new technologies and materials that are more efficient at the work site, to reduce the potential impact on nature.

Some of our most prominent technologies applied on our construction projects are:

1) **Digitization of construction processes:**

- We developed a Digital Platform for Earthworks control that can carry out comprehensive control and monitoring of the equipment involved in the earthworks to optimize operations and improve the productivity of any project. We collect data through Machine Learning and Data analytics for predictive maintenance.
- Our **Tunnel Boring Machine Control Centre**, manages and controls in real time the performance of the different TBMs in operation in our projects. The TBM Data Control Center processes information from more than 65,000 sensors every 250 ms (milliseconds) received from each TBM to control the tunnel machine's progress, deliver KPI-based performance reports, and apply machine learning algorithms using data analytics for predictive maintenance.
- We innovate with a **new short-range (4 m) geological survey technique** for tunnels with TBM for predicting the ground conditions at the front of the TBM. This allows us to reduce geological uncertainty by viewing results in real time, without any impact on the tunnel machine's productivity as well as reducing the risk of the TBM being stuck or delayed due to geological unplanned events.

- In tunnels, we also innovate by **designing and patenting a laser to avoid over-digging** in conventional tunnel boring and to adjust the excavation section to the project's design section. In real time, the laser continuously projects and geo-references the excavation section over the front of the tunnel. This enables up to 65% improvement in digging accuracy and reduces cost overruns in materials, time and personnel.
- We run an open innovation programme where some of our technical challenges are shared and we attract and cooperate with world-class start-ups. One of the projects developed as part of the I'MNOVATION Startups Programme used drones in tunnels to optimize and digitize the construction process. The use of drones allow us to obtain an accurate survey model that we can incorporate into the BIM model, volumetric calculations, progress follow up or tracking work and safety conditions for the employees. .

2) Reducing the environmental footprint of the construction projects:

- We develop **circular economy solutions** based on the creation of industrial symbiosis synergies for the improvement of the ground conditions in our projects. Often, soils do not meet the technical specifications that are required by the design of the infrastructure and must be discarded or treated for improving its technical characteristics. We have implemented technological innovation that facilitates the use of industrial **waste as secondary raw materials in construction** for improving the soil conditions and avoid its disposal to a landfill. For example, we have used f waste paper ash as an alternative hydraulic road binder to replace cement and/or lime to carry out these ground treatments.

3) New materials:

- **Composites** are made up of resins and fibres which, when combined, allow for the creation of a new material that provides much better performance than that achieved by the materials separately. Composites stand out for their **lightness** (up to 10 times lighter than traditional materials), their mechanical resistance, their electromagnetic transparency and their **high resistance to corrosion**.
- We also innovate in **concrete** with initiatives related to solutions to corrosion problems and increasing the **durability** of infrastructures in **adverse climatic conditions** such as humidity and high temperatures, as well as to reduce the environmental footprint aiming for low-carbon concrete structures. For example, we have used hydrophobic coatings for protecting concrete structures in marine environment or polymeric or steel short fibre to replace steel re-bars in the TBM tunnel segments.

It is a fact that developers and contractors alike have realized the need to work smarter for the future. It is not just about ditching the spreadsheets to manage multibillion-dollar projects or using drones to monitor construction sites. It is about embracing innovation and non- disruptive technology is muscling its way into the Middle East's construction sector.