6.10.1. CONSTRUCTION

The management of research, development and innovation in construction activities is coordinated by the Dragados departments and by Hochtief companies.

In accordance with the targets established by the head companies, at the end of 2018 the ACS Group's construction companies had a total of 46 projects in progress. A total of €13.9 million was invested in 2018 in order to conduct its RD&I activities.

FASSTBRIDGE PROJECT (DRAGADOS)

The FASSTBRIDGE R&D project: Fast and Effective Solution for Steel Bridges Life-Time Extension, has received funding from the ERA-NET Plus Infravation Programme. The Infravation program has been co-financed by several European countries and the United States, as well as the 7th Framework Programme for Research and Technological Development of the European Commission. The project was developed between 2015 and 2018 by a consortium formed by 8 organizations from Spain, France, Germany, Italy and the United States, in which DRAGADOS has been the main industrial partner.

In many countries steel bridges are vital components in transport infrastructures, which frequently cause negative impacts in densely populated areas due to service disruptions, accessibility problems, delays, etc. In addition, the problems derived from its inadequate functionality also cause significant impacts on the economic activity of the affected area.

In Europe, 15% of the 300,000 existing bridges are made of steel or have structures made of concrete and steel. From this number, it is considered that approximately 68% are in need of structural interventions. In the United States, 34% of the 599,000 existing bridges are made of steel. From this number, approximately 9% is classified as structurally deficient, 15% functionally obsolete and 9.5% structurally deficient and functionally obsolete. Many of these bridges were built with outdated standards and a service life designed for 50 years that is coming to an end or has already been surpassed. In Europe, in the current scenario, it is estimated that the necessary repairs will represent 40% of the total costs of construction contracts, while in the United States, the Federal Highway Administration has declared that each year 10,000 bridges must be renovated.

The objective of the FASSTBRIDGE project has been to develop a preventive, reliable and easy to apply method to anticipate fatigue problems in existing steel bridges and use this information to calculate the life expectancy of these existing bridges using the AASHTO code or the Eurocode.

The methodology includes a method for evaluating the service life considering the fatigue of existing structures and the design and application of a reinforcement system. A new reinforcement methodology based on plates made of CFRP (Carbon Fiber Reinforced Polymer) placed by using an adhesive has been developed. The system combines a specifically formulated adhesive within the project and a commercially available CFRP plate. The materials and the system have been validated experimentally in the laboratory. Finally, a pilot application has been carried out on the Bridge over the Jarama River in Madrid, in order to validate the methodology and the system.

In the real-scale application, six welds were reinforced with three different reinforcement configurations, consisting of the application of 1, 2 and 3 layers of CFRP. All selected welds were monitored with a strain gauge to demonstrate the effectiveness of the FASSTbridge methodology before and after reinforcement. A load test was performed before and after the application of the CFRP, which included static and dynamic tests: quasi-static (20 km / h) and at low speed (50 km / h). For all measurements, a decrease in strain between 8% and 30% was measured, in accordance with the theoretical expectations. This has allowed to prove the efficiency of the solution, which implies an improvement in the useful life of the structure.

PROJECT MENHIR (DRAGADOS)

The MENHIR R&D project: Offshore floating wind turbine made of concrete in deep waters, approved in the RETOS-COLABORACIÓN 2015 notice, has been co-financed by the Spanish Ministry of Economy and Competitiveness within the State Program for Technological Research, Development and Innovation, having been executed during 2015-2018 and coordinated by DRAGADOS.

The general objective of the project has been the development, at the level of the design specifications, of a semi-submersible platform for offshore wind at great depths, built in concrete and steel, which will allow for the development of the offshore wind industry in deep waters using Spanish technology and with competitive costs for offshore wind compared to conventional methods.

The project has focused on the development of a floating structure and its anchoring system, for use in deep water, specifically designed to serve as a platform for the integration of new wind turbines. The structure is stable and resistant to the impact of waves, wind and currents, guaranteeing its durability in the hostile and extreme conditions of the high seas, which are typical for the Spanish or European coasts.

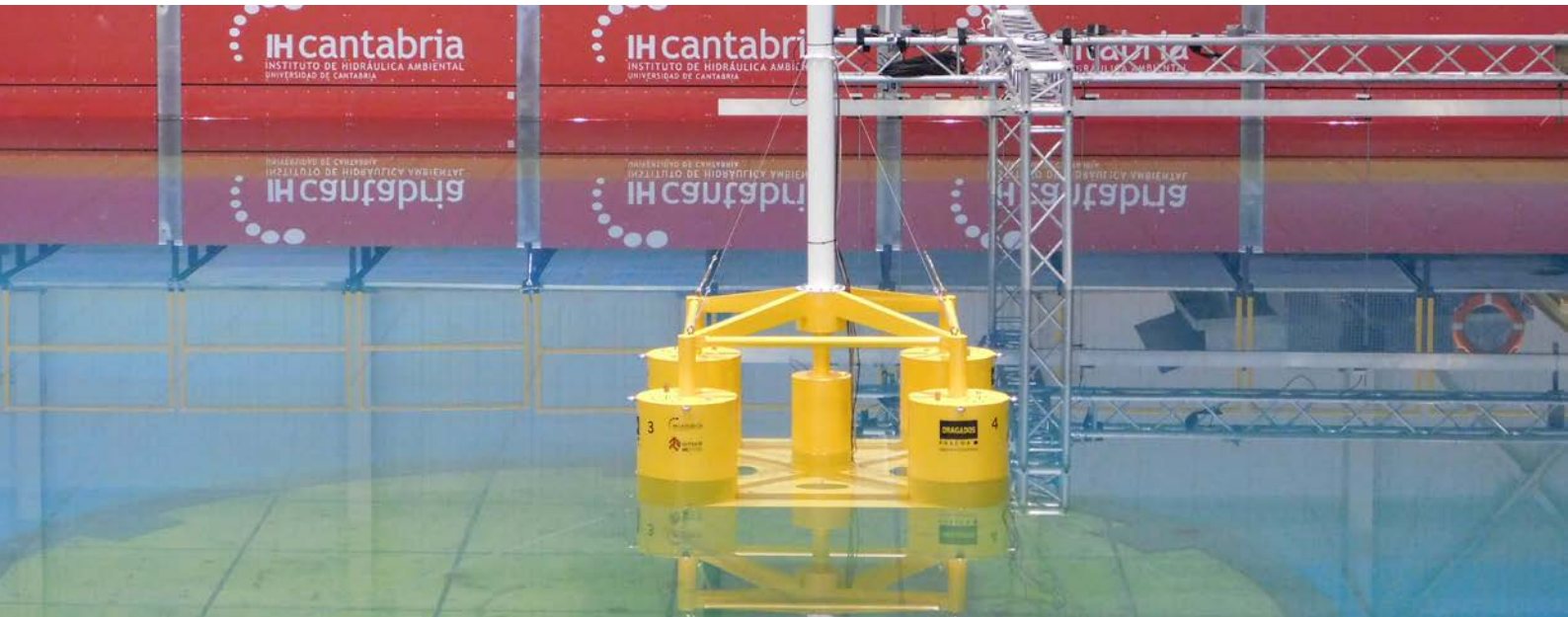
The structure was designed to be capable of offering adequate and sufficient operational conditions to accommodate a high-power turbine (10MW), satisfying the standard requirements required by the respective turbine manufacturers in order to be able to offer a sufficiently attractive production framework. The structural elements that contribute to ensuring the structural integrity of the solution: hull, transition piece, tower, anchoring lines and other elements, were also designed.

The constructive process, towing and positioning have been studied, including land and marine means, as well as the estimation of construction times, operability and sizing of the supply chain.

The technical-economic feasibility study of the equipment and its construction method, has paid special attention to its production, manufacturing costs, installation costs as well as the costs related to operation and maintenance.

For the validation of the solution and the numerical models developed, a prototype at 1/35 scale on which a battery of 101 tank tests has been carried out, consisting of two phases. During the initial phase, dry characterization tests were carried out, and characterization in water (damping, tilt, static offset), including that of the heave plates. Subsequently, during the main testing phase, 85 simulation tests of environmental conditions of waves (regular and irregular), current and wind were conducted. Likewise, the execution of the tests has included the simulation of loads in two directions, both at 0 degrees and at 45 degrees.

The test has validated the design of the executed platform. Essentially, laboratory tests involve the reproduction, at laboratory scale, of operational and extreme waves (up to 12 meters of significant height), which demonstrate that the design achieved, meets the technical requirements of the project.



EXPANSION OF BIM CAPABILITIES AT HOCHTIEF

Building information modeling (BIM) is the digital tool of the future for the execution of projects. The design and construction of projects using BIM is what customers in many countries are currently demanding. The methodology is based on actively connecting all the people participating in a project using 3D computer models that can be detailed with additional information, such as deadlines, costs and utilization.

Based on this model, project participants can also calculate the carbon footprint and possible savings. HOCHTIEF recognized this potential from the outset and founded the company HOCHTIEF ViCon GmbH, which specializes in these methods. The objective is for HOCHTIEF ViCon to be the BIM expert in all HOCHTIEF, offering courses in this area both for its own employees and as a provider of courses for other companies, as well as a consultant and advisor specialized in BIM for projects undertaken by the public administration or private companies. Additionally, BIM is already used in many of HOCHTIEF's companies. In 2017, the activities of EIC were fundamental to ensure the Kitemark certification of CIMIC from the British Standards Institution (BSI) in recognition of its experience and implementation of BIM. EIC's business activities play a fundamental role in ensuring the consistent implementation of digital engineering in CIMIC. Leighton Asia, for example, used BIM in the Passenger Clearance Building project in Hong Kong to construct the Roof of 40,000 square meters at a height of 30 meters. Currently, CIMIC is the only company in Australia that has been awarded the BSI Kitemark for Design and Construction (BSI PAS 1192-2, BS 1192 and BS 1192-4).

Turner in the United States, also uses BIM for almost all its projects being a pioneer of its use in that country. The increasingly widespread use of BIM not only promotes good planning and management of the construction process, but also simplifies maintenance and operations when combined with other digital applications such as 3D printing information, which provides an optimization for the project teams, being able to reliably improve safety, reduce execution risks and improve the overall quality of the project, among other benefits.

Thus, in 2018 the number of completed projects accumulated using BIM increased to 2,300 projects (compared to 2,052 in 2017) and the number of employees trained on the subject stands at 1,179 (819 in 2017), all of which is in response to meeting the needs of the customers, while offering sustainable products and services and, therefore, improve its position in the market.

NUMBER OF EMPLOYEES PROVIDED WITH BIM OR SIMILAR TRAINING IN 2018