

COLLABORATIONS

Collaborations of works and departments in certification of **R&D&I** activities

FCC Construcción 2023





The National R&D Department manages the certification process of innovative actions carried out in the different work centres once they have been completed. The certification process necessarily needs the discretionary involvement and collaboration of the different work centres involved in each project.

This entire certification process entails important advantages for the company:

- Provides references of R&D&I projects for construction tenders and other tenders related to these types of activities, obtaining additional marks specially in public tenders.
- Obtains tax deductions for R&D&I in corporate tax.
- Increases the areas of R&D&I activity covered by the R&D&I Management System Certificate in accordance with Standard UNE 166002:2021

En este último año de 2023 se han completado las siguientes certificaciones:

REMODELING OF THE SANTIAGO BERNABEU STADIUM: “CONTROLLED SUPPORT DEVICES FOR LARGE CIVIL STRUCTURES”

REMODELING OF THE SANTIAGO BERNABEU: “DEVELOPMENT OF STRUCTURAL FASTENING DEVICES FOR THE CLADDING OF A THREE-DIMENSIONAL FACADE”

ATENEA (NEW DISCON): COMPETITIVE IMPROVEMENT OF THE INTEGRATED BUSINESS MANAGEMENT SYSTEM PROCESS USING LOW CODE



Certificate

SANTIAGO BERNABEU

Remodeling of the Santiago Bernabeu

“Controlled support devices for large civil structures”

This activity has been certified as “TECHNOLOGICAL INNOVATION” thanks to the help and collaboration of the Bernabéu construction staff and the Special Works Department of the Technical Directorate..



This technology has been implemented in the remodelling works of the Santiago Bernabéu. The development of the “for construction” design of the structure resulted in an increase in its weight of 8,000 kN in respect to the original estimation. Most of this increase was located in the facades of the four ends, which reduced its structural safety coefficient. This required actions to restore the value of those coefficients back to those specified in the standards.

In order to restore the safety coefficient to its expected value, instead of modifying the designed structure, the philosophy followed in the design was to relieve the loads on the structure by creating forces that acted against and/or complemented gravity. These forces were set by the designer, in number

and position, to adjust and increase the safety coefficient of the structures against their own weight loads and the overloads of use.

Controlled hydraulic systems were installed for the creation of the stabilizing forces. The existing diaphragm walls of the old stadium structure, located on the North and South facades, receive the loads and direct them to the foundation. The use of hydraulic circuits in industry is a practice that is used very frequently today. But its use in structures and, above all, for the purpose envisaged in this project, was a novelty in Spain and, probably, in the world.

The total number of stabilising loads was set at eight. Four of them were placed on



the concrete diaphragm walls of the old structure, distributed equally on the North and South facades of the stadium, and each load was set at a figure of 1,000 kN.

During 2022, the hydraulic systems for generating stabilising forces were designed.

The manufacture of the controlled support devices in Germany, their assembly on the diaphragm walls of the old concrete structure of the Bernabéu and the adjustments for fixing the loads to be transmitted to the trusses of the ends, were carried out in 2023. Finally, the built and assembled system was commissioned and tested to check its correct operation, adequacy and performance.

The development of the controlled support devices also included the manufacture and assembly of the fastening elements, both to the façade trusses and to the concrete diaphragm walls of the old structure, which were designed by FCC experts in the previous year.

It should be noted that, within the assembly process, an additional complication arose that had to be resolved by demolishing a section of a grandstand area which interfered with the position of the devices and some

associated safety elements, such as railings and access platforms to the devices for their assembly, calibration and use.

Subsequently, once the devices were assembled, they were put under loads.

Due to structural reasons of the facades, which were under construction when the DACs were loaded, this operation was carried out in two phases:

- A first phase was carried out on the third week of May 2023 and consisted of putting the devices under 90% of the final load.
- The loading sequence was completed in a second phase in the second week of June by adding the remaining 10% of the load.

Following the instructions marked in the procedure “RSB-FO-PO-R26-IN-ES-0004-ROO-DAC loading sequence”, the first phases have been carried out by breaking down the operation in four loading steps. The second steps were carried out in a single phase.



The connection between the DACs was carried out in two groups, corresponding to the 4 units located on each of the North and South facades, thus giving them operational independence.

The 4 DACs at the North end were activated in the first phase. Each of their cylinders was subject to the 4 steps of 25 Tm specified, and each lower brace of the support beam was loaded to 37.5 Tm. This process was replicated in the DACS at the South end

during the second phase.

These loading steps were alternated between the four phase elements to guarantee the maximal symmetry in loads as possible during the process.

The loading was carried out with a software application. The parameters of the loading process were displayed on the screen of the application used in active mode.



**Bernabéu Devices
Certificate**

SANTIAGO BERNABEU

Remodeling of the Santiago Bernabeu

“Development of structural fastening devices for the cladding of a three-dimensional facade”



It has been certified as “TECHNOLOGICAL INNOVATION” thanks to the help and collaboration of the Bernabéu site staff and the Special Works Department of the Technical Directorate.

Three-dimensional facades consist of a thin exterior cladding and a support structure that collects the loads received by the cladding and transmits them to the general structure of the building.

Buildings using this type of facade tend to be large, so expansion joints must be provided. There is therefore a need for a specific study of the fastening of the cladding in the expansion zones that allows its movement, following the changes in temperature, without suffering damage, which is the

ultimate goal of the project.

The R&D project undertaken by FCC is developed to define this fastening system and is developed in two very specific stages:

- A first stage in which the devices are designed.
- A second stage in which the designs are turned into a physical reality, manufacturing the prototypes that will be placed in a chosen demonstrator, which is the new Santiago Bernabéu Stadium.

The first stage was carried out in 2022, the second in 2023.

Following these criteria, the slats were built,

transported to the site and mounted on the expansion joints, attached to the secondary structure of the North and South facades of the new stadium during 2023. The designed fastening devices were placed on these slats, and their effectiveness was verified.

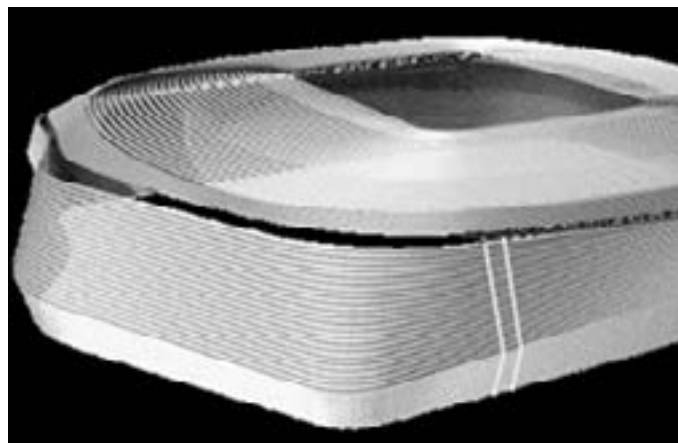
The dimensions of these facades are so large that they have required the inclusion of four expansion joints, which are located, specifically, on the North and South facades. The special slats provided with the fastening systems designed in 2022 as part of this R&D project were installed in these areas.

It should be noted that the assembly of the slats in the expansion areas did not begin until the rest of the slats on the two facades were in place. Once completed, the activity of assembling the anchors of the slats in the joints to the secondary structure, which had previously been incorporated into the main structure of the North and South facades, began.

In order to achieve a perfect fit with the rest of the slats, the individual dimensions of each of them were measured on site. These measurements were then used as a starting point for their manufacture, which was later bespoke made in the workshop. During their manufacture, the slats were fitted with the devices designed in 2022 and, once manufactured, they were sent to the site for assembly.

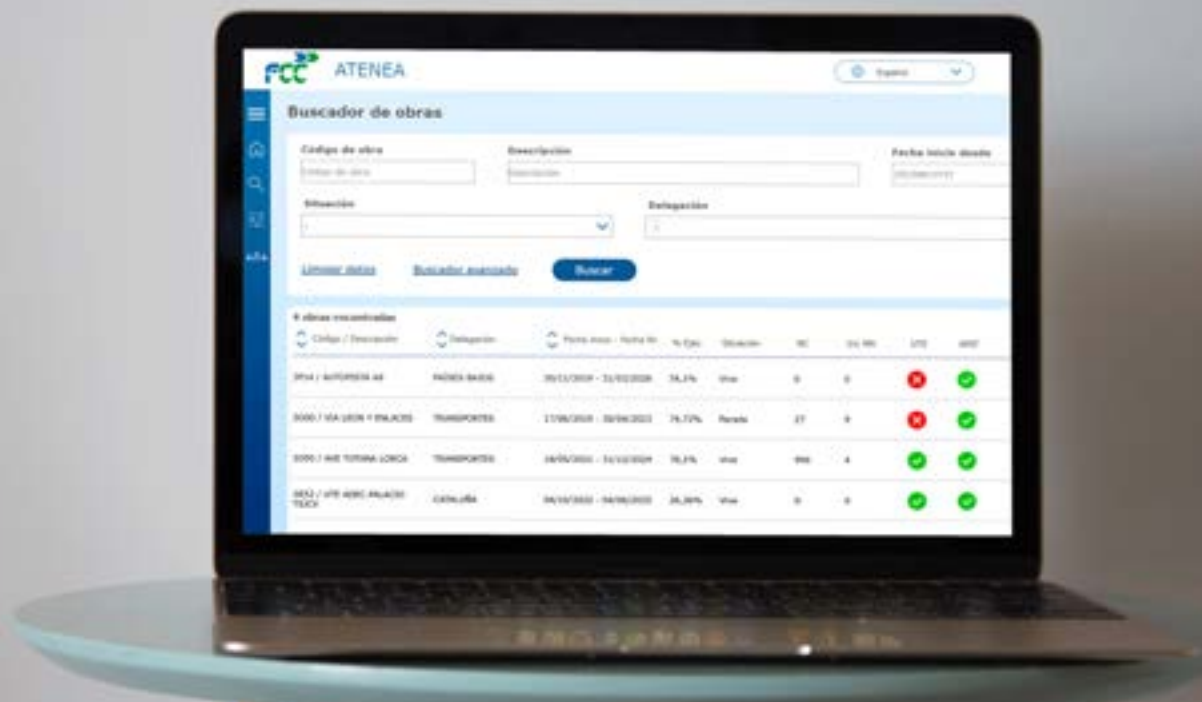
Staff on site determined the adequate moment for the commencement of the assembly of these special slats, starting with those in the expansion joint area located on the South façade and near the Castellana façade (West façade). The assembly was done by using a mobile crane to bring the pieces as close as possible to the facade, and two telescopic platforms, where the assembly workforce was located, to bring them closer to the positioning ends of the slats.

At the end of November 2023, the entire façade cladding of the new Bernabéu Stadium had been completed, including the expansion joint slats.



**Bernabéu Facade
Certificate**

Competitive improvement of the integrated business management system process using low code



This R&D project has been certified as “TECHNOLOGICAL INNOVATION” thanks to the help and collaboration of the staff of the FCCCO Knowledge Management Department and the staff of the Systems Division of FCC Industrial

A new software tool has been developed as part of the R&D project to help and ease the implementation of the IDI, Quality, Environment and other Management Systems on the construction sites.

Existing tools and best practices have been analysed. A functional analysis and a design proposal have been carried out.

One of the objectives of this project is to make it flexible and provide versatility in the different contexts in which FCC Construcción projects are developed.

The design of this tool will be carried out in a low-code programming environment, based on spreadsheet formulas, allowing a collaborative design of the tool between IT staff and advanced users.

The new tool is equipped with approval workflows, alert systems on document compliance dates, and dashboards, with the aim of being a transparent tool for the user within a collaborative environment.

