INNOVATIVE ACTIONS 2023

FCC Construcción

During 2023, innovative actions have been carried out with the aim of improving certain work processes. From the R&D&I Directorate, we want to recognize and highlight the importance of some of these actions and the effort made by the teams involved in them. Their contribution has been fundamental in promoting a culture of continuous improvement within the organization, optimizing work processes, and fostering innovation.

Directorate of Sustainability and Innovation (National R&D&I Department)

INDEX

Digitization of Rebar Schedules

Title of the Action

Digitization of Rebar Schedules

Related Work Centers

3S97 – 113 Homes in Alcalá de Henares

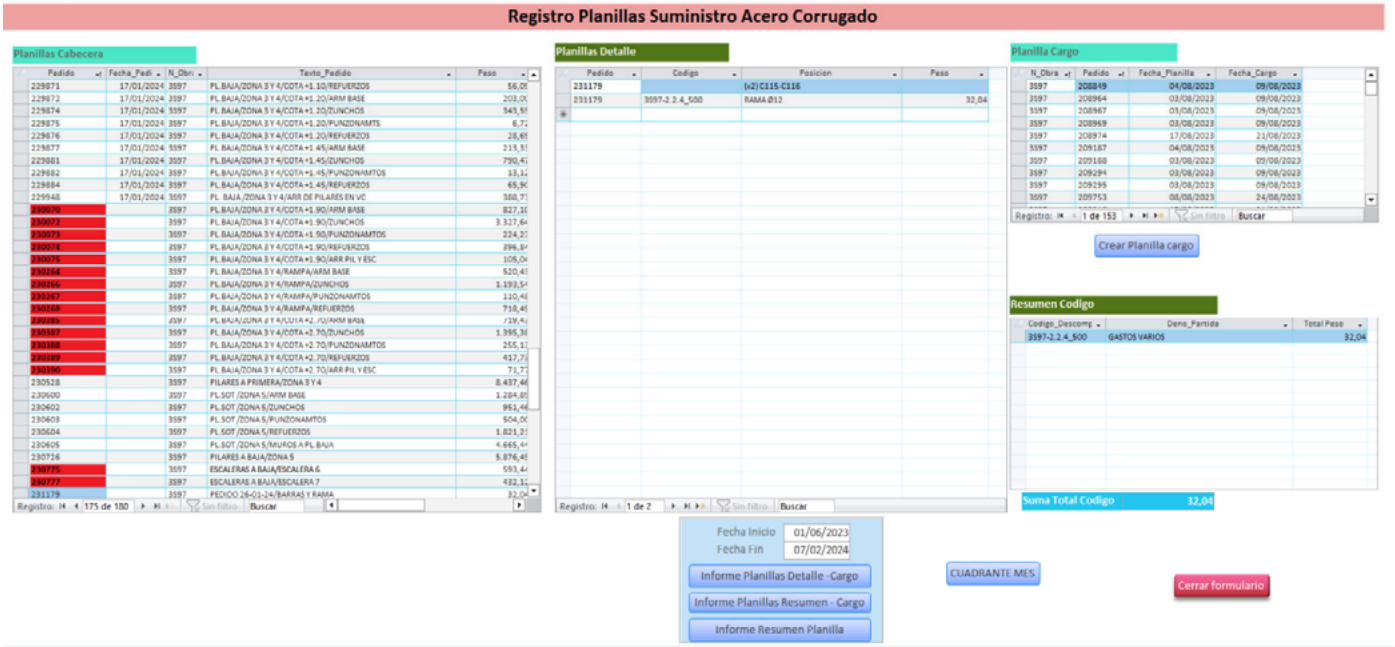
3T31 – 108 Homes in Tres Cantos

Summary of the Innovation:

Digitization of the schedules provided by the supplier.

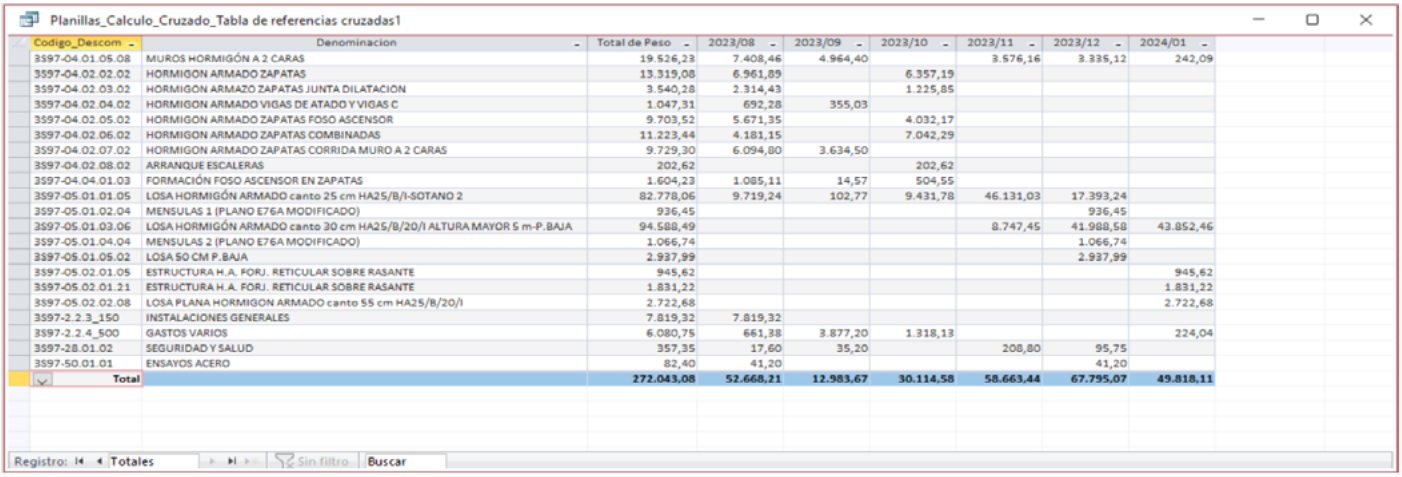
It consists of sending an email from the construction site to a predefined recipient with a predetermined subject, attaching the schedules to be digitized.

Using Power Automate, the attached files are processed to extract a series of fields from them.



These fields are sent to a database, where each of the quantities broken down in each of the schedules must be assigned to their corresponding budget item.

A table is generated indicating the kilograms of steel that have entered the construction site each month, broken down by each budget item.



Codigo_Descom	Denominacion	Total de Peso	2023/08	2023/09	2023/10	2023/11	2023/12	2024/01
3597-04.01.05.08	MUROS HORMIGÓN A 2 CARAS	19.526,23	7.408,46	4.964,40		3.576,16	3.335,12	242,09
3597-04.02.02.02	HORMIGON ARMADO ZAPATAS	13.319,08	6.961,89		6.357,19			
3597-04.02.03.02	HORMIGON ARMAZO ZAPATAS JUNTA DILATACIÓN	3.540,28	2.314,43		1.225,85			
3597-04.02.04.02	HORMIGON ARMADO VIGAS DE ATADO Y VIGAS C	1.047,31	692,28	355,03				
3597-04.02.05.02	HORMIGON ARMADO ZAPATAS FOSO ASCENSOR	9.703,52	5.671,35		4.032,17			
3597-04.02.06.02	HORMIGON ARMADO ZAPATAS COMBINADAS	11.223,44	4.181,15		7.042,29			
3597-04.02.07.02	HORMIGON ARMADO ZAPATAS CORRIDA MURO A 2 CARAS	9.729,30	6.094,80	3.634,50				
3597-04.02.08.02	ARRANQUE ESCALERAS	202,62			202,62			
3597-04.04.01.03	FORMACIÓN FOSO ASCENSOR EN ZAPATAS	1.604,23	1.085,11	14,57	504,55			
3597-05.01.01.05	LOSA HORMIGÓN ARMADO canto 25 cm HA25/B/I-SOTANO 2	82.778,06	9.719,24	102,77	9.431,78	46.131,03	17.393,24	
3597-05.01.02.04	MENSULAS 1 (PLANO E76A MODIFICADO)	936,45					936,45	
3597-05.01.03.06	LOSA HORMIGÓN ARMADO canto 30 cm HA25/B/20/I ALTURA MAYOR 5 m-P.BAJA	94.588,49				8.747,45	41.988,58	43.852,46
3597-05.01.04.04	MENSULAS 2 (PLANO E76A MODIFICADO)	1.066,74					1.066,74	
3597-05.01.05.02	LOSA 50 CM P.BAJA	2.937,99					2.937,99	
3597-05.02.01.05	ESTRUCTURA H.A. FORJ. RETICULAR SOBRE RASANTE	945,62						945,62
3597-05.02.01.21	ESTRUCTURA H.A. FORJ. RETICULAR SOBRE RASANTE	1.831,22						1.831,22
3597-05.02.02.08	LOSA PLANA HORMIGON ARMADO canto 55 cm HA25/B/20/I	2.722,68						2.722,68
3597-2.2.3_150	INSTALACIONES GENERALES	7.819,32	7.819,32					
3597-2.2.4_500	GASTOS VARIOS	6.080,75	661,38	3.877,20	1.318,13			224,04
3597-28.01.02	SEGURIDAD Y SALUD	357,35	17,60	35,20		208,80	95,75	
3597-50.01.01	ENSAYOS ACERO	82,40	41,20				41,20	
Total		272.043,08	52.668,21	12.983,67	30.114,58	58.663,44	67.795,07	49.818,11

In conclusion, this system achieves:

- **An improvement in the control of steel supply pro forma.**
- **It allows for the comparison of budget measurements with those actually executed, helping to detect measurement deviations, non-conformities, or contradictory prices.**

Progress Tracking Test of Construction Work with 360-Degree Photographs

Title of the Action

Progress Tracking Test of Construction Work with 360-Degree Photographs

Related Work Center

3P97 – 42 Homes in Arroyo del Fresno

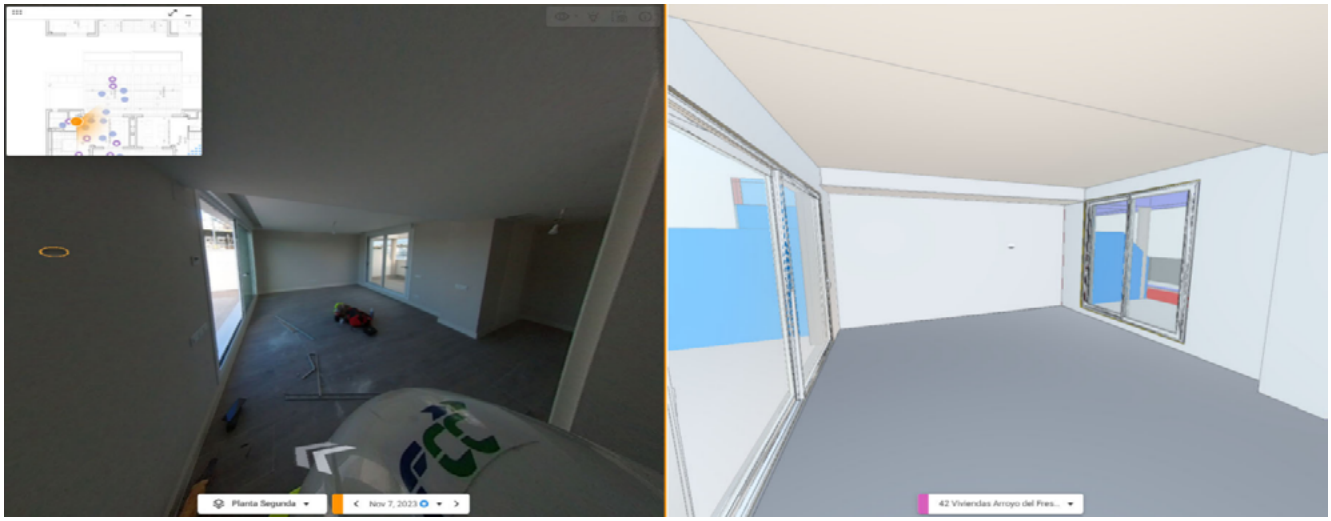
Summary of the Innovation

Testing a platform for tracking construction progress using 360-degree videos taken periodically on-site.

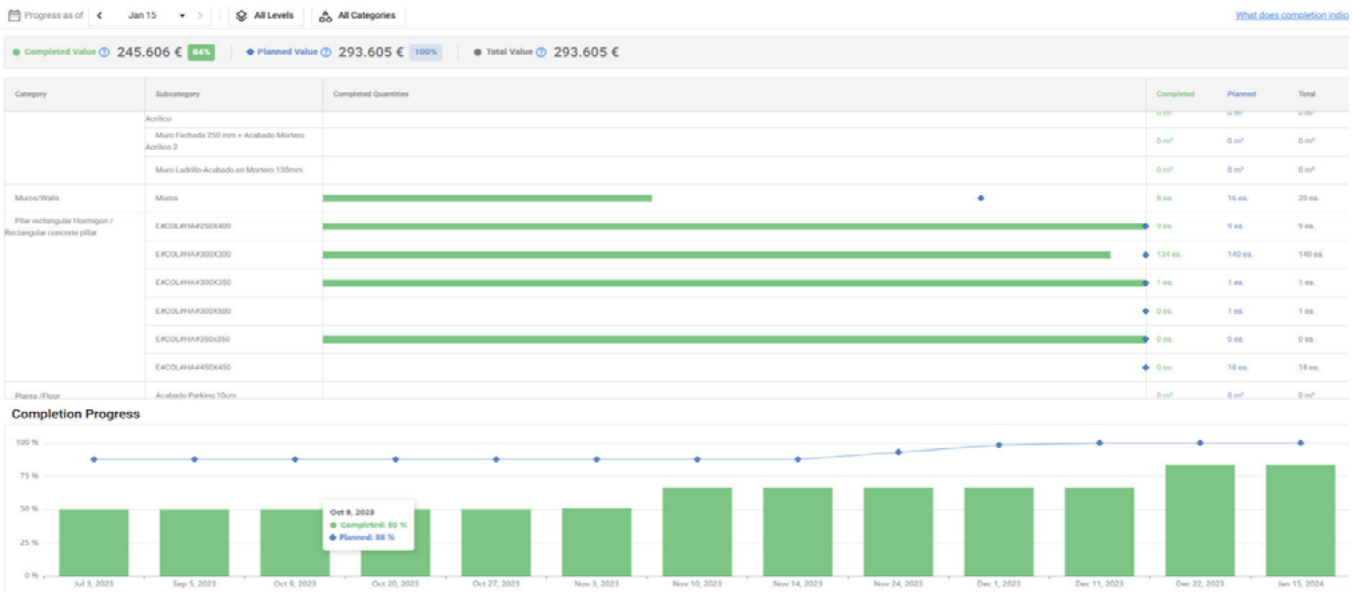
Two years ago, based on a proposal from DI Lab, a platform called OpenSpace was tested, which allowed for the comparison of photographs of the same location on the construction site taken on different dates or with the BIM model. In 2023, **Cupix** has started to be tested, which, in addition to what the previous platform allowed, **initially enables the updating of the construction schedule.**

It also allows for the **comparison of photographs from different dates.**:

Additionally, it allows for the comparison of reality with the BIM model.



It is possible to update the schedule based on the photographic reports (currently with many limitations, only at the BIM family level)



Important conclusions from this action include:

- Measurements can be taken on the platform. It is not very precise, but it serves as a reference. It allows for seeing differences between what was planned and what was executed.
- The platform generates a 3D model from the construction photographs.
- The platform allows for uploading photographs taken by a drone, which would enable tracking the exterior of the construction site.
- Point clouds can also be uploaded.
- Although it was not within the initial scope of the test, it has been possible to isolate the photographs of the pilot apartment to create a link that can be provided to the Property for commercial use."

Cost Control Management of Construction Works

Denominación de la actuación

Cost Control Management of Construction Works

Related Work Centers

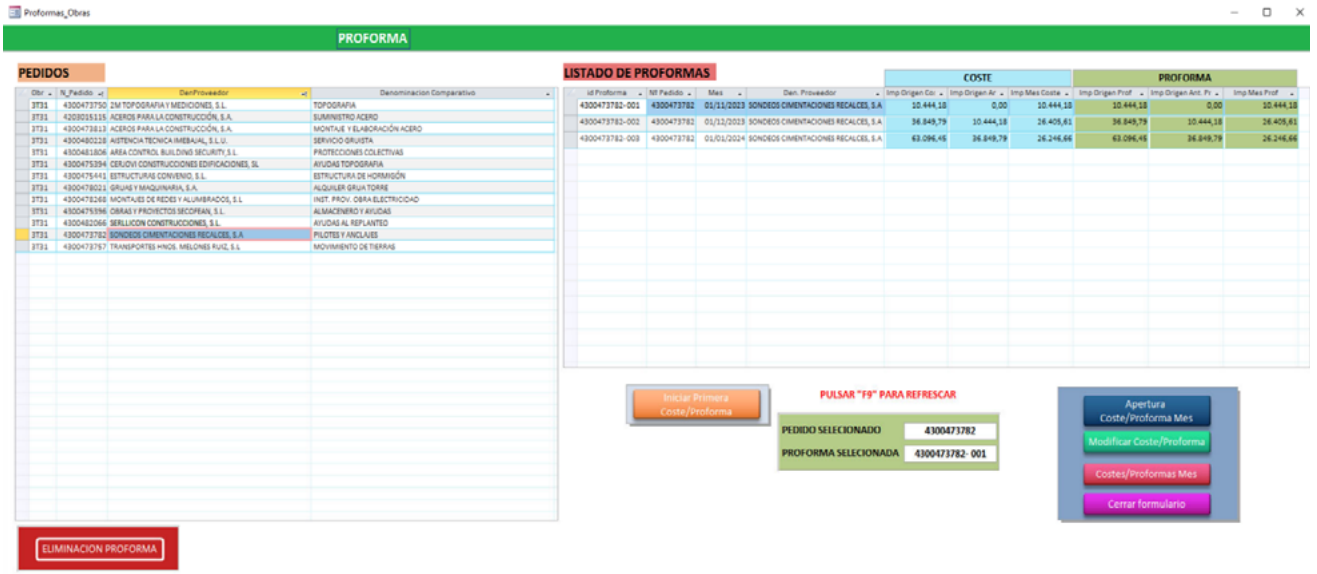
3Q31 - 80 Homes in Alcalá de Henares

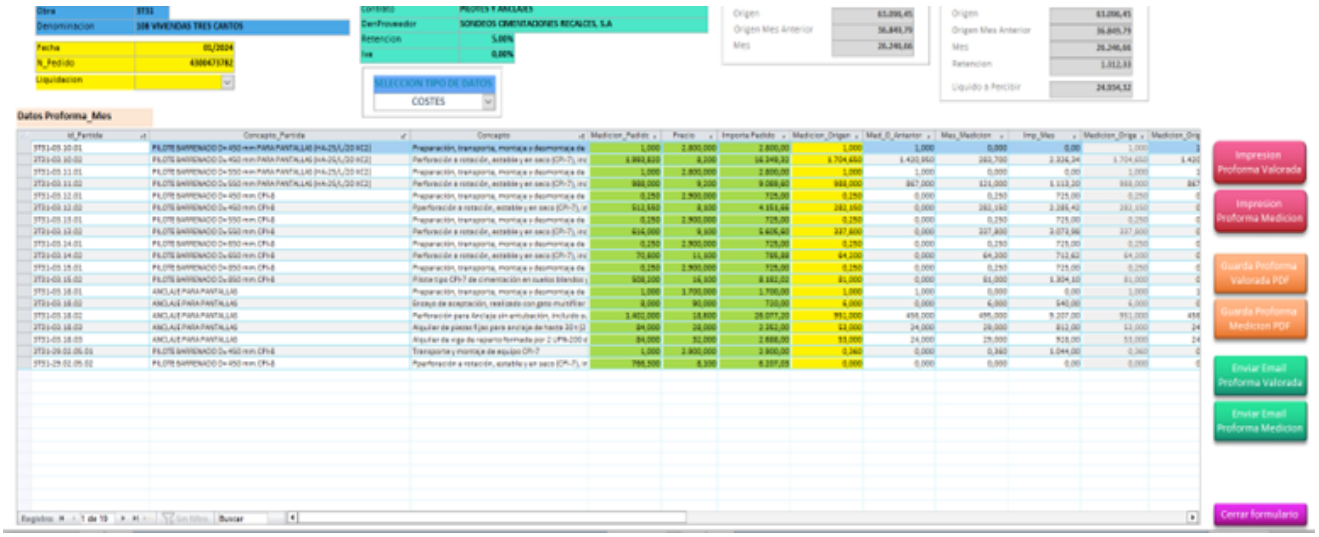
3S97 – 113 Homes in Alcalá de Henares

3S26 – 64 Homes in Tres Cantos

3T31 – 108 Homes in Tres Cantos

Summary of the Innovation: The pro formas are filled out from the database. This controls the original consumption, indicating the items that have been 100% consumed in the contract. In this way, **it is possible to monitor which items exceed the contract measurement and which ones need extensions**





Regarding materials, when they are taken out of the warehouse, the process to follow is to indicate which budget item their cost should be assigned to.

Additionally, a similar control can be maintained for indirect costs, with a monthly report comparing the forecasted costs with the actual costs assigned.

It also allows for the detection of cost deviations or costs that are not associated with any budget item, such as those derived from non-conformities or contradictory prices.

If the month is closed, it allows for generating reports of all the deviations in the construction project.

Structural Work Progress Tracking Based on Concrete Delivery Notes

Title of the Action

Structural Work Progress Tracking Based on Concrete Delivery Notes

Related Work Center

3S97 – 113 Homes in Alcalá de Henares

Summary of the Innovation

Tracking and tracing the concrete structure based on concrete delivery notes.

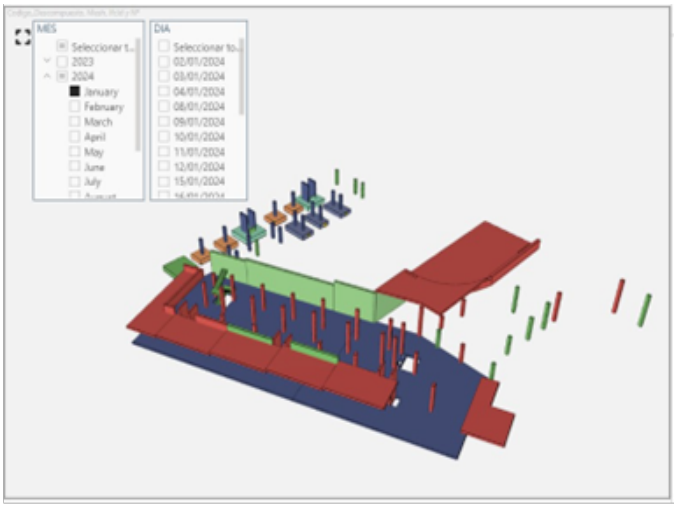
Using printed information or data manually obtained by the construction team, and a properly coded BIM model, all the data from the delivery note is integrated into a database and displayed in Power BI.

- It starts by writing a series of predefined data on the delivery note
- All the information from the delivery note is extracted through a Microsoft PowerApp.

As an example, the concrete from a delivery note can be poured in several locations; the quantities and locations of these elements are manually entered into the database.

- Once the entire process is completed, the traceability is displayed in Power BI by floors or by dates

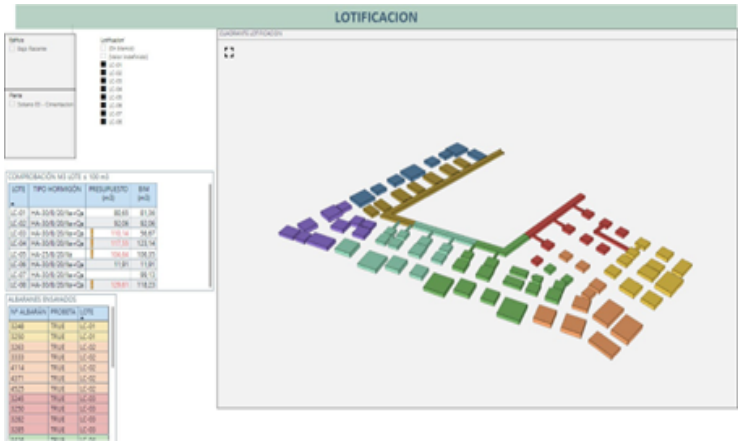
Traceability by floor (foundation)



Traceability by dates (January 2024)

It allows for the comparison of budget measurements, BIM model measurements, and actual measurements according to the delivery notes for each concreted element. This improves the tracking and control of construction losses

It allows for visualizing the lotting of the different elements



- If there are no changes in the lotting, the concrete lotting spreadsheet can be obtained already filled with the data from the delivery notes and lots.
- From all this properly structured information, a draft of the pro formas for the different executed items can be generated.
- The production and/or certification of the concrete structure items can also be extracted.
- It could be connected to a schedule that is coded in the same way, allowing for tracking.

Punch List Management with the ACC Builder Application

Title of the Action

Punch List Management with the ACC Builder Application

Related Work Center

3R36 – 61 Homes in Sant Joan Despí

Resumen de la innovación

This action consists of testing the ACC Builder platform from Autodesk for managing construction punch lists

Data collection on site

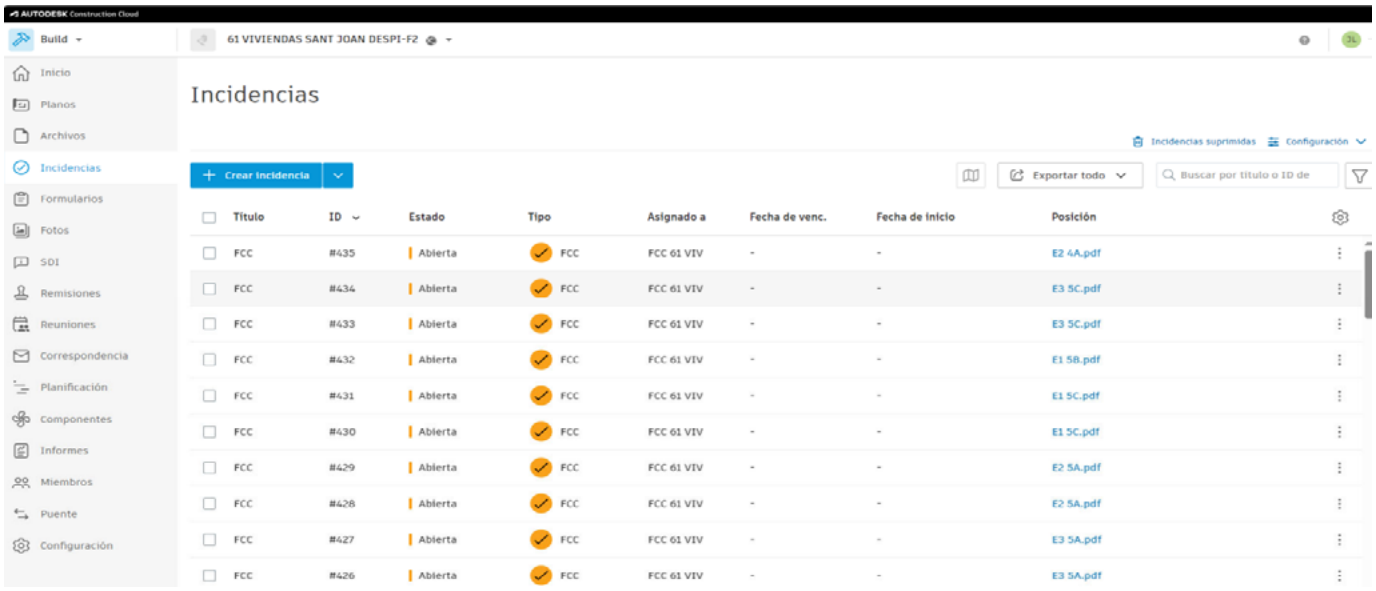
Using the Incidents section of the ACC Build platform, each punch list item for finishes to be improved is being directly noted on-site.

This platform allows for **direct management of incidents**, eliminating the need to manually create a list that must then be transferred to a spreadsheet.

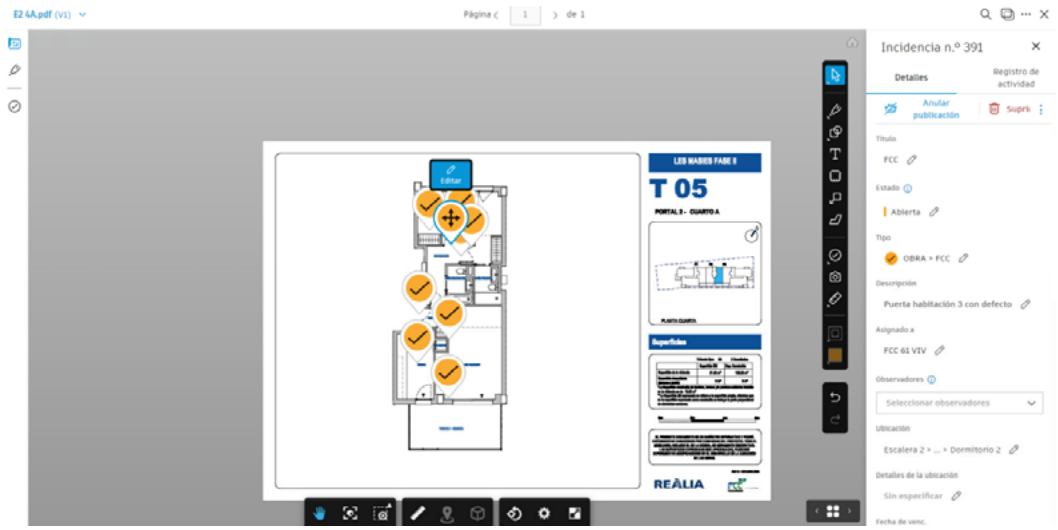
Additionally, **it encourages collaboration among the construction team**, as any team member can open or close a new incident.

It also allows for the inclusion of the **Project Management and/or external** Engineering team so they can add their punch lists to the platform.

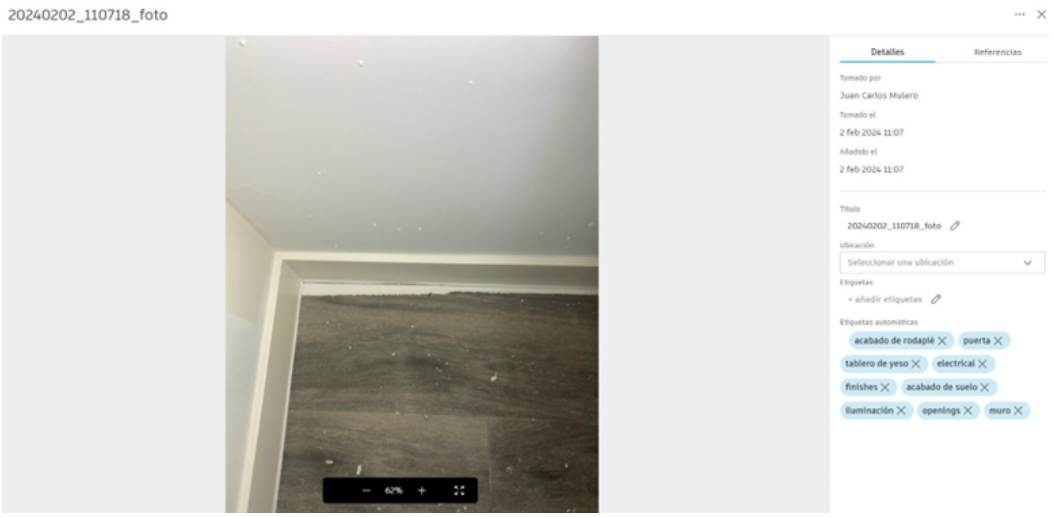
It could even be shared with **subcontractors** who need to carry out the punch list items



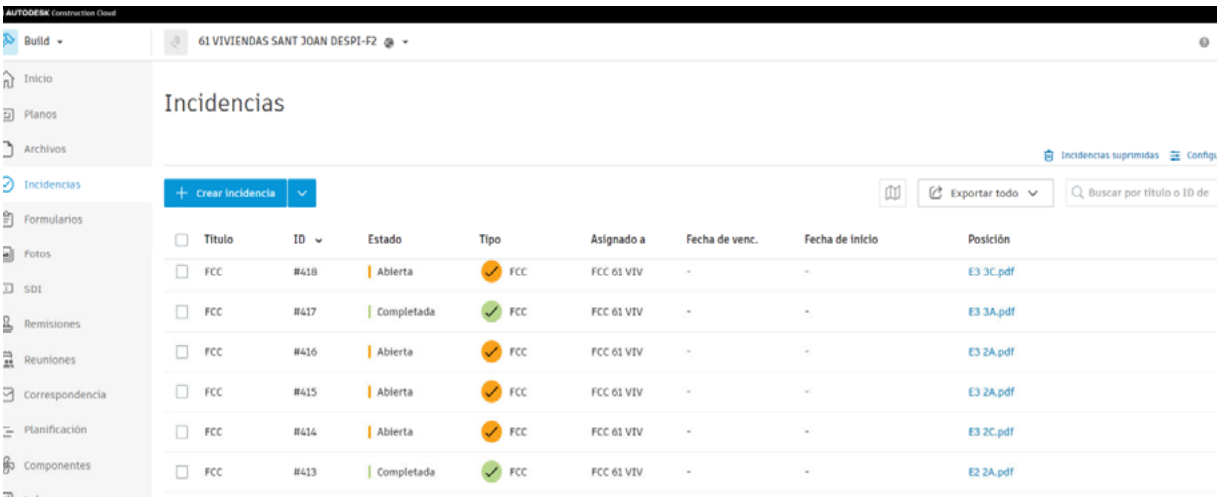
Each punch list item is **indicated on a floor plan of the home,** which facilitates its location



It allows for attaching a **photograph** to facilitate its identification.



Once the issue has been resolved, any team member can close



it.

3D Printing (Models)

Title of the Action

3D Printing (Models)

Related Work Centers

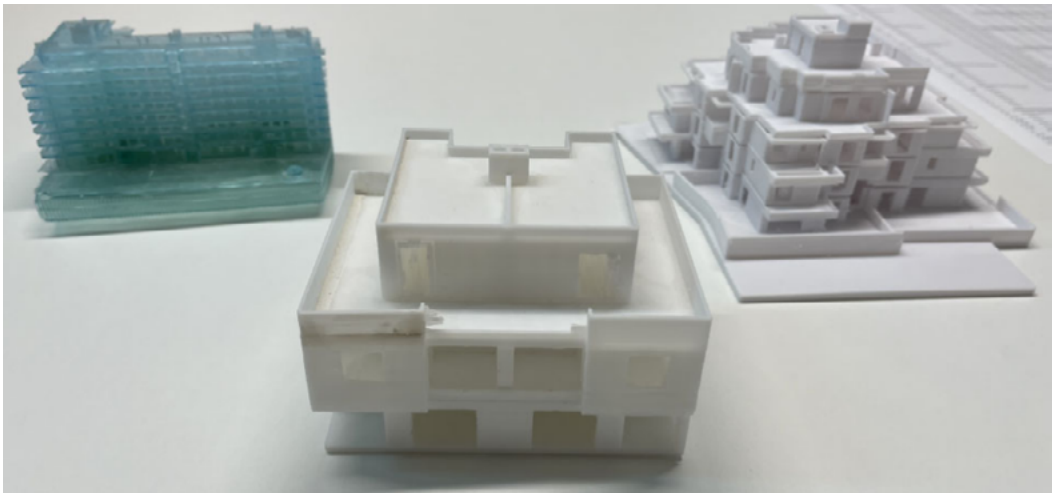
3S97 – 113 Homes in Alcalá de Henares

3T31 – 42 Homes in Arroyo del Fresno

3Q99 – 74 Homes in Tres Cantos

Summary of the Innovation

This action **involves leveraging the BIM model to print models of the buildings to be constructed using 3D printers.** Models of buildings from various developments have been printed using 3D printers.



There is the possibility of printing floor by floor to view the layouts of the different levels.

Virtual/Augmented Reality Test in Construction

Title of the Action

Virtual/Augmented Reality Test in Construction

Related Work Center

3S26 – 64 Homes in Tres Cantos

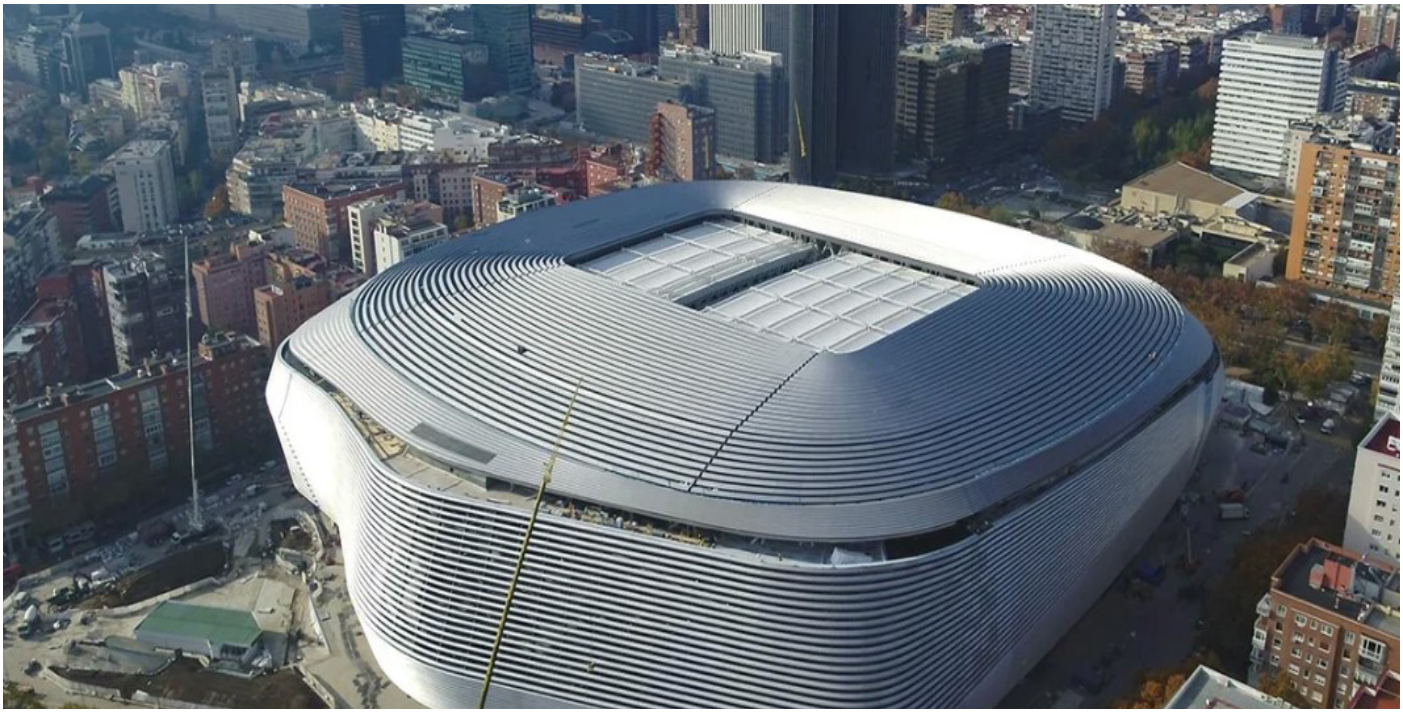
Summary of the Innovation

Virtual/Augmented Reality systems have been tested on the construction site. The VT-Platform was used, where the BIM model of the project was uploaded, and tests were conducted to assess the feasibility of using it to modify some parameters directly on-site.

Properly configured, it could be used to track the progress of the construction, production, or certification.

Possibility of viewing the BIM model on a mobile device.

Acoustic Membranes



Title of the Action

Acoustic Membranes

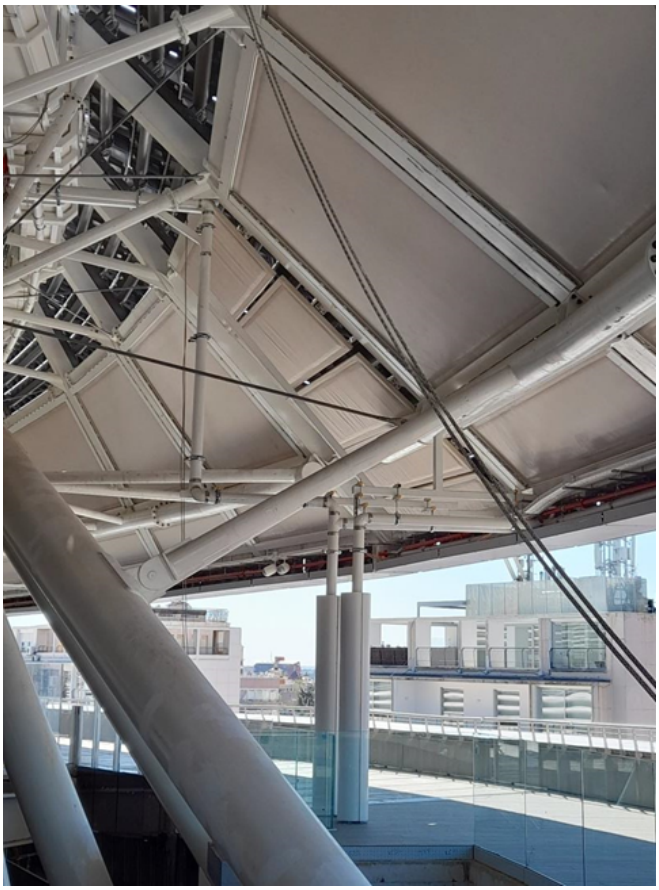
Related Work Center

3038 - Santiago Bernabéu Stadium Remodeling

Summary of the Innovation

Among the different solutions for the acoustic shielding of the stadium, a novel approach stands out: tensioned canvases arranged on the facade facing the interior of the stadium, functioning as **acoustic screens integrated into the facade substructure.** These acoustic screens are made of a special canvas, essentially a type of PTFE membrane bags filled with nanogel, which increases acoustic insulation towards the exterior of the stadium.

These canvases are placed above the skywalk in the North and South stands.



Correspondence Registration

Title of the Action

Correspondence Registration

Related Work Centers

All FCCCo Portugal Centers and Projects

Summary of the Innovation

With the need to improve the organization and archiving of correspondence, the Portuguese delegation developed REGISCOR with its IT department.

The application has been installed for several years, but it has been continuously improved, and work on it continued throughout 2023. It allows for the **registration and coding of all correspondence from the delegation and projects. REGISCOR is developed in Microsoft Access and replicated in an ASP file.**

This application allows, in addition to registration (assigning a reference to all correspondence sent or received by the company and projects), the storage of all project correspondence, especially emails that previously remained in each user's Outlook.

It also allows, once the project is completed, to consult and access all important correspondence with stakeholders: clients, technical assistance, permitting and licensing authorities, suppliers, etc.

It is designed to separate registration and consultation by division.

Benefits of the Application

Acquisition and Maintenance Costs

The systematization allowed for an initial and subsequent annual benefit with the cost of acquiring and maintaining a similar application on the market. Such applications do not exist in isolation and, as such, would have very high annual subscriptions.

Personnel Time Cost

With REGISCOR, workers spend on average, about 1 hour less per day managing correspondence.

Paper Reduction

This systematization allows for archiving documents in digital format without having to print them for future reference. This can result in significant savings in paper acquisition and paper waste.

Advantages of REGISCOR

- Saves costs for the organization
- Saves time for workers, allowing them to focus on more important tasks on the construction site
- Reduces errors and duplications that occur with manual records (people forgetting to register the code they already used)
- Reduces paper usage and packaging waste
- Reduces the loss of information that can be important during the warranty phase of the projects, in customer claims, and helps us defend against costs that are not our responsibility
- Allows for consulting all important correspondence of the projects and organization from any computer, without the need for travel to the temporary archive at the machinery park, also saving the time of personnel at this center searching for old documentation
- Allows for organizing and searching all correspondence by division, dates, subject, sender, receiver, and others
- The application can improve by replicating in ASP files and has some issues in SharePoint

Videoboard Structure Assembly

Title of the Action

Videoboard Structure Assembly

Related Work Center

3038 - Santiago Bernabéu Stadium Remodeling

Summary of the Innovation

As part of the development and construction of the New Santiago Bernabéu Stadium, FCC Construcción commissioned an engineering firm to study and design the structure of different areas of the new stadium. One of these areas is known as the Under Roof, whose design, calculation, and preparation of graphic and BIM documentation have been developed by the engineering firm in collaboration with the construction team and FCC's technical services.

A perimeter halo facing the field is projected, along with 10 rear screens facing the stands; 4 at the ends and 6 on the sides. Additionally, new lighting, heating, and public address systems are planned. To support this system of technological installations, a set of walkways at the level of the main roof trusses is projected, along with a substructure hanging from the main beams.

A metal structure hanging from the main roof trusses is projected, with three different structural systems depending on whether it is an end videoboard, a side videoboard, or a corner videoboard:

End Videoboards: The substructure consists of a series of portals, each hanging at two points from the two lower chords of the end trusses.

Between each pair of portals, transverse beams are arranged to support the maintenance walkways as well as the technological installations, particularly to support the videoboard screen.

Lateral VM: The substructure is divided into 5 independent spans hanging from its ends, between which movement joints are provided. The reason for dividing this structure into sections is to allow the Video Scoreboard structure to follow the deflection movements of the rolling truss on which it hangs, opening and closing the joints between sections with displacements compatible with the requirements of the video scoreboard. In other words, each of the five spans follows the deflection of the roof truss by rotating as a rigid solid depending on the movement of the two roof suspension points.

Corner MV: the substructure consists of three independent floor structures (plus the rail beam level structure; connected by vertical 'sticks' for anchoring the screens). This substructure has to allow for the relative movement between bottom and side substructures imposed by thermal actions and relative vertical movements of the two supporting trusses (cable-stayed and rolling).

The central sections of the east and west sides have been pre-assembled on the ground, on auxiliary platforms, and then hoisted complete to the roof from which they hang.

The extreme areas of the east and west sides, those corresponding to the four corners and those of the north and south bottoms, were assembled at height, piece by piece.

Implementation of Dalux Infra for Information Management

Title of the Action

Implementation of Dalux Infra for Information Management

Related Work Center

3R07 UTE Sotra Link Cons JV

Summary of the Innovation

Use of **Dalux** Infra for:

- Visualization and consumption of graphic information (3D models, 2D layers, real-time photographs, point clouds, 360-degree photographs, etc.)
- Management of Technical Queries, management of Undesired Events, Requests for Design Modifications, quality assurance and its processes, BREEAM certification study, and more processes.
- On-site application use for Geolocation and basic AR Visualization.
- Automatic daily updates of models shared by the designer or creation of the federated model

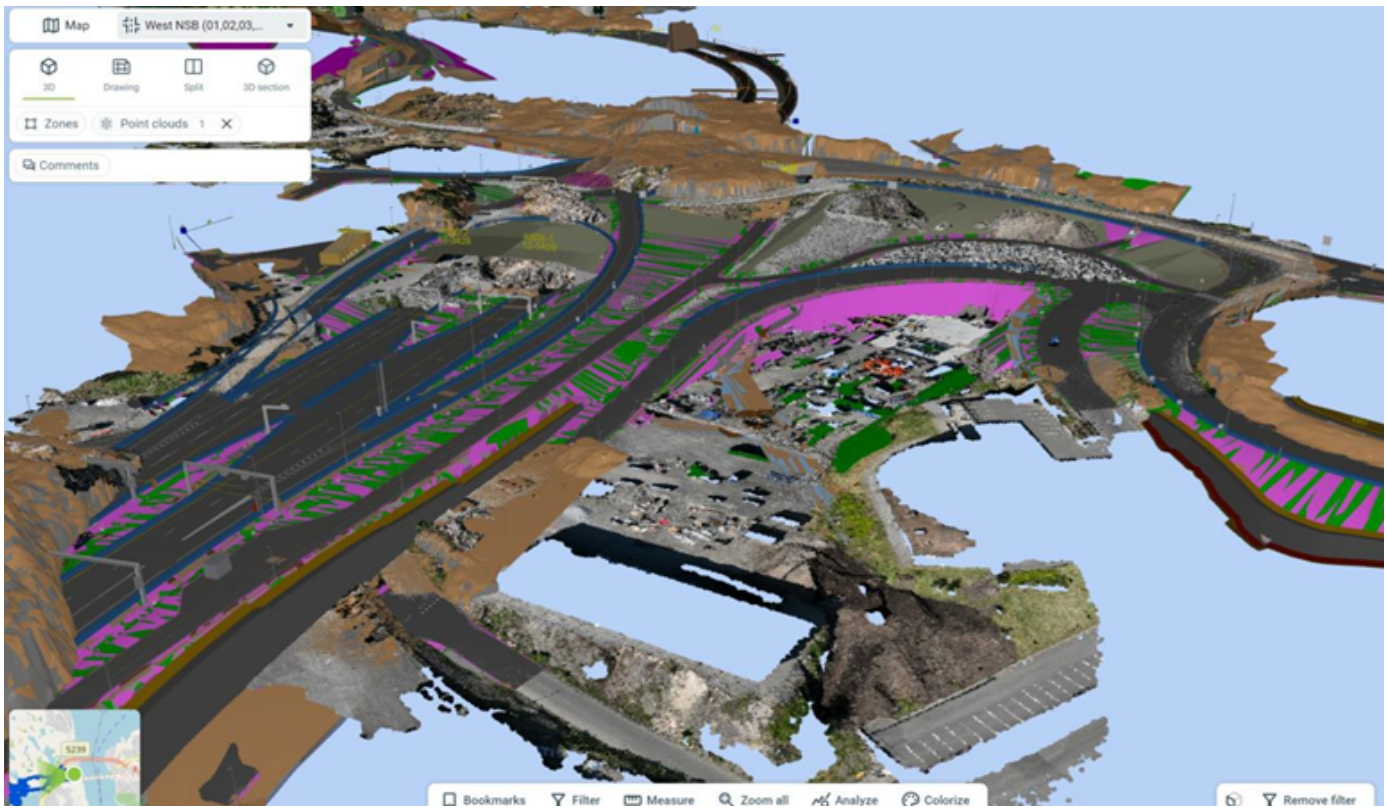


Image 1. Final design with progress shown using point clouds.

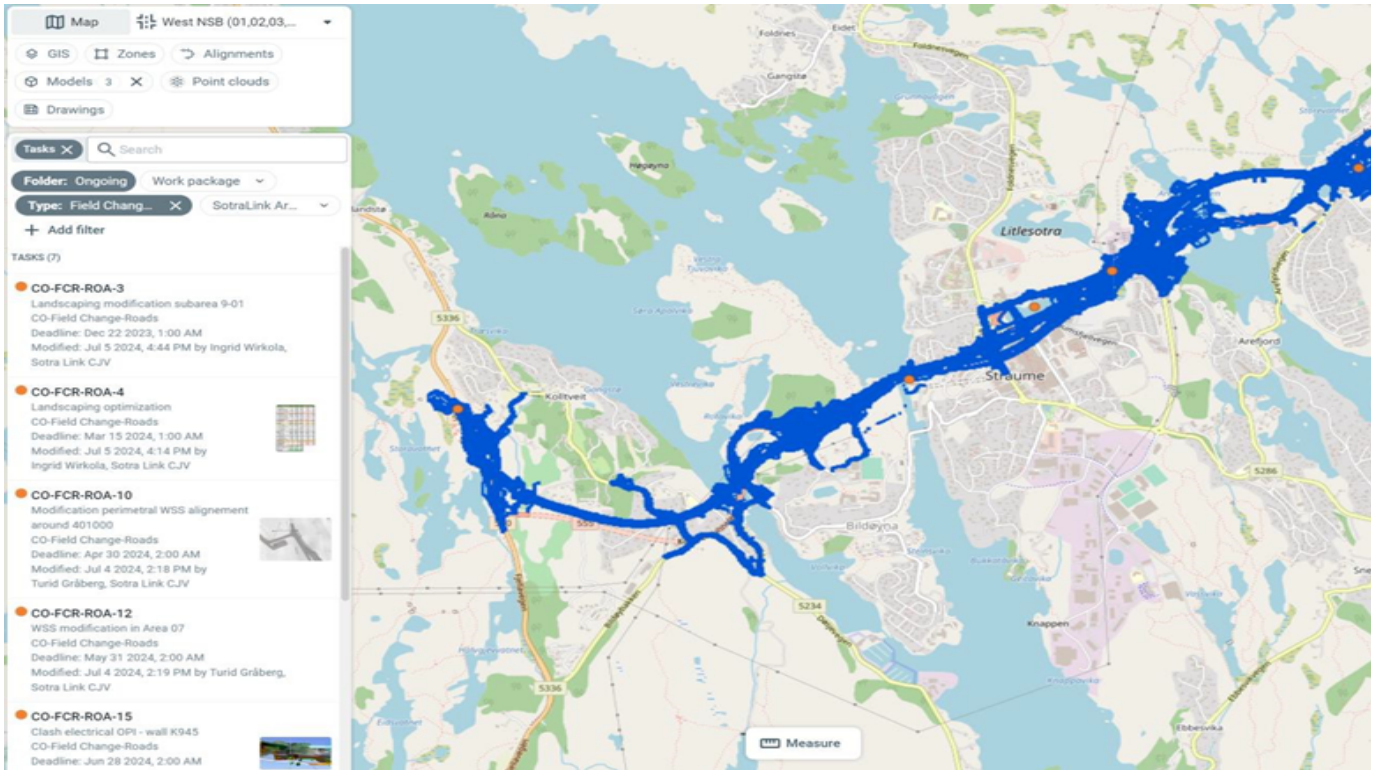


Image 2. Geolocation of tasks and checklists, in this example: Field Change Requests

The implementation of Dalux Infra in our project aims to **optimize the management and visualization of graphic information through 3D models, 2D layers, real-time photographs, and other advanced tools.** This allows us to have a comprehensive understanding of the project and early identification of issues.

Dalux Infra also improves the management of technical queries, undesired events, design modifications, quality assurance, and BREEAM certification studies, integrating all these processes into a single centralized platform. This simplifies workflows and reduces the risk of errors.

The on-site application of Dalux Infra, which facilitates geolocation and augmented reality visualization, is invaluable for the field team, allowing for better coordination between design and construction and improving spatial accuracy for perfect geographic identification.

Finally, the automatic daily update of models shared by the designer ensures that everyone works with the most recent information, creating a federated model that enhances project collaboration and consistency. Dalux Infra is a comprehensive tool that increases efficiency, quality, and collaboration in our infrastructure projects.

Application of Geographic Information Systems (GIS) in Hydraulic Works

Title of the Action

Application of Geographic Information Systems (GIS) in Hydraulic Works

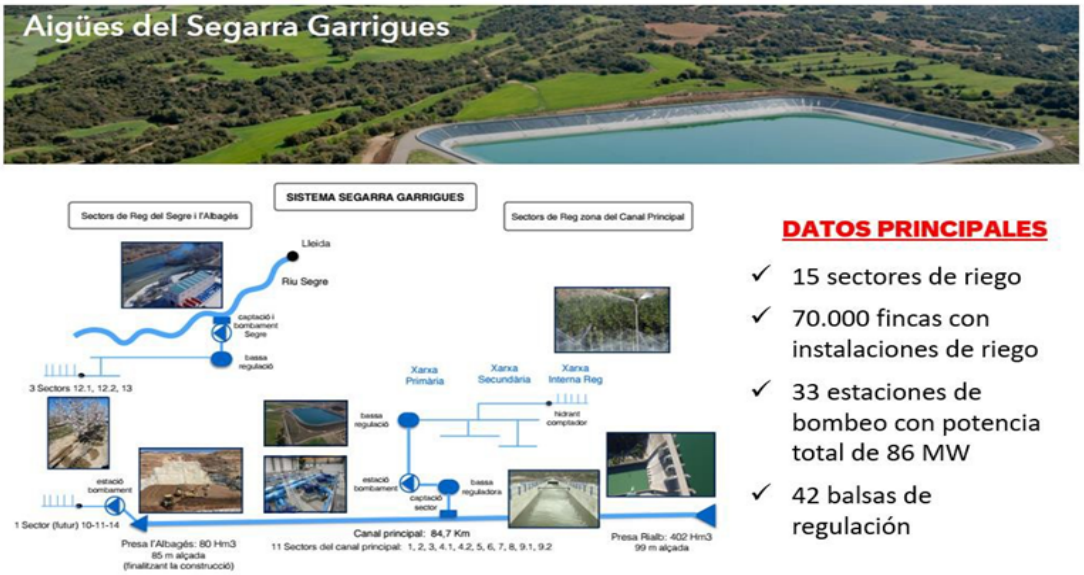
Related Work Centers

ASG Lleida Works – 3P55 / 3R33 / 3S00 / 3S81

Summary of the Innovation

FCC Construcción is involved in the execution of different sections of the irrigation network in the province of Lleida for AIGÜES DEL SEGARRA-GARRIGUES (ASG), a private entity that manages land consolidation, project drafting, execution, operation, and maintenance of the hydraulic network associated with the left bank of the Segre River.

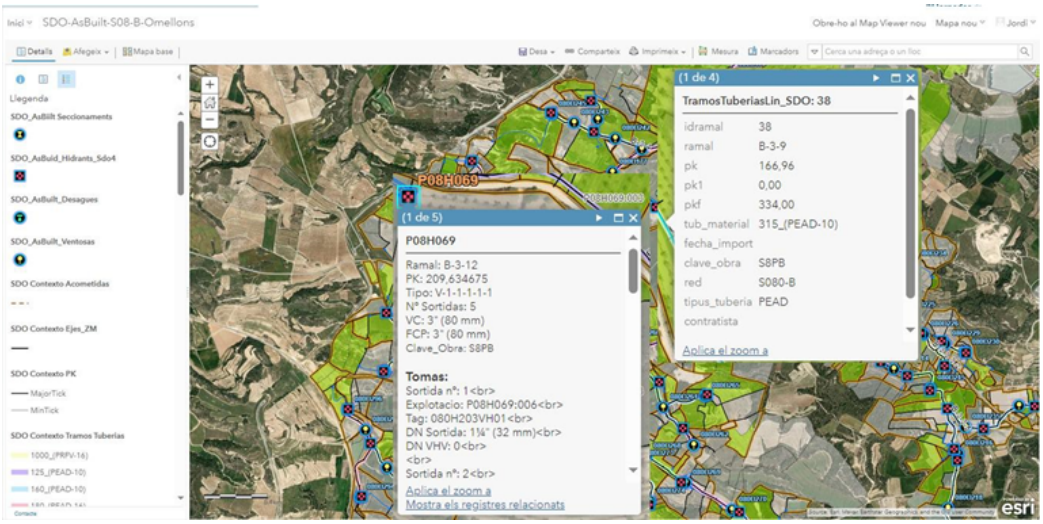
Given the described context, this type of work is highly suitable for the application of Geographic Information Systems (GIS) work environments. Thus, both the visualization of the irrigation distribution networks and hydraulic accessories, as well as the completion, consultation, and use of data for execution control, are perfectly integrable into its software environment.



Application of ARCGIS in the Execution of Hydraulic Works

To develop the optimal management model for the ASG works, interaction with ESRI's ARCGIS ONLINE software has been chosen. It is a cloud-based geographic content management system that allows organizations to manage their information. Through its mobile and tablet apps, ARCGIS ONLINE enables fieldwork with relevant project content, making it highly efficient for this type of civil work.

The attached figure shows an example of the distribution network of one of the sections under construction, specifically Sector 8 in the vicinity of the municipality of Els Omellons (Les Garrigues, Lleida). The great advantage of ARCGIS is the association of metadata with any of the elements represented in the network plan: sections, segments, hydrant characteristics, pipe sections, etc.



Therefore, any user of the system can access these metadata from their mobile device, without being restricted by location (site or office) or network availability (except for updates with new data).

Additionally, another innovative aspect that has had a significant impact on the site is the integration of Geographic Information Systems with Quality Control requirements (Inspection/ Reception Point Programs), both from the ASG client and FCC Construcción's own Management System. For this purpose, the SURVEY123 module of ARCGIS ONLINE has been used, based on data collection in smart forms. Among its advantages are the ability to select customized response formats, compatible multi-page forms, offline support, and the issuance of inspection characteristic reports.

By using SURVEY123 forms, great synergy is achieved with the visualization and management of the ARCGIS model, as it integrates quality inspections on the actual location of elements or associated activity points. This aspect of geographic location and metadata linkage is very relevant when defining the so-called inspection and testing states, as the application allows for a global view of which sections or elements of the network have undergone specific inspections, their approval status, and any possible incidents.

Use of Expanded Clay as Fill Material in Embankments

Title of the Action

Use of Expanded Clay as Fill Material in Embankment

Related Work Center

3R83 - Pont Carrer Santander Accesses (Barcelona)

Summary of the Innovation

Introduction

In the context of the ACCESSOS PONT CARRER SANTANDER works, the geotechnical study of the project and the location of some affected services provide information that makes it necessary to lighten the embankment for two reasons:

1. The grounds on which the embankment and the projected retaining structures must be placed are composed of anthropogenic fills and silts (according to the geotechnical study), and it is necessary to transmit the minimum possible loads to limit and minimize potential settlements.
2. In some sections, the embankment is located above existing service infrastructures, and it will be necessary to lighten it to avoid increasing the loads

Scope

The embankments will be constructed using lightweight material such as expanded clay aggregate (arlita) to lighten the fill and minimize the impact on underground infrastructures. These infrastructures include a service gallery and a T-302 section concrete collector.

Regarding the potable water supply pipe (Ø1200mm) located on the "mountain" side at the foot of the slope on Santander Street, an open-cut construction was carried out to divert it, thus avoiding future overloads and ensuring access for maintenance of the service.

System Used

The lightweight material used was expanded clay aggregate (arlita), which is considered a good solution when aiming to lighten the fill over underground structures and/or low bearing capacity soils, due to its low density (less than 450 kg/m^3 once in place), high bearing capacity, and acceptance as selected soil according to PG-3.

Lightweight material (Arlita): 8,248.38 m^3

Excavator (compaction) weight: 4.74 Tn

GENERAL MATERIAL CONDITIONS:

- Granulometry: 10/20
- Visual appearance: grains are almost spherical, without vertices, fracture faces, or noticeable edges.
- Density: 4 KN/m^3

Procedure

The material was poured directly from the truck. Initially, a layer of about 30 cm was spread to cover the lower geomesh that had been previously placed. Once this layer was compacted with three passes of the excavator and/or a vibrating plate, the rest of the arlita was spread in layers of approximately 0.5 m. These layers were compacted with between five and ten passes of the machine, achieving approximately a 10% reduction in the thickness of the spread layer.

The degree of compaction achieved on site was visually checked. The verification consisted of observing the absence of material deformations after the circulation of heavy vehicles over its surface