

# Instalación de Losa Superior del Hipogeo y Bandeja de Césped N°6 en el Estadio Bernabéu, Madrid - España.

*Installation of the Hypogeum Top Slab and the Grass Tray N°6 at Bernabeu Stadium, Madrid - Spain.*

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## RESUMEN

Para la remodelación del Estadio Bernabéu del Real Madrid, Sarens fue subcontratada para transportar dos vigas retráctiles dentro del estadio y propuso y desarrolló un nuevo método de elevación y deslizamiento de la losa superior del Hipogeo de 650t y la bandeja n°6 de césped de 350t. Con una programación extremadamente ajustada y teniendo que compartir al mismo tiempo el área de trabajo con muchos otros subcontratistas, el equipo de Sarens preparó todos sus equipos, además de realizar los trabajos de elevación y deslizamiento, exclusivamente desde la zona del terreno de juego para no interrumpir los trabajos dentro del Hipogeo.

## ABSTRACT

For the Real Madrid's Bernabeu Stadium Redevelopment, Sarens was subcontracted for transporting two retractable beams inside the stadium and proposed and developed a new method of statement for jacking and skidding the 650t Hypogeum top slab and the 350t tray n°6 of grass. Within an extremely tight schedule and sharing a work area with many other subcontractors at the same time, Sarens' crew had to prepare all equipment, plus perform jacking and skidding works, exclusively from the pitch area to avoid disrupting the works inside of the Hypogeum.

**PALABRAS CLAVE:** Construcción estructuras, equipos de transporte modulares, gateo, deslizamiento.

**KEYWORDS:** Construction of structures, SPMT (Self Propelled Modular Trailers), jacking, skidding.

## 1. Introduction

Sarens was subcontracted by PHB for Real Madrid's Bernabeu Stadium Redevelopment. It's one of this century's most remarkable feats of engineering, installing a stunning new retractable roof and pitch.

As part of a nearly billion-euro renovation project, the world-famous Bernabeu is increasing seating capacity by 4000, adding ten metres of height, and installing a stunning new

retractable roof and pitch. And it's doing it all without disrupting a single game, thanks to a Roman-inspired building approach that allows for construction to continue without interrupting on-field events.

Bernabeu will host a variety of spectacles most days of the year, from business conferences and concerts to tennis matches, basketball games, besides Real Madrid victories.

A retractable pitch means that the stadium's six massive trays of grass can be moved underground inside the Hypogeum via a hydraulic elevator, revealing a new concrete surface for a variety of events, concerts, and conferences. The Hypogeum is huge concrete shaft 30m depth where the pitch grass trays can be stored to protect them.

Teaming up with client PHB, Sarens transported two retractable beams inside the stadium and proposed and developed a new method of statement for jacking and skidding the Hypogeum top slab and the tray n°6 of grass. Sarens also faced the challenge of working in a busy city environment, which meant that transporting equipment to the site and out presented its own logistical challenges, and most of the times during night shifts.

## 2. Features of the items handled

### 2.1 *Transportation of two steel retractable beams inside the stadium*

Our client had tried bringing these two beams inside the stadium via conventional trailers, but the total transport height proved too high to pass through the inner stadium gates. These beams were the last ones to complete the set of 12 retractile beams on the top of the Hypogeum.



Figure 1: Retractable steel beam being loaded outside the stadium.

Each beam measured 15 meters length times 2.25 metres height and weighed 30t. Sarens had to transport them from outside the stadium

(see Figure 1) to the reach hook of the cranes that were placed inside the stadium close to the Hypogeum (see Figure 4).

This meant passing tightly through the internal stadium gates (see Figure 2), managing small curves, and travelling up and down a 17.6% slope (see Figure 3) from the outside ground level to the internal grass level.



Figure 2: Retractable steel beam passing through the internal stadium gates.



Figure 3: Slope of 17,6%.



Figure 4: Retractable steel beam inside the stadium driving to the Hypogeum.

### 2.2 *Jacking and skidding of Hypogeum top slab*

This top slab had a huge dimensions of 115m length, 13m width and 1.5m height, and weight up to 650t (see Figures 7 and 8).

The equipments required for its original installation were the same ones that are actually operating the retractable pitch, but they were not going to be delivered on time. In order to save two weeks of the overall stadium renovation schedule, it was decided to install this top slab by other temporary equipments that could be delivered on time.

The top slab had to be jacked up 1.5m from its fabrication position, then skidded 15m over the Hypogeum, and to end its installation it had to be jacked down to its final position (see sequence of Figures 7, 8, and from 13 to 18).

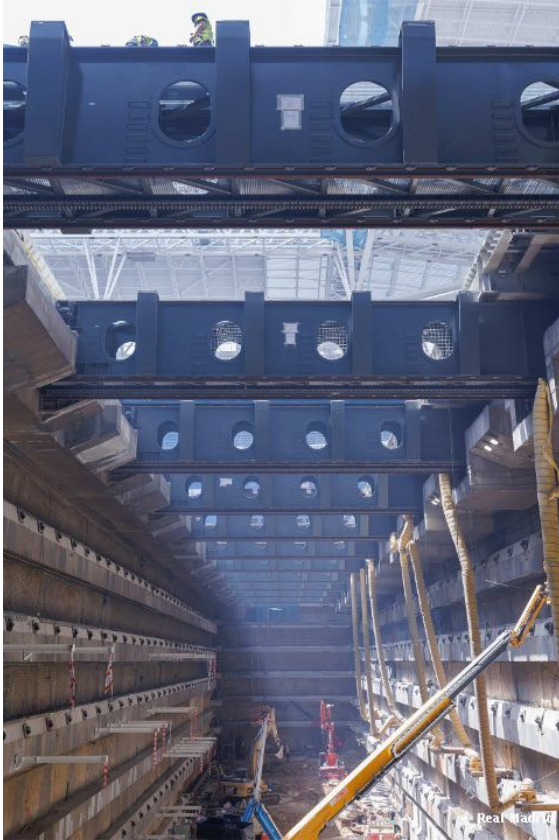


Figure 5: Retractable steel beams on final position on top of the Hypogeum.

### 2.3 Jacking and skidding of Grass Tray N° 6

This grass tray had a similar huge dimensions as the Hypogeum top slab of 115m length, 13m width and 1.5m height, and weight up to 350t.

For the same schedule reason as for the top slab, it was decided to install it right after the top slab by temporary equipments.

As top slab, the grass tray had to be jacked up from its fabrication position to install the skidding equipments, then skidded to reach the internal side of the Hypogeum top slab, and to complete the installation it had to be jacked down to its final position (see Figures 19 and 20).

## 3. Equipments selected for each operation

### 3.1 Two steel retractable beams inside the stadium

When Sarens got an urgent call on a Saturday morning, once the client realized it was not possible to bring these beams inside the stadium by conventional trailers. The total transport height proved too high to pass through the stadium internal gates.

Sarens arranged in a rush to send a special Self Propelled Modular Trailer (SPMT) of 4+4 axel liens with an integrated power pack unit (see Figure 6) to be ready on-site by next Monday night to introduce each beam during the next two night shifts, to avoid interruptions of all the other activities that were under development around the stadium and that would have to be stopped due to this transport. Each axel line has a gross capacity of 48t (net one 43.5t).

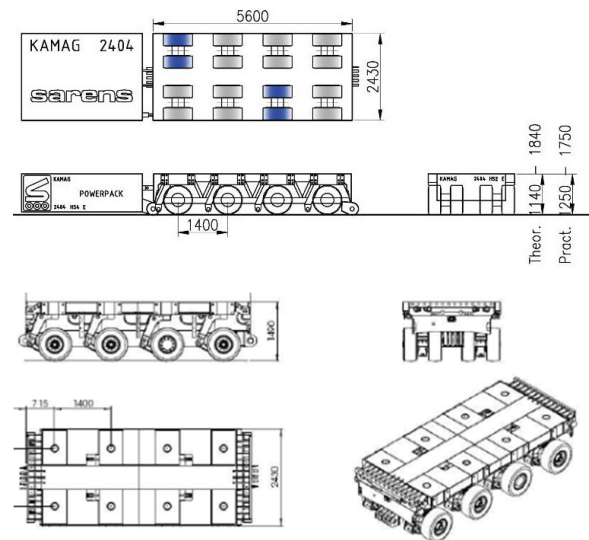


Figure 6: General dimensions of a 4 axel line SPMT.



Figure 7: Hypogeum Top Slab before initial jacking.

### 3.2 Hypogeum top slab

Sarens proposed to PHB an installation Method of Statement fulfilling our strict client's needs that can be summarized as:

- not working at all from inside the Hypogeum, in order to let all the other activities and subcontractors to complete their tasks without any interruptions due to our activities).
- And with the minimum required equipments able to handle the top slab from the minimum points but without changing/modifying the structural design of the top slab (and just with minor punctual reinforcements). After a detailed study, it was decided that the top slab could be handle from only 8 of the 12 retractile beams.



Figure 8: Hypogeum Top Slab before initial jacking.

To achieve all this, Sarens proposed an installation method consisting of:

- to jack up 1,5m the top slab from only 16 points (8 at each side along the 115m ) on the same transversal section that matches with the selected 8 retractile beams (see Figures 9, 10 and 13 to 15).



**Figure 9: Cantilever gantries with 250t climbing jacks**



**Figure 10: Cantilever beams with 250t climbing jacks**

- to skid the top slab 15m by 8 lines (see Figures 11, 12, 19 and 20) supported on eight of the selected retractable beams over the Hypogeum (among all the 12 ones, two of the ones Sarens had to transport inside the stadium as mentioned at paragraph 3.1).



**Figure 11: Skidding lines on the retractable beams.**

- finally jack the top slab down 0,5m again from the same 16 points used at the initial jacking (8 points at each side along the 115m).

Sarens supplied the following equipments:

- to jack up the top slab: PHB designed and supplied 8 cantilever gantries at one side of the top slab (see Figure 9) and 8 cantilever beams at the other side (see Figure 10). Below each of these cantilevers gantries and beams, Sarens supplied 16 climbing jacks up to 250t single capacity.
- to skid the top slab: 8 skidding lines of 30m length each, and with a double skid beams connected to a push pull unit of 25t single capacity at each of these 8 lines (see figures 10, 11, 12, 19 and 20).
- finally to jack it down: 16 hydraulic jacks up to 100t and 150mm stroke.

### **3.3 Grass Tray N° 6**

Same as for the Hypogeum top slab, Sarens proposed to PHB a similar installation method of statement fulfilling again our strict client's needs (see paragraph 3.2).

Main difference was that the initial jacking of the grass tray was only 0.3 meters to install the skidding equipment (instead of 1.5m for the top slab).

Sarens supplied the following equipments:

- to jack up and down the grass tray: 16 hydraulic jacks up to 100t and 150mm stroke (see Figure 20, in orange colour).
- to skid the grass tray: 8 skidding lines of 30m length each (see Figures 12, 19 and 20), and with a double skid beams connected to a push pull unit of 25t single capacity (see Figure 12) at each of these 8 lines.



Figure 12: Push-pull units moving the tray n°6.

## 4. Conclusions

All manoeuvres were performed on time during days and nights shifts on June & July 2022, to the entire client's satisfaction and without any incident.

And all this accounting a very tied global site schedule, that was updated almost on daily basis considering the progress of all the activities that were performed on the pitch and in the rest parts of the stadium.

With up to seven Sarens crew members giving it their all, Sarens executed all operations on time and was congratulated by PHB's for our performance from start to finish, and especially for solving the all site's issues without any delays so all works (ours and the ones for other subcontractors at a time on the pitch) could be completed on time.

## 5. Acknowledgements

Sarens is grateful to have been part of this iconic project. We would like to thank all crew members involved for making it possible, and to our client for entrusting us with such a momentous operation.

## References

In the following links the reader may find [1] a short video of 2min 36" explaining how the retractile pitch works and [2] a trailer of 30" of the complete explanation (50 min) of the overall stadium renovation:

[1] <https://www.realmadrid.com/es-ES>

[2] <https://www.nationalgeographic.es/megaestructuras-el-bernabeu-del-siglo-xxi>



Figure 13: Hypogeum Top Slab after 1,5m jacking.



Figure 14: Eight cantilever gantries with 250t climbing jacks after jacking 1,5m the Hypogeum Top Slab.



Figure 15: General top view with the Hypogeum Top Slab ready to be skidded after jacking 1,5m.

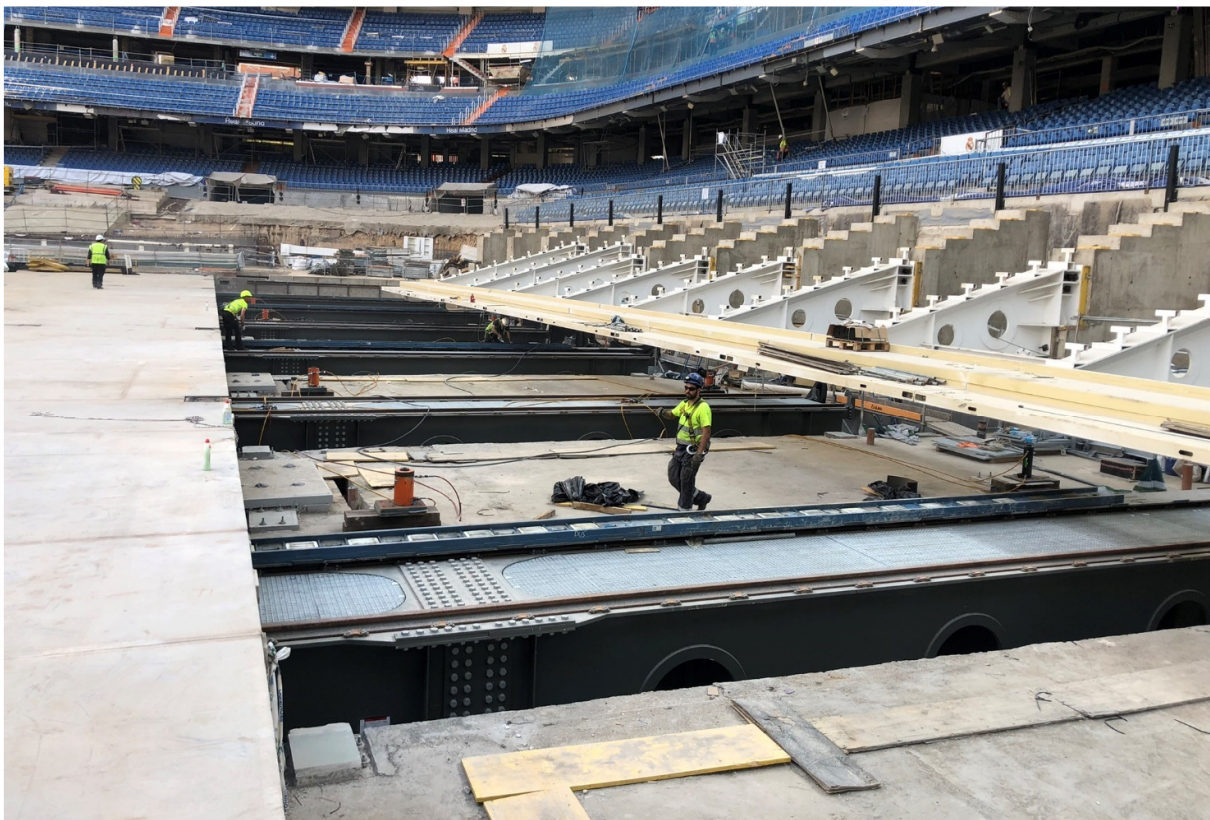


Figure 16: Preparation of the 8 skidding lines of the Hypogeum Top Slab on the retractable steel beams.



Figure 17: Skidding the Hypogeum Top Slab below the lateral seats.

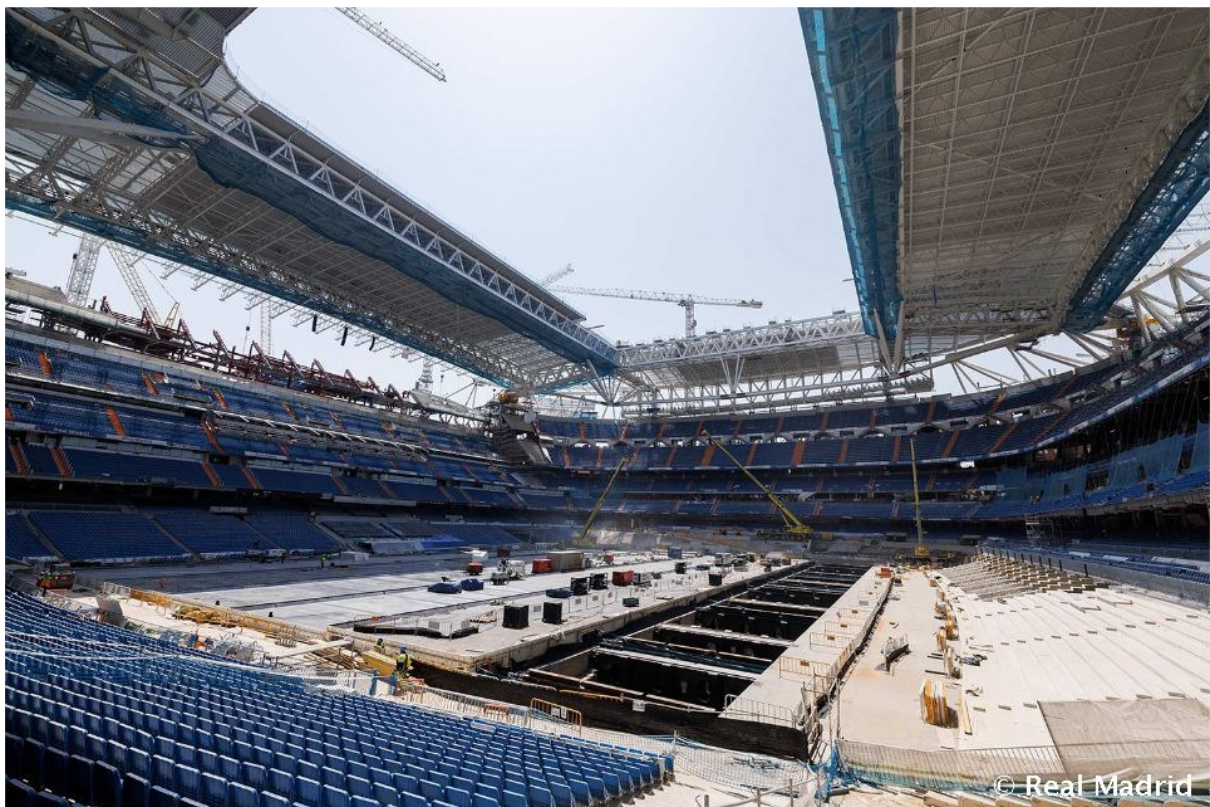


Figure 18: Hypogeum Top Slab going close to its final position.

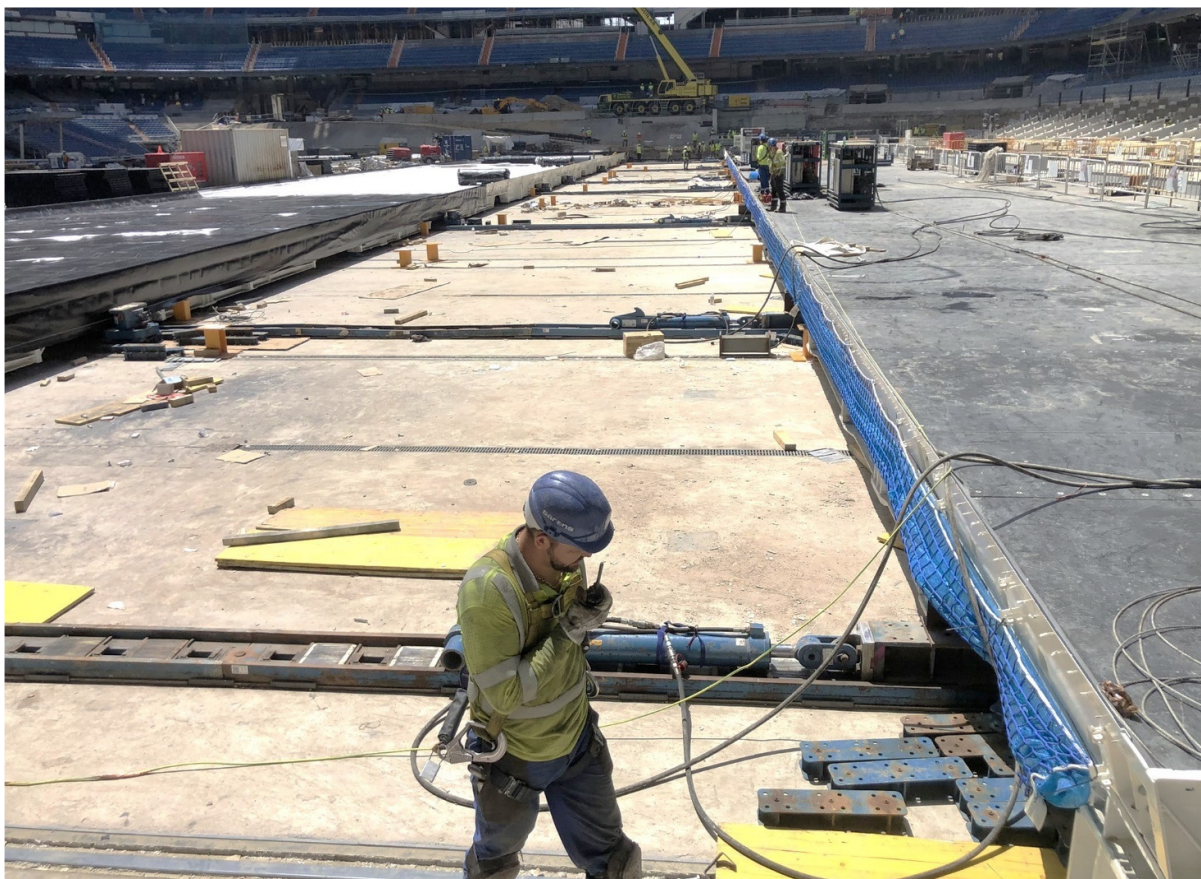


Figure 19: General view of skidding the Grass Tray N°6 with the 8 skidding lines.



Figure 20: Grass Tray N°6 at the end of the skidding side by side the Hypogeum Top Slab.