

## Case study: Munich Allianz Arena Stadium

- Alexandre Gonçalves

The Allianz Arena stadium, completed in 2004, hosted World Cup matches in Germany 2006 and became an icon of world architecture (see Figure 1). With its unusual external and chameleonic appearance, its façade can change colors according team there, red, blue or white (see Figure 2). With a capacity of 66 thousand people, the stadium is shared by two teams: FC Bayern München and TSV 1860 München.



Figure 1 – The Allianz Arena is an icon of world architecture.

Source: [http://pupload.wikimedia.org/wikipedia/commons/0/0e/Allianz\\_Arena\\_Pahu.jpg](http://pupload.wikimedia.org/wikipedia/commons/0/0e/Allianz_Arena_Pahu.jpg)

The Allianz Arena was born in the creative minds of two Swiss architects: Jacques Herzog and Pierre de Meuron. The duo of the HDM office, based in Basel, Switzerland, faced a great challenge and conceived an architectural miracle. The HDM had already designed a smaller stadium in Basel, the Saint Jacob; But it was a second division stadium, which served as experience, but nothing compared to the challenge of designing an ultramodern stadium for the World Cup. It is difficult to find defects in the Allianz, which according to the authors' own statement "was perfect."



Figure 2 – Allianz Arena changes color according to the teams that play.

Source: <http://news.thomasnet.com/MTallianzarenacombio.jpg>

### **Situation**

The stadium is located in a suburban area of Munich, in the northeast of the city, and very close to its territorial limit (see Figure 3).

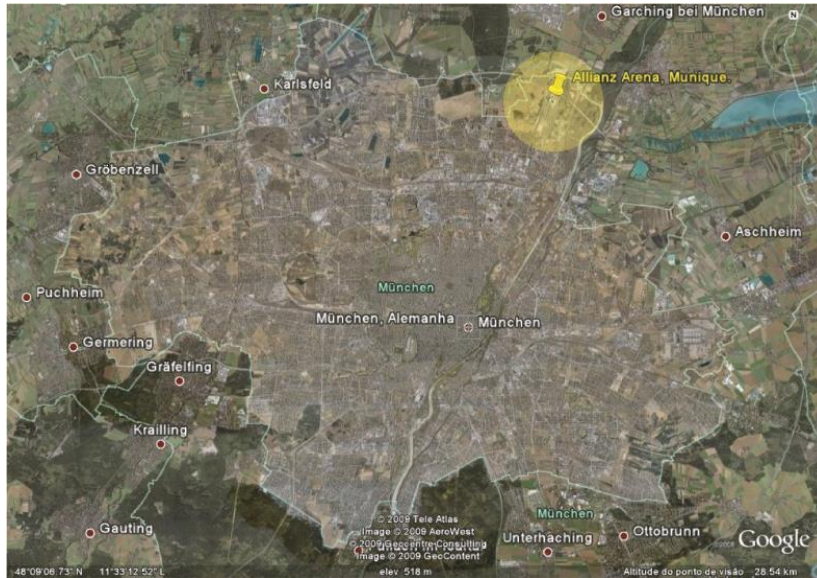


Figure 3 – Stadium situation in Munich.

Source: Google Earth, Authorship: Alexandre Gonçalves.

The access roads are: E52, E45 and 9. The highway 9 leads to the center of Munich and the others are part of an outer ring that runs through the suburban area and gives access to nearby cities (see Figure 4).

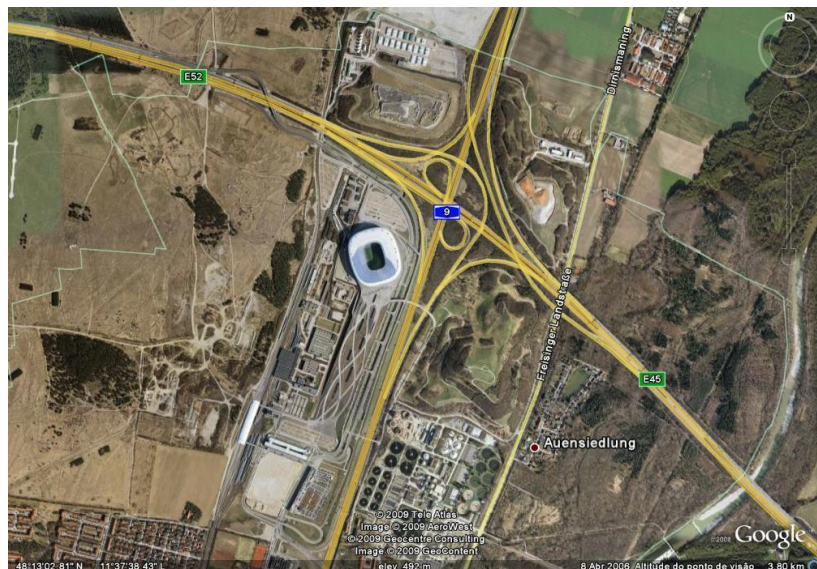


Figure 4 – Allianz Arena is in the suburban area of the city.

Source: Google Earth.

### Implantation and accesses

The accesses were meticulously thought out at the Allianz Arena to ensure a perfect flow of people and vehicles. Roads were duplicated on access highways. The railway lines were

extended to the extensive Esplanade that gives access to the stadium. Measures were taken to leave the public away from the cars and near the trains.

In figure 5, at the left of the stadium is the Esplanade with gardens for access of fans who arrive from the train station in the extreme left. Under the Esplanade is the parking lot. To the right, the two blue areas are intended for bus parking.

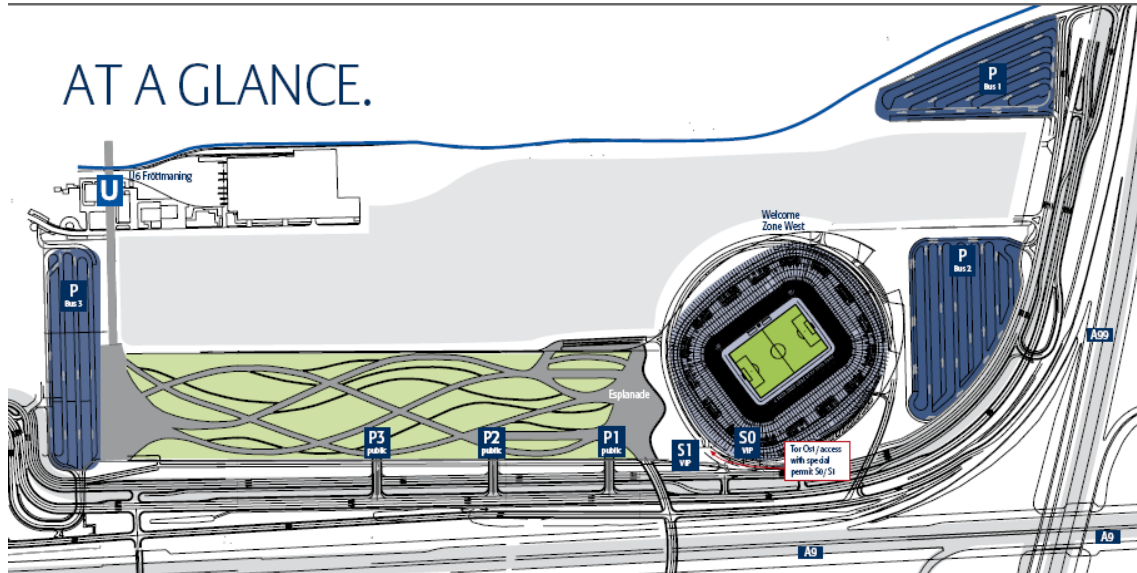


Figure 5 – The accesses to the stadium.

Source: [www.allianz-arena.de](http://www.allianz-arena.de)

The railway access was one of the key strategies for solving public transport problems. Figure 6 shows the modern train station.



Figure 6 – Train station near the stadium.

Source: [www.allianz-arena.de](http://www.allianz-arena.de)

## **Ticket office**

The ticket office sector of the Allianz Arena is extensive and perfectly sized to meet the large flow of people. The rows are separated by iron bars (see Figure 7).



Figure 7 –Allianz Arena ticket office.

Source: [http://www.mimoa.eu/images/977\\_1.jpg](http://www.mimoa.eu/images/977_1.jpg)

## **Esplanade**

The treatment of the external areas is marked by the large terrace on the parking lot, which connects the train station to the stadium. The composition is formed by curved paths that intertwine and large grassy areas. It can be seen in Figure 8 that the lighting posts were specially designed. The voids are to facilitate the air circulation of the parking lots and exhaustion of polluting gases emitted by vehicles.



Figure 8 – Esplanade photo.

Source: [http://www.mimoa.eu/images/976\\_1.jpg](http://www.mimoa.eu/images/976_1.jpg)

## Project

The Allianz Arena has seven different levels, which divide players, press, VIP, staff, security and the general public. The intention of the architects was to make a stadium as architecture work and not exclusively of engineering. Figure 9 is a floor plan of upper level in the second ring of grandstands. Figure 10 is a floor plan of a higher level, which allows visualizing the three rings of grandstands.

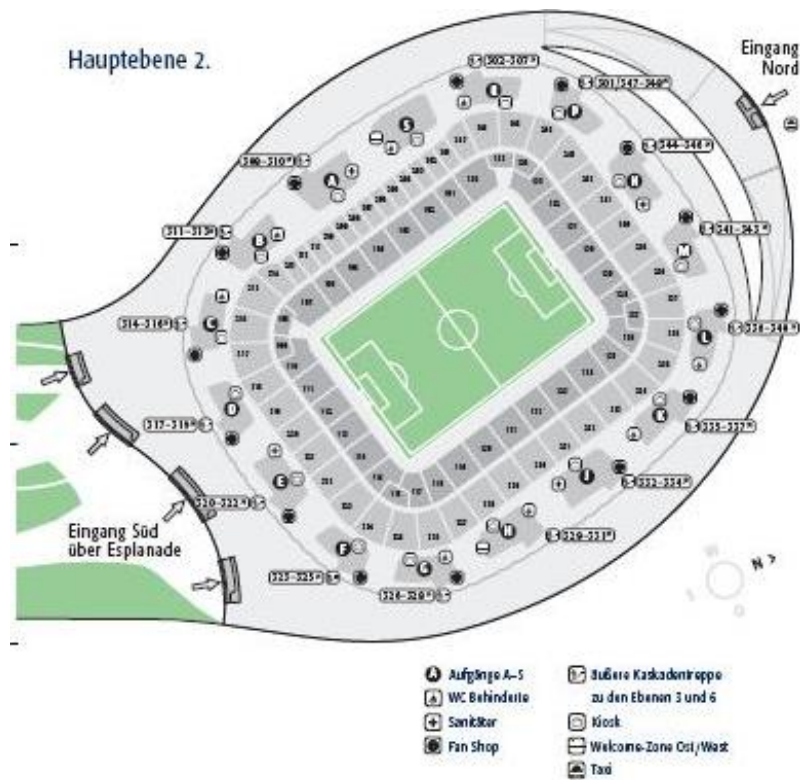
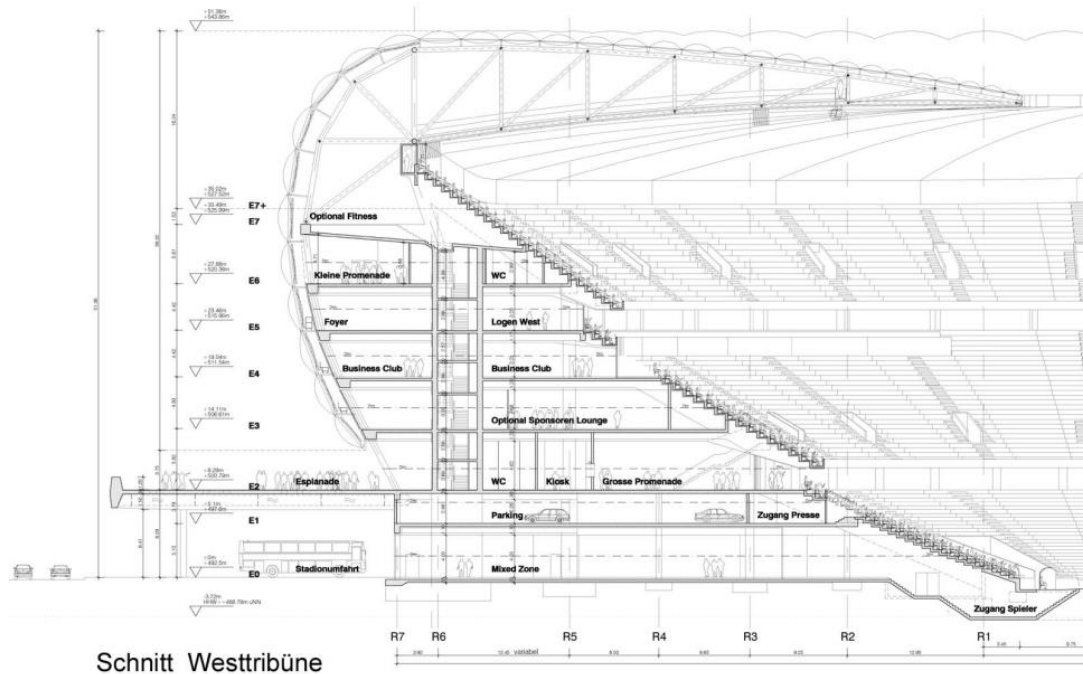


Figure 9 – Floor plan: upper level of the second ring.  
 Source: [www.allianz-arena.de](http://www.allianz-arena.de)



Figure 10 – Floor plan: upper level of third grandstand.  
 Source: [www.allianz-arena.de](http://www.allianz-arena.de)

The section in Figure 11 illustrates the functional distribution at the various levels and exhibits fundamental constructive aspects of design. At the two lower levels E0 and E1 are the Mixed Zone which includes the arrival of the players' buses and the parking lot for cars. At the arrival level of the Esplanade, called E2, are the toilets and public walk. At E3, Lounge for Sponsors. At level E4, Business Club. In E5, Foyer. In E6, Toilets and Living. In E7, Optional Function.



Schnitt Westtribüne

Figure 11 – Section illustrates functional, technical, and structural resolutions.

Source: [www.allianz-arena.de](http://www.allianz-arena.de)

The cutting 3D model, shown in Figure 12, demonstrates the level solutions and constructive systems for a better understanding of the project.



Figure 12 – Allianz Arena cutting 3D model.

Source: FISCHER, Joachim. German Football Stadiums. Daab, 2006.



## **The start of construction**

The demand came when it was realized that the Munich Olympic Stadium (1972) would not be able to host World Cup games. The city needed a new stadium. The stadium director, Bernd Rauch, who was in charge of time and logistics, was responsible for maintaining the work on time and on budget. FIFA demands that the stadium be ready one year before the event, putting pressure on managers. The lead engineer was Stefan Wellstein, who was responsible for conducting this work with cost estimated at 412 million dollars or 340 million euros.

At the construction site were found buried bombs of World War II. If they remained buried they would not be dangerous, but if a machine touched one of them, it would cause damage to the workers. The Munich anti-bomb squad was fired to deactivate them, delaying the progress of enterprise. Even with these unforeseen events, Bernd Rauch tried to keep some of the construction going. There are 22 cranes, and some with 70 meters high. 1,500 employees from over 20 countries worked on the site.

## **Concrete**

The concrete has undergone rigorous quality control. Density and strength are tested before and after application. Each portion is analyzed in its consistency. Then a dry block is weighed, measured, and has its capacity to withstand loads analyzed. After the tests, the concrete is taken to the construction site. The stadium is supported by 350 concrete pillars. To support a 1,000 tons load on each pillar, the concrete is placed in a mold and tied to a centrifuge; It is then compressed using a force nine times greater than gravity (9G). There are 200 thousand cubic meters of concrete throughout the construction. Because of the heat, it had to be dampened with sprinklers to ensure it dried slowly and remained solid.

## **Safety**

Security aims to establish the flow of fans safely and comfortably. Using computer simulation programs, architects have designed routes that will decrease evacuation time. The rapid evacuation intends to empty the stadium in 15 minutes. Figure 13 shows one of the access stairs to the grandstands.



Figure 13 – Access stairs to the grandstands.

Source: FISCHER, Joachim. German Football Stadiums. Daab, 2006.

### **Grandstands**

Ladder modules and concrete grandstands are assembled locally with the use of cranes and cables. The modules are prefabricated. Each one weighs 18 tons; And more than a thousand units are used. There are 3 levels of bleachers: the lowest seats 20,000, the middle 24,000, and the highest 22,000 fans. The grandstand is 7.5 meters from the field, and the upper platform has a slope of 34 degrees, the maximum that engineering could achieve.

### **Comfort**

The Allianz Arena provides exquisite comfort for users. The internal circulation is made by elevators and escalators, in addition to conventional stairs. (See Figure 14).

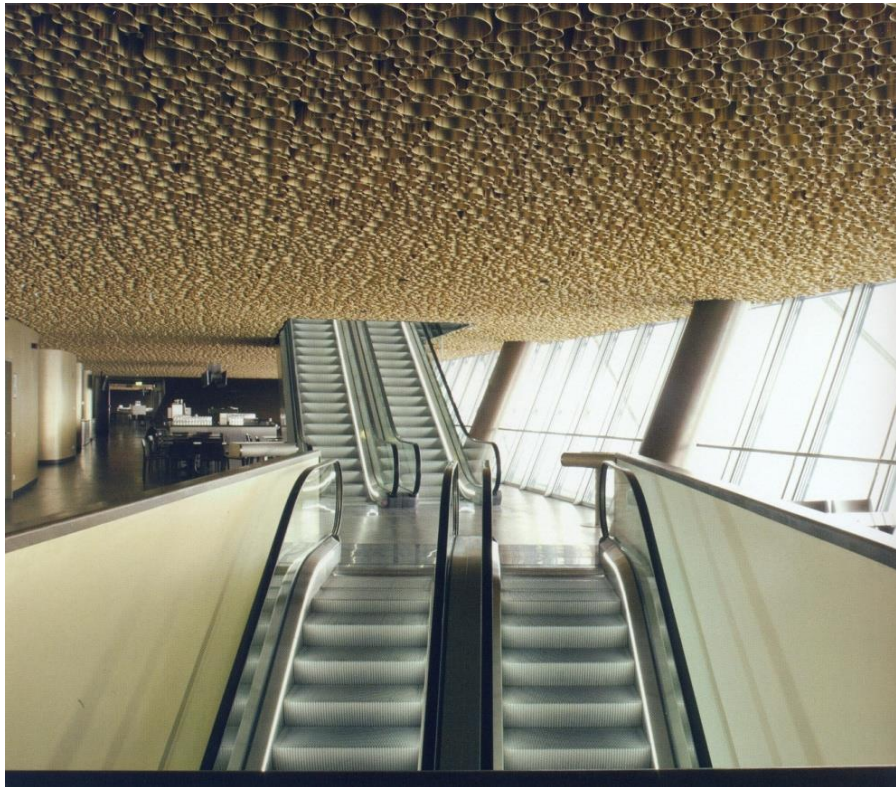


Figure 14 – Escalators inside the stadium.

Source: FISCHER, Joachim. German Football Stadiums. Daab, 2006.

The restaurants have been positioned at strategic points and provide incredible views of the arena's interior. (ver Figure 15).

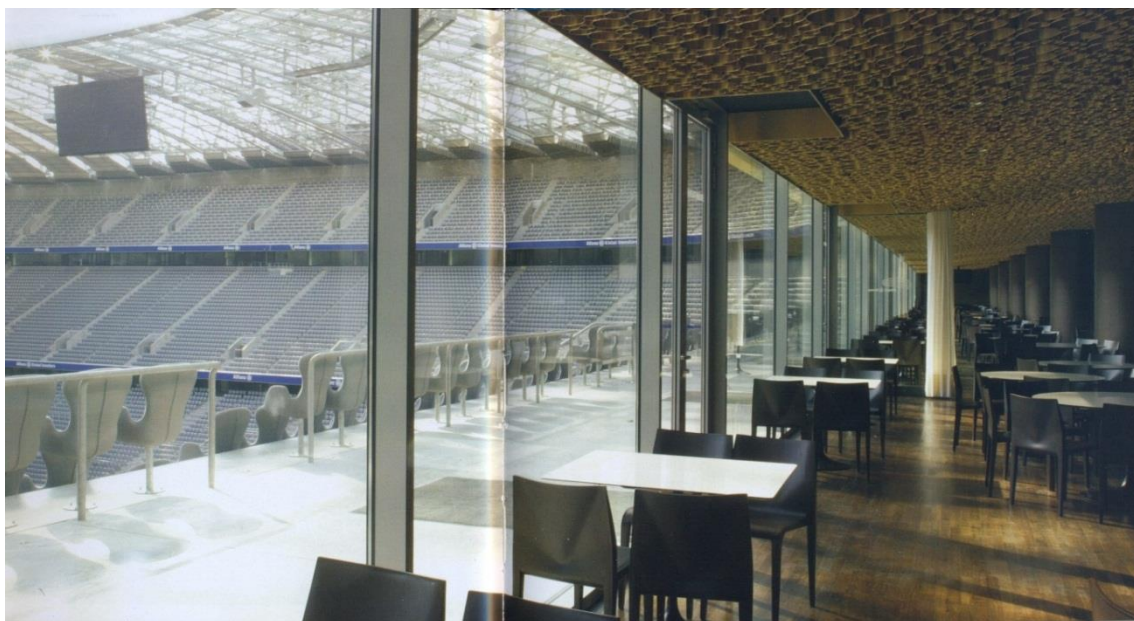


Figure 15 – Restaurant at the Allianz Arena provides views in the interior of the stadium.

Source: FISCHER, Joachim. German Football Stadiums. Daab, 2006.

## Roof

The roof uses an intricate system of steel beams and pillars of different sizes. The pieces need to be hoisted at 50 meters by a super crane, as shown in Figure 16. The larger trusses are 65 meters and weigh 100 tons. The master beams are arranged like the braces of a bicycle wheel, forming a strong and light structure.



Figure 16 – Cranes raise up the metal trusses to 50 meters high.

Source: [www.metalica.com.br](http://www.metalica.com.br)

## Steel grid

The steel grid that extends from the roof to facade is one of the great attractions of the project. It is a composite of diamond-shaped cushioned shells attached to a metal grid (see Figure 17). It is a large membrane shell already built, and had a special machinery for its manufacture. An ETFE (Ethylene Tetrafluoroethylene) membrane is 2mm thick and covers 2,874 inflatable panels that are part of the ceiling, mounted manually by 55 meters in height (see Figure 18). The material is 98% translucent, allowing natural light reaching the grass. The membrane does not need to be changed periodically, as in other stadiums. Some of these panels measure 35m<sup>2</sup>.



Figure 17 –ETFE membranes are fixed on metal grid.

Source: [www.metalica.com.br](http://www.metalica.com.br)



Figure 18 – Workers at 50 meters high install the membranes.

Source: [www.metalica.com.br](http://www.metalica.com.br)

The ETFE membrane underwent elastic and tensile tests, as it should be prepared for eventual falling objects from the sky, such as meteorites and aircraft parts, as well as fire resistance and adverse weather conditions such as snow, wind and rain.

After installation, the panels are inflated with air through air pumps placed at the top of the building. The air is pumped to the panels through tubes, and fans keep constant pressure inside them. Figure 19 shows an overview of the facade during panel installation.



Figure 19 – Membrane attachment stage.

Source: [www.metalica.com.br](http://www.metalica.com.br)

Another project innovation is the retractable lining ceiling, which allows shading the grandstands when necessary (see Figures 20 and 21).

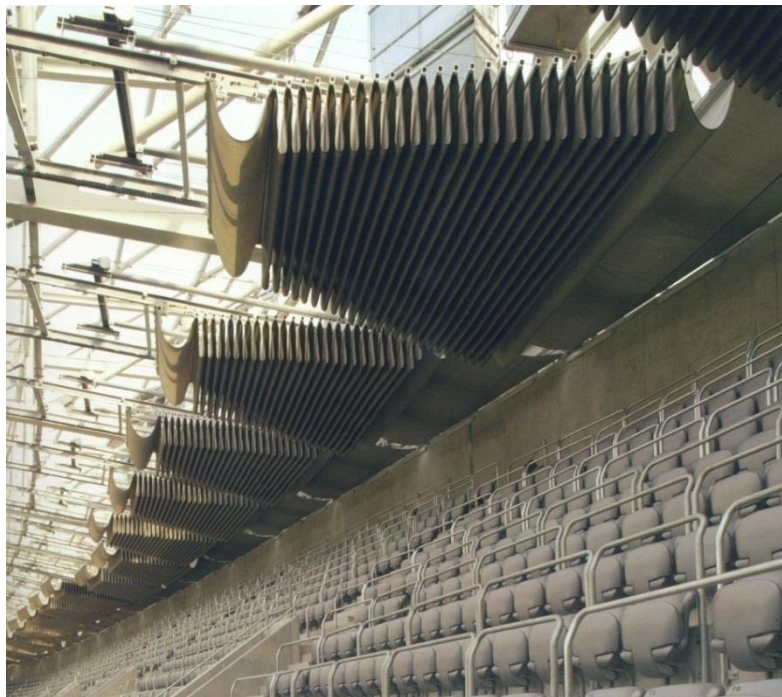


Figure 20 – Retractable ceiling collected.

Source: FISCHER, Joachim. German Football Stadiums. Daab, 2006.



Figure 21 – Retractable ceiling extended.

Fonte: FISCHER, Joachim. German Football Stadiums. Daab, 2006.

## Lighting

One of the architects' main wishes was that the roof membrane was illuminated. A computerized electrical system is able to turn on and off the lights of each panel individually. There are 25,000 fluorescent lamps that make the Allianz Arena a bright spectacle on Munich nights (see Figure 22).

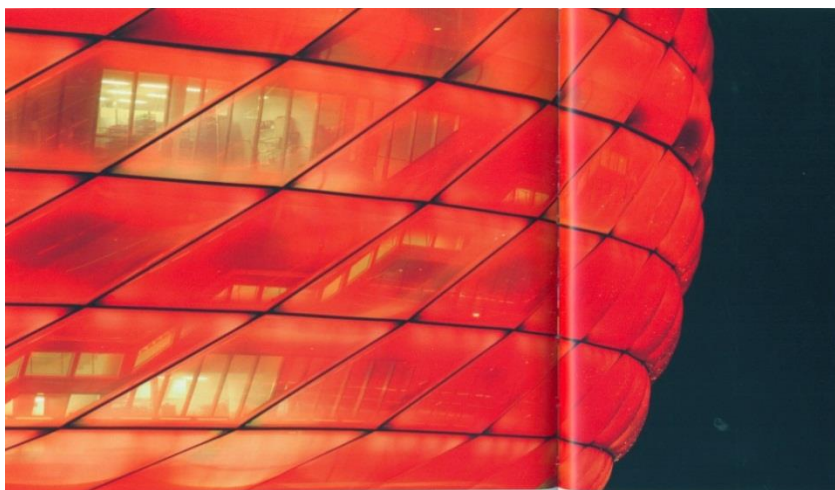


Figure 22 – 25 thousand fluorescent lamps illuminate the façade.

Source: FISCHER, Joachim. German Football Stadiums. Daab, 2006.

## Parking lot

The car park has a capacity for 10 thousand cars, being the largest parking lot in Europe (see Figure 23).



Figure 23 – Parking lot for 10 thousand vehicles.

Source: [www.allianz-arena.de](http://www.allianz-arena.de)

## Seats

The seats with ergonomic design were installed manually. The seat units are foldable, which facilitates people movement when they are unoccupied (see Figure 24).

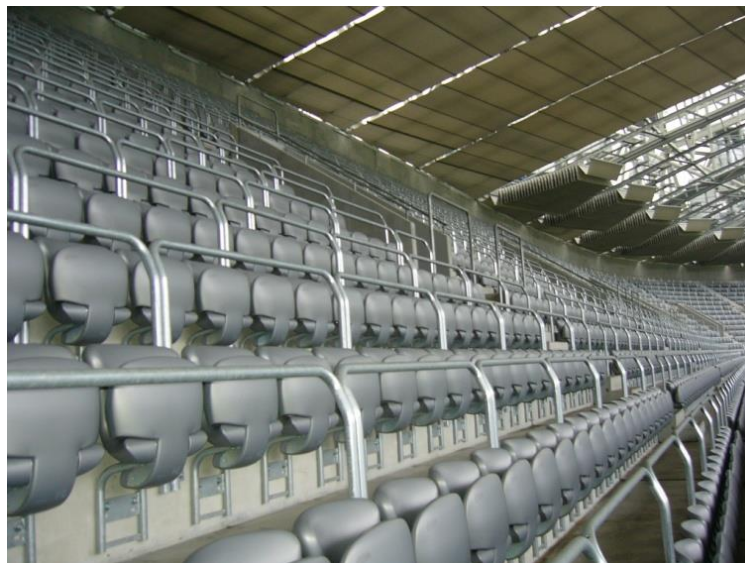


Figure 24 – Stadium seats are foldable.

Source: [www.allianz-arena.de](http://www.allianz-arena.de)



## Grass

A special type of grass was cultivated: there are 3 varieties; If one succumbs to bad weather, the other two will thrive. In all, they are 250 rolls of grass (see Figure 25).



Figure 25 – 250 rolls of grass form the spectacle carpet.

Source: [www.allianz-arena.de](http://www.allianz-arena.de)

## Volumetry

The Allianz Arena volumetry has a monolithic aspect, which refers to Colosseum. This homogeneity added to its monumentality causes the rounded block to gain a massive visual weight. However, at the same time as the Arena becomes heavy, its inflatable membrane cushions seem to make it float. This sensation of fluctuation is reinforced by the fact that the membranes do not reach the floor (see Figure 26).



Figure 26 – The Allianz Arena volumetry is monolithic.

Source: Google Earth.

## General informations

### Allianz Arena

**Location:** Munich, Germany

**Description:** New stadium construction

**Conclusion:** April 2005

**Capacity:** 66 thousand people

**Technical data:** steel roof with 65 m cantilever; Mixed tubular pillars (section filled with concrete) on facades; 2,400 t of tubular elements in the roof structure and facade; Construction area: ~ 37.6 thousand m<sup>2</sup>.

**Architectural design:** Jacques Herzog & Pierre De Meuron

**Structural Design:** Arup & Partners

