DIPLOMARBEIT / MASTERARBEIT

NEW FOOTBALL STADIUM FOR THE CITY OF CAGLIARI

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INTRODUCTION

The theme developed in this book consists of a proposal for a new football stadium in the city of Cagliari (Sardinia, Italy). The new building will take the place of the old one, a structure of the seventies that nowadays cannot answer to the neccessities of the city and to the requests and standards of the FIFA (Fédération Internationale de Football Association). The approach involves at first a research about the stadiums of the past and of the present, as well as an analysis of the city, trying to understand the necessities of such a big intervention in a specific area.

The work that precedes the project represented a necessary tool to answer to the demands in the specific case of Cagliari. The project itself is an attempt to respond to a typological function as a football stadium, looking at the suggestions of the international regulation.

I want to thank all those people who supported me during my studies.

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Stadium and *arena: definition*

The word stadium comes from the Greek word stadion (στάδιον), denoting a measure of length equalling approximately 200 metres. Nevertheless, there were different lengths of stadia because units had not been standardized, i.e. stadia varied in lengths from 149m to 213m.

The term arena is derived from the Latin word for sand or sandy land, referring to the layer of sand that was spread on the activity area to absorb spilled blood. Today stadia and arenas can be described as large buildings with areas for accommodating spectators around an activity area. In contrast to stadia, arenas are often described as enclosed stadia.

HISTORICAL DEVELOPMENT OF STADIA

The oldest known stadium is the one in Olympia, Greece, where the Olympic Games were held from 776 BC onwards. Initially 'the Games' consisted of a single event where one sprinted along the length of the stadium. In contrast, a Roman stadium was slightly smaller with a distance of 125 passus (double-paces) which is equal to about 185 meters or 607 feet. These Greek and Roman stadia have been found in numerous ancient cities.

The first stadium to be used in modern times, and the only one to be used during the 19th century, was the excavated and refurbished ancient Panathenaic stadium which hosted the Olympic Games in 1870, 1875, 1896, 1906, and 2004.

historical development of stadia

Ancient Greek and Roman stadia

At around 2,700 B.C., football was developed in China and, originally, was called cuju (cu=play with the feet, ju = ball). The game was then brought to Assyria, to Egypt, to Rome, and on to England, where it became popular during the fourteenth century.

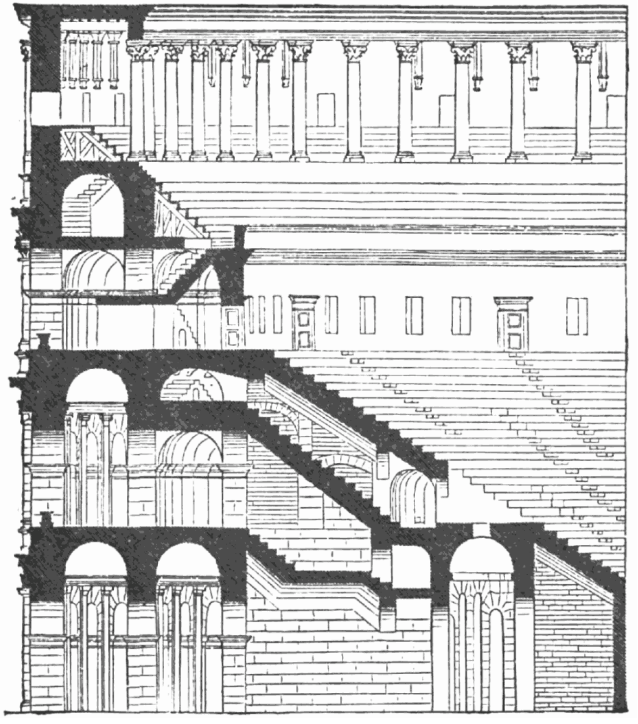
The first Olympic Games were held in 776 B.C. in Greece. As a result, sports events and at that athletics became popular and led on to the Olympia event being on of the most famous. Due to these developments, sports venues were required and demanded for the competitions as well as for training purposes. Venues were then built for the Games at the religious centres of Olympia, -delphi, Corinth, and Nemea. The running track at Olympia was about 192m long, 32m wide, and made of beaten earth. The whole venue was U-shaped and provided space for 45,000 spectators, who were accommodated on stands along the running track. Greek sports had an impact on the culture, especially on the art, of the whole country.

At the beginning, foot races were held as back-and-forth races, so there was a rectangular-shaped activity area. The track was situated at the base of a valley, because the sloping sides provided clear views and, therefore, formed natural stands for spectators. The next stage in the development of sports venues was to add earth walls, which held the seating tiers for spectator accommodation. Thus, the first material used for construction was earth for the stands.

Around 330 B.C., the Panathenaic Stadium was built in Athens. The seating tiers at that stadium were made of stones and formed like steps around the activity area. It had a U-shaped form due to a curve that was added to one end of the track.

colosseum

The Circus Maximus and the Colosseum, Rome



colosseum, cross section

historical development of stadia

From about 400 B.C. on, another famous and large ancient venue was developed & built; this was the Circus Maximus in Rome. It was used for horse and chariot races and had been redeveloped throughout the ages on various occasions. In its largest form (660m long and 210m wide), it is believed that the circus held 385,000 spectators. In its form today, the Circus Maximus is still used as a venue for certain festivals or concerts.

The Colosseum was commissioned by the Emperor Vespasian between 70 and 72 AD and was completed in 80 AD by his son Domitian. It was built on a marshy site of a lake near the site of Nero's enormous palace. There was a colossus (a very tall statue) of Nero nearby, from which legend says the Colosseum's name was originated from, later destroyed in the great fire of Rome.

The Colosseum was cleverly designed. Most of today's stadiums, especially in the form of spectator accommodation and structures alike have been inspired by the concepts introduced in the Colosseum's building structure, even in modern times, e.g. it could be evacuated in five minutes. The most inventive part of the Colosseum was its cooling system. It was roofed using a canvas covered net-like structure made of ropes, with a hole in the centre to provide a breeze for the audience

Another nifty feature the Colosseum had was a vomitoria - a passageway that opens into a row of seats from below or behind. The vomitoria of the Colosseum in Rome were designed so that the massive venue could fill in 15 minutes. The venue offered place for 50,000 spectators. Under the elliptical activity area (84m to 54m) with a wooden floor, there was a seven-meter high basement. The whole elliptical structure of the stadium had a size of l89m by 155m. The structure consisted of 80 arched openings, which were formed by an arch and columns and were supported by the lower storeys (There were 80 entrances at ground level, 76 for ordinary spectators and 4 for the imperial family) - a truly magnificent architectural development for its time. It's also a building of great beauty and design.

During the Middle Ages, the Colosseum was converted into a fortress and the marble was used to make quicklime. During the Renaissance period, but mostly in the Baroque age, the ruling Roman families (from which many Popes of the Catholic Church came from) used it as a source of marble for the construction of St. Peters Basilica you see today.

The broadening structure, from the top to the base, solved three problems:

1. providing optimal views for the spectators as the broadening structure formed the artificial hillside that formed the stands.

2. stabilizing the structure in its form, as well as by a series of barrel vaults and arches.

3. providing space for internal concourses, i.e. there were larger areas for the higher number of spectators at the base & the stadium could have been evacuated in minutes.

The Colosseum was used for some 500 years, which when compared to that of modem sports venues is a long lifetime. It provided the scene for gladiator contests and other entertainment events like naval and aquatic displays, for which it even could be flooded with water.

historical development of stadia

Revival of sports activities

A change came during the 18th century. Europe, in the midst of an Industrial Revolution, led to a revival of sports activities. The venues built in the eighteenth century were the Champ de Mars in Paris. The stands around the U-shaped activity area were formed by earth walls with rows for up to 600,000 spectators. For constructing the venue, there were 12,000 hired workers and 180,000 other people who volunteered in their spare time. Therefore, it became a symbol of the French Republic.

At the beginning of the nineteenth century, Emperor Napoleon I built a stadium in Milan as a symbol for the French nation. Originally, the stadium had temporary stands. In 1827, they were redeveloped into permanent stands and the capacity of the stadium was increased to 30,000. As the Colosseum in Rome, the stadium had an elliptical form with a size of 326m by 125m.

Throughout the nineteenth century, various venues were built. They were not only used for sports, but also for theatrical events. The models for these venues were the Greek hippodromes and the Roman circuses and amphitheatres. Examples are: the Royal Albert Hall in London, UK, the Cirque d'Hiver in Paris, France, and the Madison Square Garden in New York, USA. Exhibitions and trade fairs needed people to display and sell the products. Thus, these events were linked and held at the same time. In 1867 for example, the World's Fair exhibition was held at the Champ de Mars in Paris. These developments brought a change in the design and construction of sports stadia.

The modem Olympic Games were introduced in 1896. Thus, they led to a worldwide construction of new stadia.

In 1863, in the UK, the Football Association (FA) was set up to provide rules for British Football and Rugby. Other countries followed and in 1904 the FIFA (Fédération Internationale de Football Association) was founded in Paris. Due to the rules, a greater number of teams could compare in tournaments. Thus, the number of spectators grew and stadia followed this trend and, became larger.

The twentieth century

white city stadium, london

historical development of stadia

For the Olympic Games in London, in 1908 the White City Stadium was built on the grounds of the British Empire Exhibition. It was one of the first stadia that had a steel roof over the stand. As other venues at that time, it was a multi-purpose arena for various sports activities. The White City Stadium was demolished in the l980s. The structural element of this roof is a trussed beam. All bars forming triangles characterize an ideal framework. The steel can carry tensile as well as compression forces. With trussed beams, a lighter structure and a longer span than with a normal beam can be realized. However, the columns at the front obstructed the views of spectator on the activity area.

The Olympic Stadium in Colombes, Paris, built for the Games in 1924 in France, was groundbreaking for the architecture of European stadia. It was free of decorative elements and was not modelled on any historic stadium. Both longitudinal sides of the stands were roofed by a steel construction. The structural element of the roof of the Olympic Stadium in Paris is a trussed beam that is used to build a cantilever structure. Like at the White City Stadium in 1908, there were columns that obstructed the view within the seating area.

The Prater Stadium in Vienna, designed by O. E. Schweizer, was finished in 1931. The still existing running track is surrounded by the elliptical stand, which is made of board marked concrete. The framed construction had a glass façade - behind this there were rooms, which gave shelter to the spectators when it was raining. To reduce the visual range to the pitch, it was decided to build the stadium without a cycling track. It was planned to build an iron-concrete roof over all stands with a 9m cantilever structure. In its original configuration the stadium offered 60,000 seats for spectators. In the 1950s, a third tier extended the capacity. The stadium was renovated and, in 1986, got a roof with a compression/tension ring structure.

In 1936 the Olympic Games were held in Berlin, Germany. For the Games it was redeveloped and extended to provide accommodation for 110,000 spectators. After the Games the stadium was not only used for sports events, but also for political events. The stadium was redeveloped and became a historical monument in 1974. In 2006, it was again redeveloped and modernized for the Soccer World Cup 2006.

In 1947-1950, the world's largest stadium, the Estádio Mario Filho in Rio de Janeiro, known as the Maracanã Stadium, was inaugurated for the Soccer World Cup in 1950. It accommodated up to 140,000 spectators. In 1963, it is believed to have held 180,000 spectators.

In 1964 the Olympic Games were held in Tokyo, Japan. The main stadium (the Jingu National Stadium) was redeveloped to increase the capacity. In addition, there were two fully enclosed venues: the Swimming Arena (for 4,000 spectators) and the Sports Arena (for 15,000 spectators); both designed by Kenzo Tange. The president of the International Olympic Committee (IOC), Avery Brundage, called the Swimming arena a cathedral for swimming.

The twentieth century

historical development of stadia

olympic stadium, munich

Throughout the twentieth century, long-span and lightweight structures were developed out of historical forms of the sail, the tent, and the vault. New structures and materials led to a wider span and lighter form. The new materials used included high strength PVC coated polyester fabrics.

Historically, the Olympic Stadium in Munich with its cable-net structure is one of the most important developments by architects Gunter Behnisch and Partners & by the structural engineers who were Frei Otto and Fritz Leonardt. In 1972, the Olympic Stadium in Munich, with its impressive roof structure as its main attraction, had a swimming hall and a sports hall included in the stadium complex. With a construction of some 78,000 m2, the roof over the stands of the Olympic Stadium is formed by a cable net structure in the form of a tent. The cable net is supported at the rear of the stands and as a result the roof structure provides an unobstructed view for the spectators. PVC-coated polyester fabric is stretched over the cable net structure and used as roof covering material. This is just over one part of the stadium and the other part is uncovered.

What is becoming more and more important is to build enclosures to be independent of the weather conditions. Such structures need to be wide span and they need to be able to support a wide range of external loads, e.g. large moving roofs, retractable membranes, sliding roofs as well as the development of long-span structures like air supported structures.

The French architect Roger Tallibert, in 1976, designed the main stadium for the Olympic Games in Montreal. It even had a retractable roof that was supported by cables from a high reinforced concrete tower. However, the intended retractable system proved too ambitious and the retractable roof was replaced by a fixed permanent roof later on.

In 1989, 93 football supporters were killed in Britain's worst-ever sporting disaster. They were crushed to death at Hillsborough stadium in Sheffield during the FA Cup semi-final between Nottingham Forest and Liverpool. The crush is said to have resulted from too many Liverpool fans being allowed in to the back of an already full stand at the Leppings Lane end of the ground. There was a lack of guides for the design of stadia. The government in the UK acted and set up the Football Stadia Advisory Design Council to provide design guidelines. The first step was to introduce all-seater stadia for more safety.

The stadium built for the 1996 Olympic Games in Atlanta was designed to be converted after the games into a baseball stadium.

In particular for Olympic Games, stadia were designed as multi-purpose venues. However, during the twentieth century, a lot of stadia, which were designed for one specific sports activity, were developed. Due to different requirements of each sport, there are specific forms for these stadia. The big stadia were designed for the most popular sports: football, rugby, american football, baseball, tennis, and cricket. At the end of the century, there was the inverse development and stadia had to be more functional, useable for different sports or events.

Recent developments

santiago calatrava athens olympic stadium

city of manchester stadium

historical development of stadia

In the last century, stadia changed from multi-purpose venues to buildings for one specific sport and back again to multi-purpose stadia. At the end of the last century and the beginning of the twenty first century, how to use the stadia, after major events like the Olympic Games, became a problem, led to the development of making stadia multi-functional and useable for a greater variety of events. A modem stadium has to be more flexible. In addition, a modem stadium is divided into categories for various users. Hospitality areas and private boxes for the spectators provide an attraction for a new category of spectators.

The life cycle costs & sustainability have become the factors to be considered in the design of stadia. For example, Australia was the site for the Olympic Games in 2000. The Olympic Stadium in Sydney was designed to hold 110,000 spectators during the Games. However, after the Games, the stadium was reconfigured and the capacity reduced to 80,000.

Another example was in 2002, the City of Manchester Stadium which was built for the Commonwealth Games in Manchester, UK. As the Stadium Australia, it was designed to provide a configuration for the Games. The roof of the stadium was supported by a cable net structure. The venue was reconfigured after the Games and became the home of the City of Manchester Football Club in 2003. In order to increase the capacity, the activity area was lowered by excavating the ground and adding a new lower tier. This had also the advantage of bringing the spectators closer to the activity. In addition, the temporary stand at the open end of the U-shaped stand structure was removed and the gap was closed.

Moreover, in 2004 the UEFA (Union of European Football Associations) and the European Football Championship that was held in Portugal used ten stadia for the Championship. The most remarkable of them is the stadium in Braga, designed by architect Eduardo Souto Moura. The stands are just on the long sides of the pitch. The roof is formed by a catenary tension structure, supported by the structure of the two stands.

Also in 2004 the Olympic Games were held in Athens. The most impressive building was the main stadium, which was originally built in 1980 and could accommodate 80,000 spectators. The existing stands were covered by a new roof designed by Santiago Calatrava. Each of the roof segments is held by a steel arch, spanning a distance of 304m and rising to a height of 60m above the stadium.

In 2006 the Soccer World Cup was held in Germany, where twelve stadia were built or redeveloped. All stadia have roofs over the stands to provide the shelter against the elements. Some of them even have retractable roofs. The Allianz Arena in Munic is described as the most modern stadium. The main stadium, the Olympic Stadium in Berlin, was renovated, a new roof was added and the stadium was modernized, as a historical monument, according to landmark standards.

The 2008 UEFA European Football Championship took place in Austria and Switzerland. The stadiums of Klagenfurt, Salzburg and Innsbruck were planned by Albert Wimmer, with the concept of reducing the capacity after the event.

In the same year in Beijing took place the Summer Olympic Games, where the centrepiece was the Beijing National Stadium, nicknamed “The Bird’s Nest” because of its nest-like skeletal structure. The design was awarded to a submission from the Swiss architecture firm Herzog & de Meuron. The stadium hosted both the opening and closing ceremonies as well as the athletics competition.

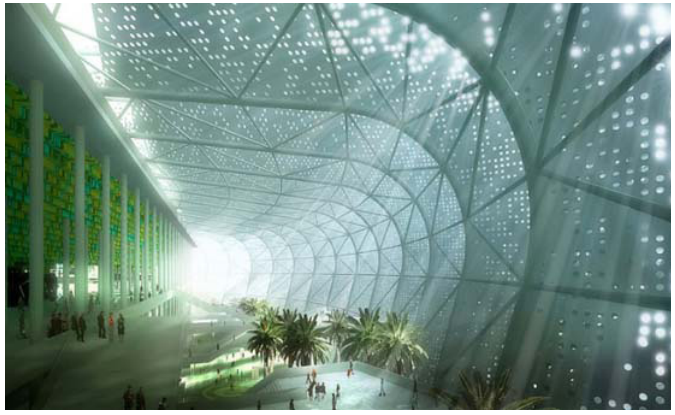
The last World Cup Championship was held in South Africa in 2010 and was hospitated by ten venues. Opened in 1989 after a 3-year-long construction period, the Soccer City stadium is famous for being the site of Nelson Mandela’s first major public speech in Johannesburg following his release from prison. The stadium had a capacity of 80,000 but a major renovation undertaken in 2008 to prepare for the World Cup saw capacity rise to 94,700 – making it the largest sports stadium on the African continent. The 69,070 seat stadium of the Green Point Stadium was built on the site of a previous arena. Designed to complement and enhance Cape Town’s thriving downtown, the new stadium is close to the shopping and entertainment district at the Victoria & Alfred Waterfront.

olympic stadium beijing, herzog and de meuron

green point stadium

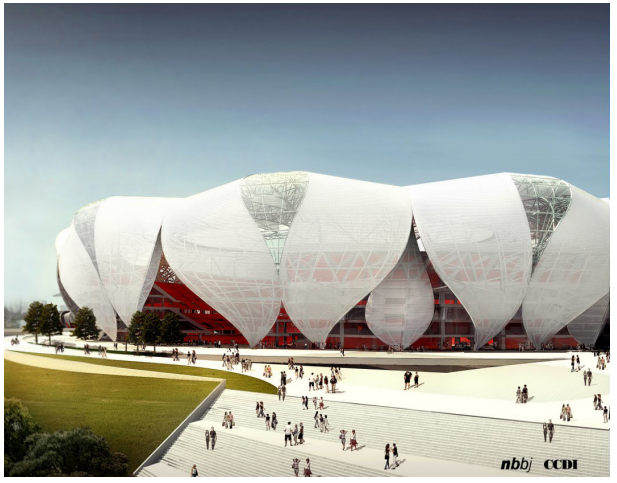
Summary and outlook

Stadia have developed from natural arenas to modern multi-purpose buildings with high comfort levels for the spectators. To meet the requirements of spectators, roof-structures had to be developed to protect or even make them independent of weather conditions. Just as architects and engineers of ancient stadia solved the problems of their times, so architects and engineers of modern arenas have to solve the problems of today. In particular, these problems are caused by financial requirements. Modern stadia have to be economic, energy-efficient and interesting for spectators as well as for investors.



grand stade de casablanca, scau-archidesign

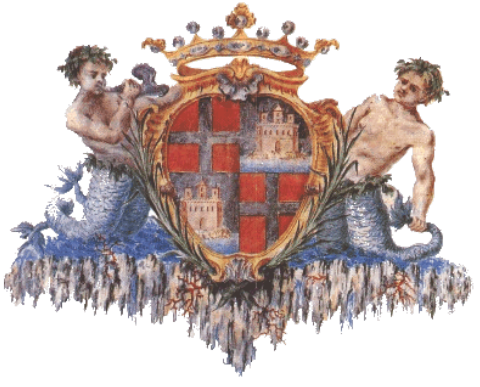
Toyo Ito: Kaohsiung Stadium



NBBJ + CCDI: Hangzhou Stadium

san nicola stadium, bari, renzo piano

THE CITY OF CAGLIARI



Cagliari is an Italian historic city located on the Angels Gulf coast, in southern of the island Sardinia, the capital of both the autonomous region of Sardinia and the province of Cagliari. The town has about 160,000 inhabitants, about 480,000 including the outlying townships. In the Sardinian language Cagliari is called Casteddu, literally means castle. The city is said to be built on seven hills: Sant'Elia, Bonaria, Monte Urpinu, Castello, Monte Claro, Tuvixeddu and San Michele.

location and data

Country	Italy
Region	Sardegna
Province	Cagliari (CA)

Elevation	4 m (13 ft)
Area	85.45 km2 (33 sq mi)
Population (2010)	- City center 157.780 - Province 561.080 - Density 1,846.5/km2 (4,782.3/sq mi)

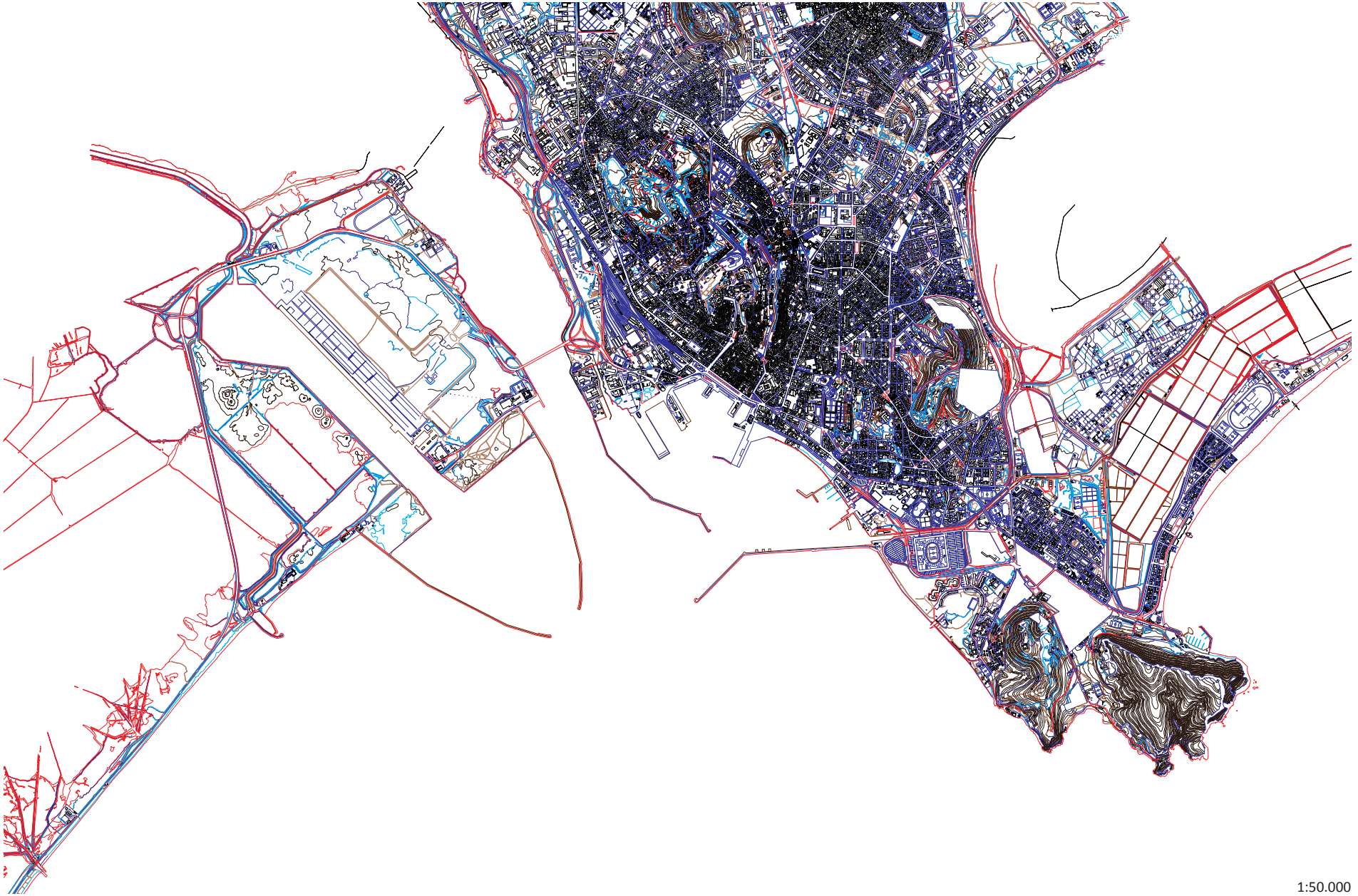
Time zone	CET, UTC+1 (- Summer (DST) CEST (UTC+2)
Coordinates	39°14’47’’N 09°03’27’’E
Gentilic	Cagliaritani
Website	www.comune.cagliari.it

the city of cagliari

Cagliari is an ancient city with a long history that has seen the rule of several civilizations. It was the capital of the Kingdom of Sardinia (which in the 1861 became the Kingdom of Italy) from 1324 to 1720 and from 1798 to 1815, seat of the important University of Cagliari and the Primate Roman Catholic archdiocese of Sardinia, the city is an important regional cultural, educational, political and artistic centre, known for its diverse Art Nouveau architecture and several monuments. It is also Sardinia's economic and industrial hub, having one of the biggest ports in the Mediterranean sea, an international airport, and the 28th highest income rate in Italy, comparable to several Northern cities, such as Turin, Vicenza and Genoa.

Cagliari has one of the longest beaches in Italy. Poetto beach stretches for 13 km and is famous for its white fine-grained sand and its clean water, rare feature for a beach town. A recent controversial intervention to save the beach from erosion has slightly altered the original texture of the sand. Poetto beach is not only a place where to swim but also a recreative one with its characteristic kiosks which serve snacks, fast dishes and various delicacies and some fresh shellfish.

In summer time at night, the Poetto beach turns into an animated spot, with live music and entertainments. On the western side lies the small tourist port of Marina Piccola, founded by the Phoenicians in the 8th century as a maritime stop, with the calcareous hill of the Sella del Diavolo towering over the city and the gulf. On the backside of the Poetto beach, the salt pan of Quartu Sant'Elena and the Pond of Molentargius stretch along. Here, several species of birds nest all-year-round: pink flamingo, sultan chicken, gray heron, duck-hawk, garzetta, Italian knight, griffon, Sardinian partridge. The elegant flamingo are probably the main attraction: they fly even thousands kilometres and come mainly from Africa. Thousands of them stay in Sardinia while a large part proceed toward other European Countries (Camargue in France, is for example, one of the most populated areas by flamingoes).



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the city of cagliari

The old part of the city (called Castello, the castle) lies on top of a hill, with a wonderful view of the Gulf of Cagliari (also known as Angels Gulf). Most of its city walls are intact, and feature the two 13th century white limestone towers, St. Pancras Tower and the Elephant Tower. The local white limestone was also used to build the walls of the city and many buildings. In Castello district, the Cathedral was restored in the 1930s turning the former Baroque façade into a Medieval Pisan style façade, more akin to the original appearance of the church from the 13th century. The bell tower is original. Near the Cathedral is the palace of the Provincial Government (which used to be the island's governor's palace before 1900). In Castello is also the Sardinian Archaeological Museum, the biggest and most important regarding the prehistoric Nuragic civilisation of Sardinia. Finally, Castello hosts many craftsmen workshops in its tightened and scenic lanes. Constitution Square, is interrupted in a covered walkway, and ends beneath the Arc de Triomphe, in the Terrazza Umberto I. In 1943, during the Second World War, the staircase and the Arch of Triumph were severely damaged by aerial bombardment, but after the war were faithfully reconstructed. The other early districts of the town (Marina, Stampace, Villanova) retain much of their original appeal and still seem to function as distinct villages within the town.

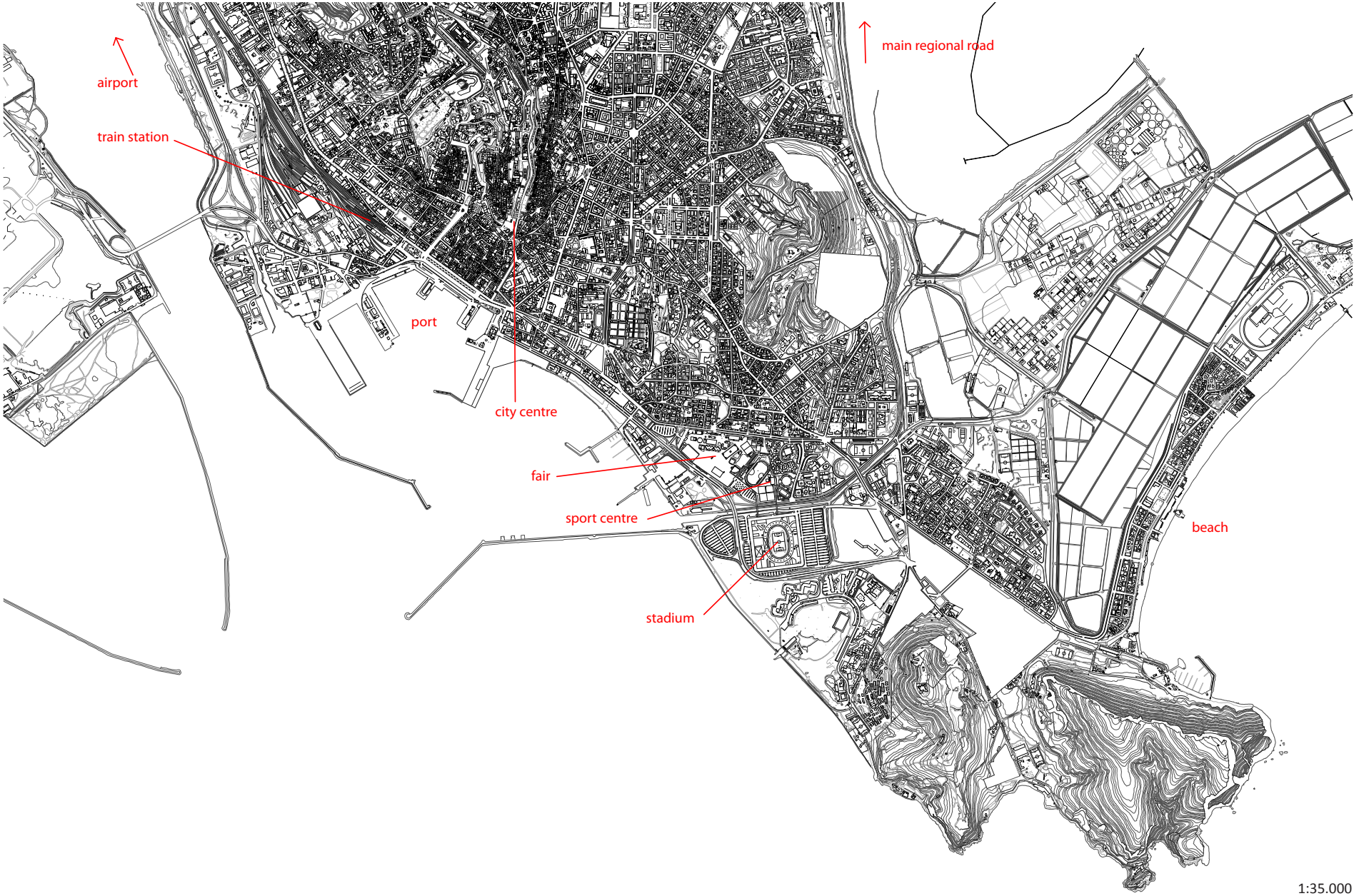
From the 1870s, with the unification of Italy, the city experienced a century of rapid growth. Many outstanding buildings were erected by the end of the 18th century during the office of Mayor Ottone Bacaredda. Many of these buildings combined influences from Art Nouveau together with the traditional Sardinian taste for flower decoration: an example is the white marble City Hall near the port. During the Second World War, Cagliari was heavily bombed by the Allies in February 1943. In order to escape from the bombardments and the misery of the destroyed town, many people left Cagliari and moved to the country or rural villages, often living with friends and relatives in overcrowded houses. This flee from the town is known as "sfollamento" (deserting). After the Italian truce with the Allies in September 1943, the German Army took control of Cagliari and the island, but soon retreated peacefully in order to reinforce their positions in mainland Italy. The American Army then took control of Cagliari.

Cagliari was strategically important during the war because of its location in the Mediterranean Sea. Many airports were near Cagliari (Elmas, Monserrato, Decimomannu, currently a NATO airbase) from which airplanes could fly to Northern Africa or mainland Italy and Sicily.

The Sanctuary of Bonaria was built by the Catalans in 1324–1329 during the siege to the Castle in which the Pisans had taken shelter. It has a small Gothic portal in the façade while the interior houses a wooden statue of the Madonna, which was thrown off a Spanish ship and landed at the foot of the Bonaria hill. The cloister of the convent is home to the Marinery Museum. The Sanctuary gives its name to Buenos Aires. The Spaniards that founded Buenos Aires visited the church of Bonaria (fair winds, buenos aires in Catalan) and asked for help from Mary of Bonaria, to whom the church is dedicated. The church faces the sea and was built where a sailor landed after Mary appeared during a tempest and saved the sailor and his ship from sinking.

Considerable other remains of the ancient city are still visible at Cagliari, the most striking of which are those of the Roman Amphitheatre, carved into a block of rock (the typical limestone from which Cagliari is built), and of an aqueduct; the latter a most important acquisition to the city, where fresh water is scarce. There exist also ancient cisterns of vast extent: the ruins of a small circular temple, and numerous sepulchres on a hill outside the modern town, which appears to have formed the necropolis of the ancient city. The Amphitheatre still stages open-air operas and concerts during the summer.

the city of cagliari


airport
train station
port
city centre
fair
sport centre
stadium
main regional road
beach

1:35.000

history of cagliari

The region around the city was likely settled by a nomadic tribe around 5000 BC, and later a permanent settlement was established by the Phoenicians as a trading colony in the 7th century BC. In the 3rd century BC the island of Sardinia was conquered by the Carthaginians, and following their defeat by the Romans, it became part of the Roman Republic and then Roman Empire. For 400 years the island, including Cagliari, experienced a period of peace until the fall of the Roman Empire. First the Vandals, and then the Byzantine Empire gained control, and then in the 6th century AD the island became an independent kingdom. This marked a downturn for the city of Cagliari, as it was all but deserted due to constant attacks by pirates. The city was rebuilt during the Pisan Republic in the 11th century and the town was heavily fortified to fend off attacks by sea. Some of these medieval fortifications can still be seen today. The Kingdom of Aragon conquered the island during the 14th century and it transferred to Spanish control for the next 400 years, until it came under the rule of the Habsburg dynasty of Austria. Finally, in 1720 the island and the city of Cagliari came under the rule of the House of Savoy.

While the Duke of Savoy maintained a capital in the city of Turin on mainland Italy, the dynasty took the title of Kings of the Sardinian Kingdom. The French tried to gain control of the island under Napoleon's rule, but the citizens of Cagliari fended off the invasion. The House of Savoy offered any concession or reward for this loyalty, and as a result the city rose up against their rules. While there was a brief period of independence from the Sardinian Kingdom, the city was retaken soon after. However, even today "Die de sa Sardigna" or Sardinian Day is celebrated on the last weekend in April.

With the unification of Italy in 1861 the city of Cagliari became part of the Kingdom of Italy, and the result as an expansion and renovation of the old city. Some of this was damaged during World War II when the city was bombed by the Allies in 1943. Following the downfall of the dictator Benito Mussolini, the Germans briefly occupied Cagliari before retreating to mainland Italy. The city was liberated by the Allies at the end of the same year. While there are scars of the past, the city remains a vibrant reminder of the role that Sardinia and the region played in the history of Italy and Europe.

sant’elia stadium

Stadio Comunale Sant'Elia is the olympic stadium in Cagliari. It is currently the home of the football club Cagliari Calcio . The stadium has a capacity of 23,486. It hosted three matches in the 1990 FIFA World Cup. Its construction began in 1970, following Cagliari Calcio's first and so far only Scudetto, thus taking the place of the old Amsicora Stadium. The stadium could accommodate up to about 60,000 spectators (the record attendance being approximately 70,000, was recorded against Saint Etienne). The stadium subsequently underwent major changes and restructuring for the 1990 FIFA World Cup. The maximum capacity of Sant'Elia Stadium was reduced to 39,905 spectators. The structure had to undergo major changes as a result of restructuring and at the 1990 World Cup, which led to changes in the St. Elias to have a capacity of 39,905 spectators. For the occasion, a Geodesic ball was built adjacent to the Central Stand (outside the stadium), which was used as a pressroom, it is still a polyvalent structure of the city. Before the 2002-03 season, due to the Football League's decision not to stage because of the practicability of the hazardous conditions on the collapse of the sectors behind the goals and one of the sector in between (three fourth of the stands).

Sant Elia
Cagliari, Italy

Capacity:	23486
Elevation:	4 m
Year Opened:	1970
Year Renovated:	1989
Pitch:	105 x 66 m

sant’elia stadium

The president of Cagliari Calcio decided, with the consent of the City Council that stipulated with him a convention of 11 years, to invest in a record time, three million euros, the plant was then changed: on the athletics track new stands in steel tubes “Innocenti” were placed (also behind the goals of the football field) to decrease the distance between the old bleachers and the football pitch. The grandstand remind intact. The new format of the stadium, designed for a capacity of almost half (23,486 seats) than in the 90’s, suffered harsh criticism after that, November 18, 2002, during the match between Cagliari and Messina, a fanatic managed to climb over the fences, evading security forces, and punch the Sicilian goalkeeper. To solve these problems the barriers between the stands and the football field have been greatly revolutionized: the iron railings were in fact removed and replaced by panels of plexiglass. Further improvements were made to allow the viewers of the grandstand a better vision: it created a gap in which the benches were buried in the ground.

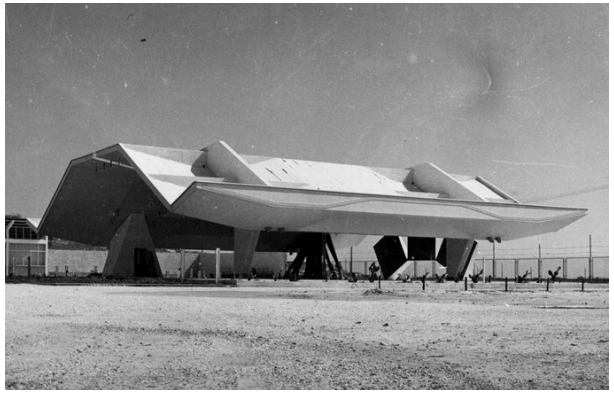
Other small changes due to new rules introduced in the Act 210, October 1, 2005, the capacity dropped to 20,270 seats.

future - works in progress

In the last years a great urban development was started in Cagliari. In this page some images of the fair possible development are showed. With the aim to requalify the area of the fair, the city of Cagliari proposed an architectural competition, with particular requests about the traffic regulation, the technologic innovation and the energetic systems.

Particular interest is also given to two existing buildings with historical value: the “Libera pavillion” (1953) and the “salt storage” made by Nervi (1958).

magazzini del sale, pier luigi nervi



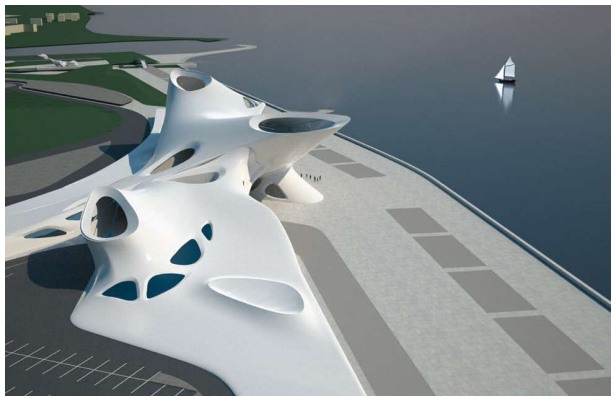
fair, padiglione libera, photo of the fifties

proposal for the riqualification of the fair quartier

In the last years a great urban development was started in Cagliari. New projects include the new Betile museum for Nuragic and modern art, designed by the Prizker Award winner Zaha Hadid: it will rise on the Sant'Elia promenade. Another already started project is the Cagliari metro: the first line is already running from Piazza Repubblica to Monserrato, one of Cagliari suburbs, and will be soon connected to the University campus; works for other lines to all the city suburbs and the airport will be soon started. The promenade from the old harbour to Sant'Elia will be totally restored. The old port in Via Roma, now to be used only as tourist and cruise port (where the cruise terminal is already finished), will be closed to ferry-boats, which will be moved to the new port in "porto canale".

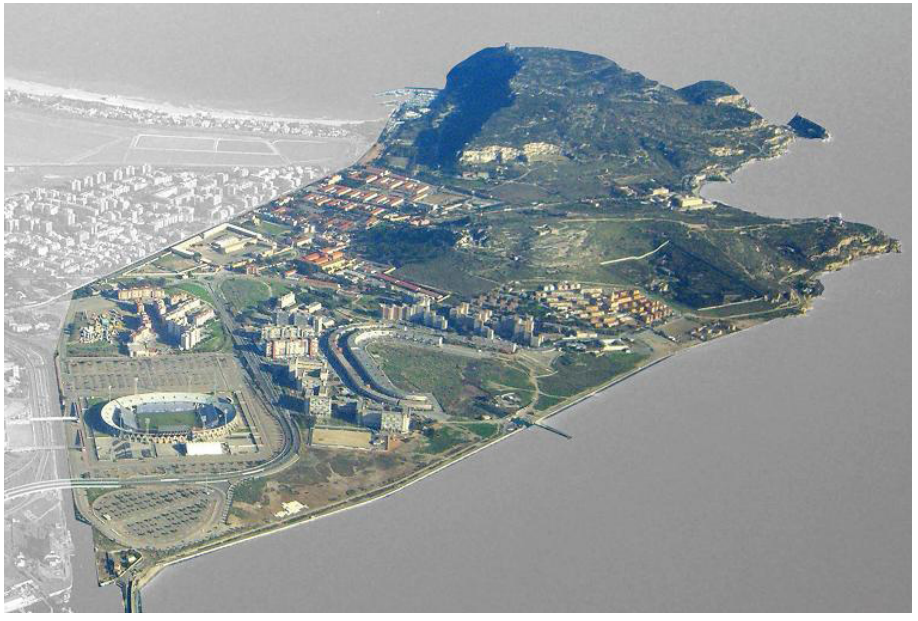
future - works in progress

betile art museum, intervention area



betile art museum, zaha hadid

betile art museum, plan



sant’elia district

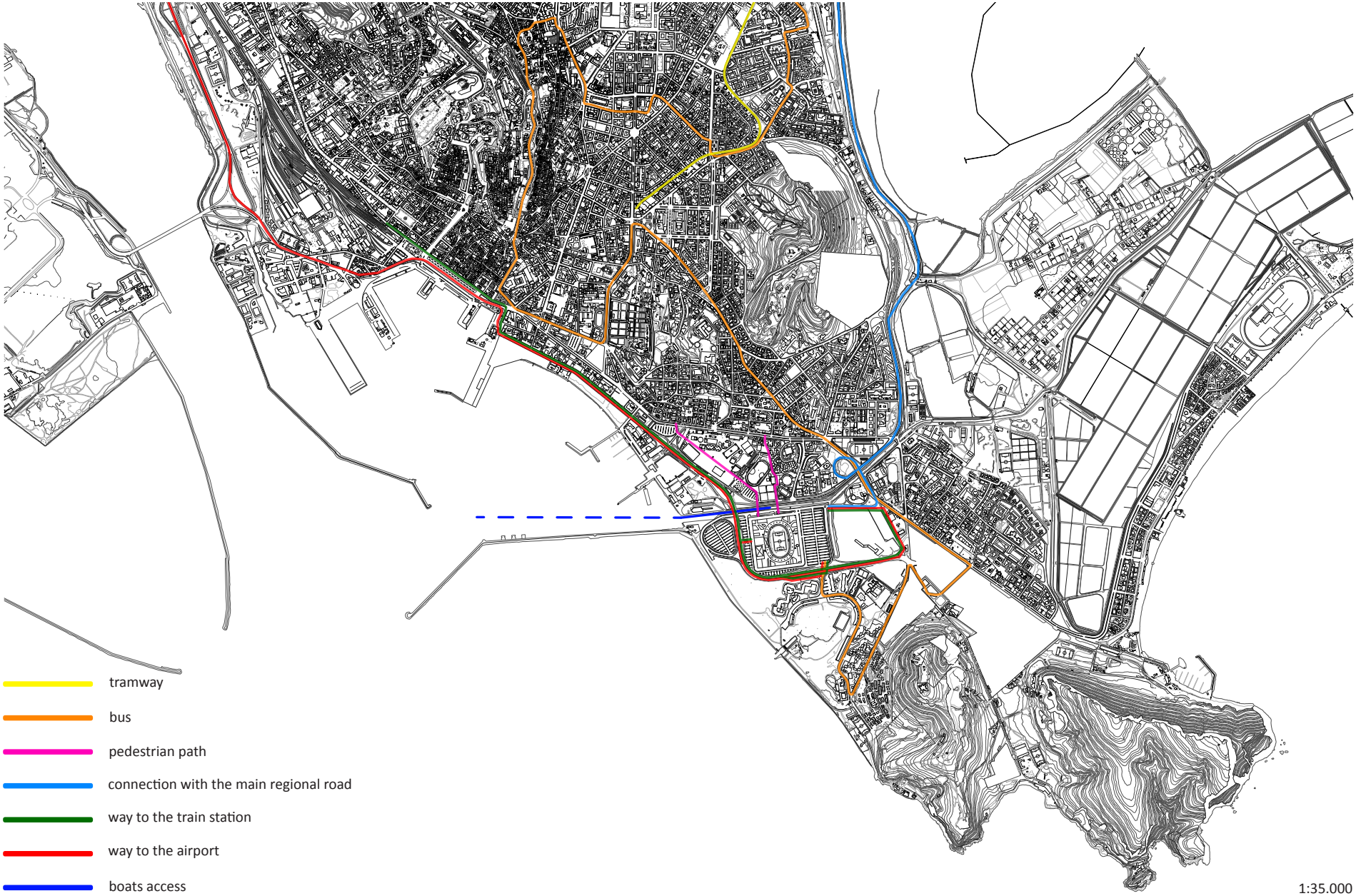
All Sant’elia district will be changed, the old ruined apartment buildings will be demolished and a new district designed by Rem Koolhaas will rise. On the promenade will also rise a great amphitheatre (20,000 seats) for concerts, as well as an aquarium where now is the old salt production plant. Other projects include the new district near the Santa Gilla pond (Piazza Santa Gilla), a luxurious beauty-center on the Poetto beach, where now is the old abandoned “Marino” hospital, the new university campus, designed by Paulo Mendes da Rocha, and the new “Parco della musica”, a great park with an amphitheatre and fountains, channels and water-games, between T-hotel and the Civic Theatre; the latter will be finished by the end of the year, while the other works will be finished by 2011–2012.

future - works in progress

development proposal for the sant'elia district

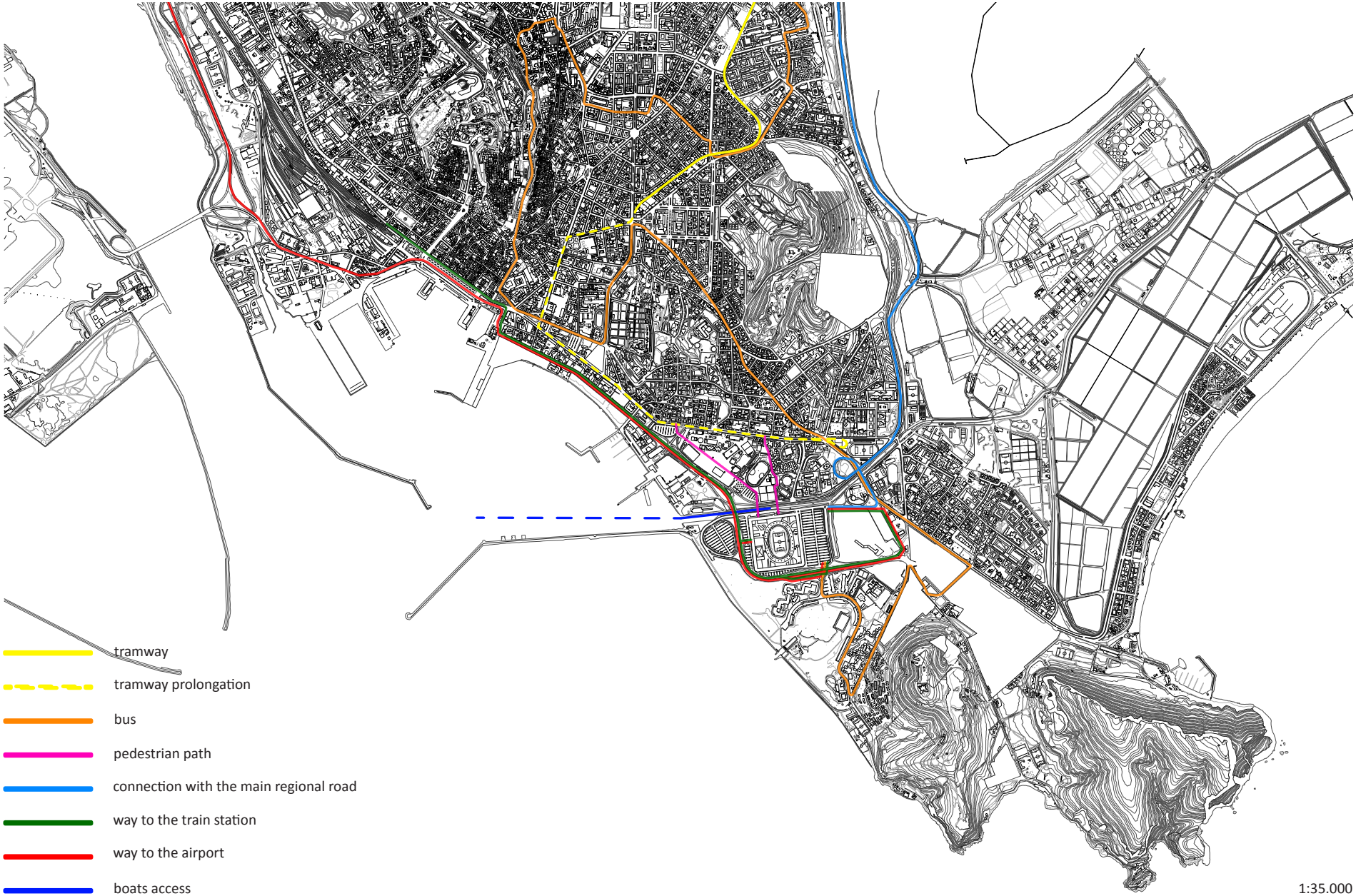
development proposal for the sant'elia district

traffic network


tramway
bus
pedestrian path
connection with the main regional road
way to the train station
way to the airport
boats access

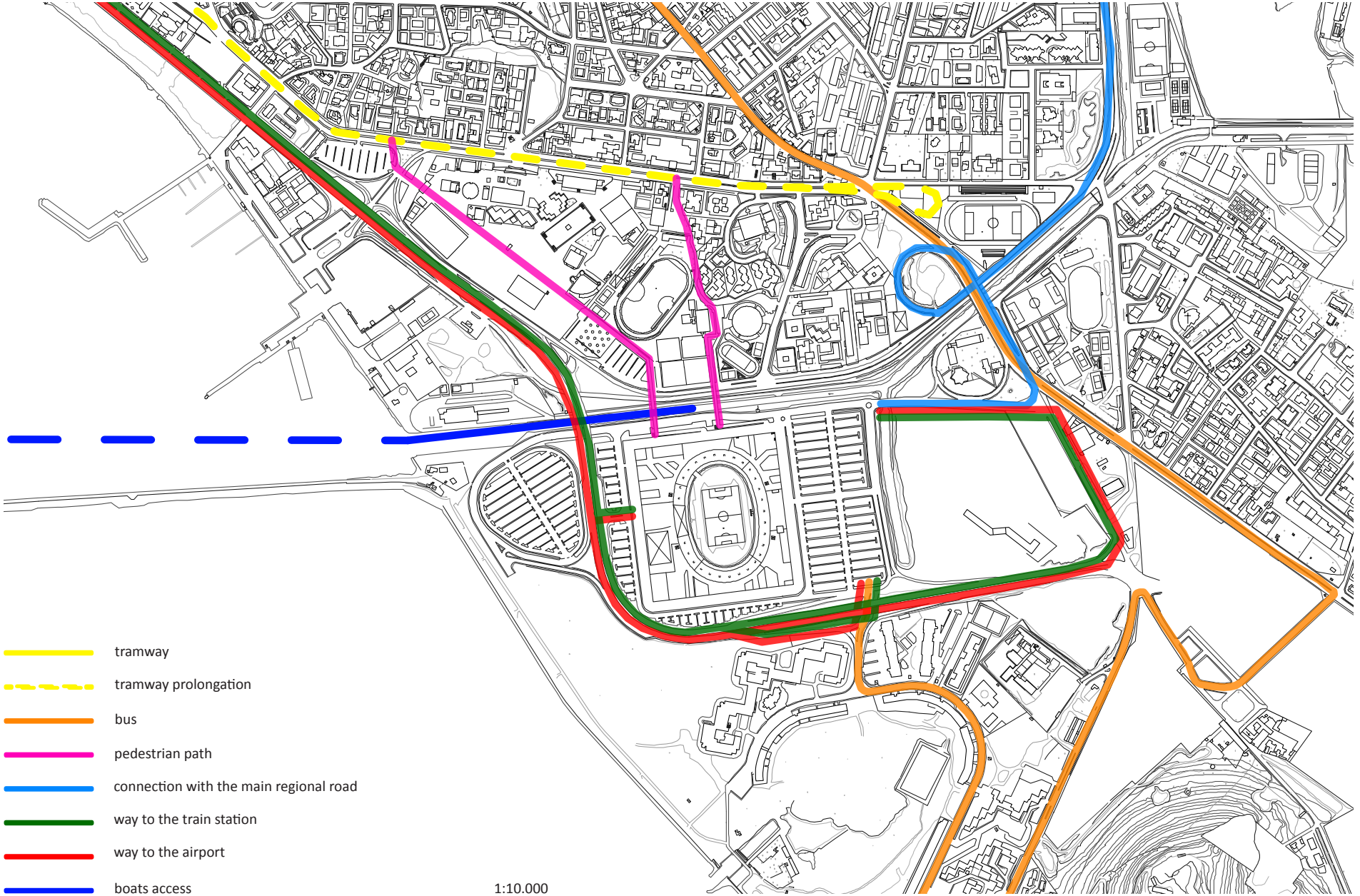
1:35.000

future - traffic development


tramway
tramway prolongation
bus
pedestrian path
connection with the main regional road
way to the train station
way to the airport
boats access

1:35.000

future - traffic development


tramway
tramway prolongation
bus
pedestrian path
connection with the main regional road
way to the train station
way to the airport
boats access
1:10.000

FIRST APPROACH AND RESEARCH

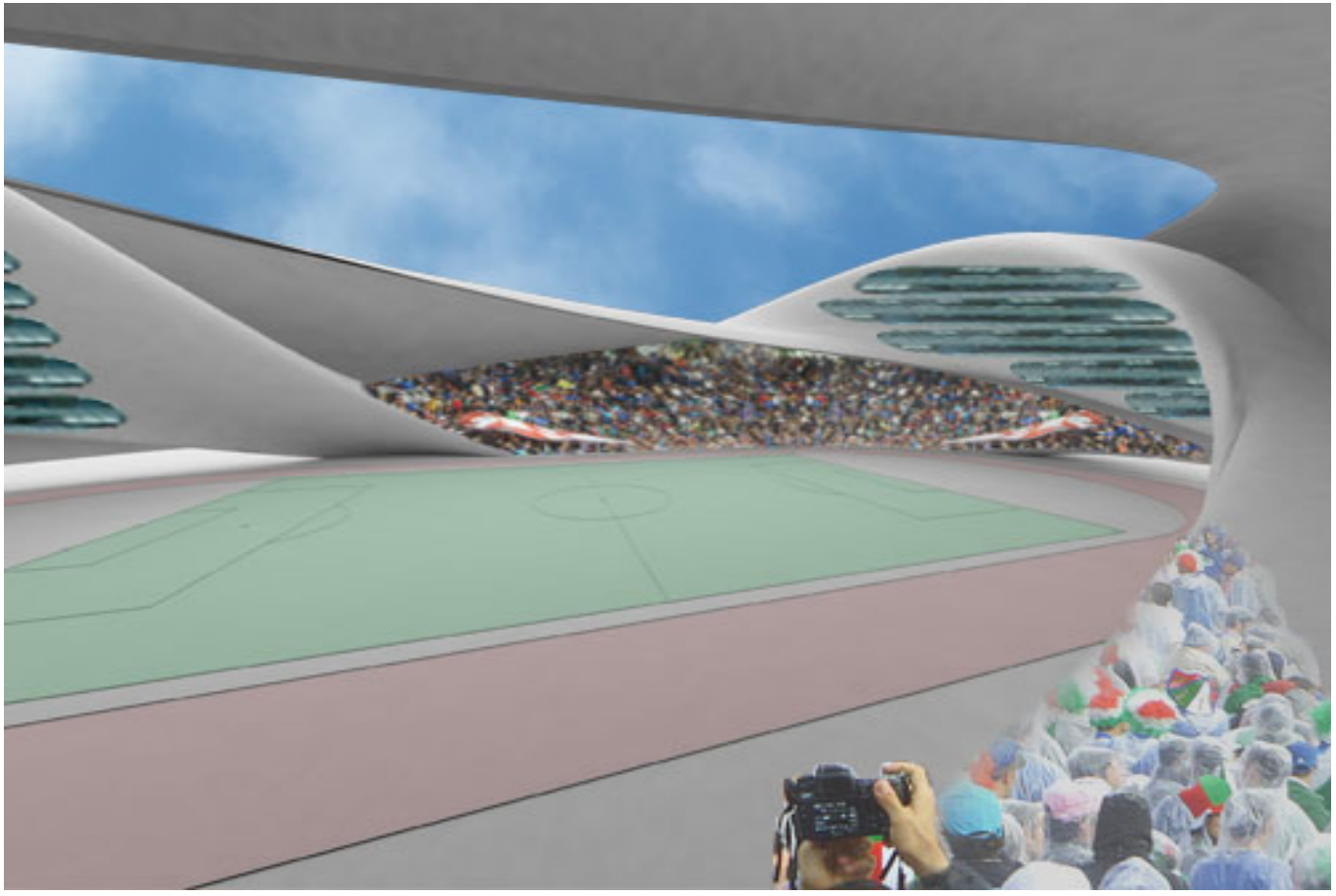
The first approach was to start immediately with the design of a concept, without any “contamination” about the rules and standards cocerning the stadium, where a concept for the circulation of the visitors was developed.

This concept was geometrically translated with a moebius strip, creating a system of loop circulation integrated with the outside skin and the tribune.

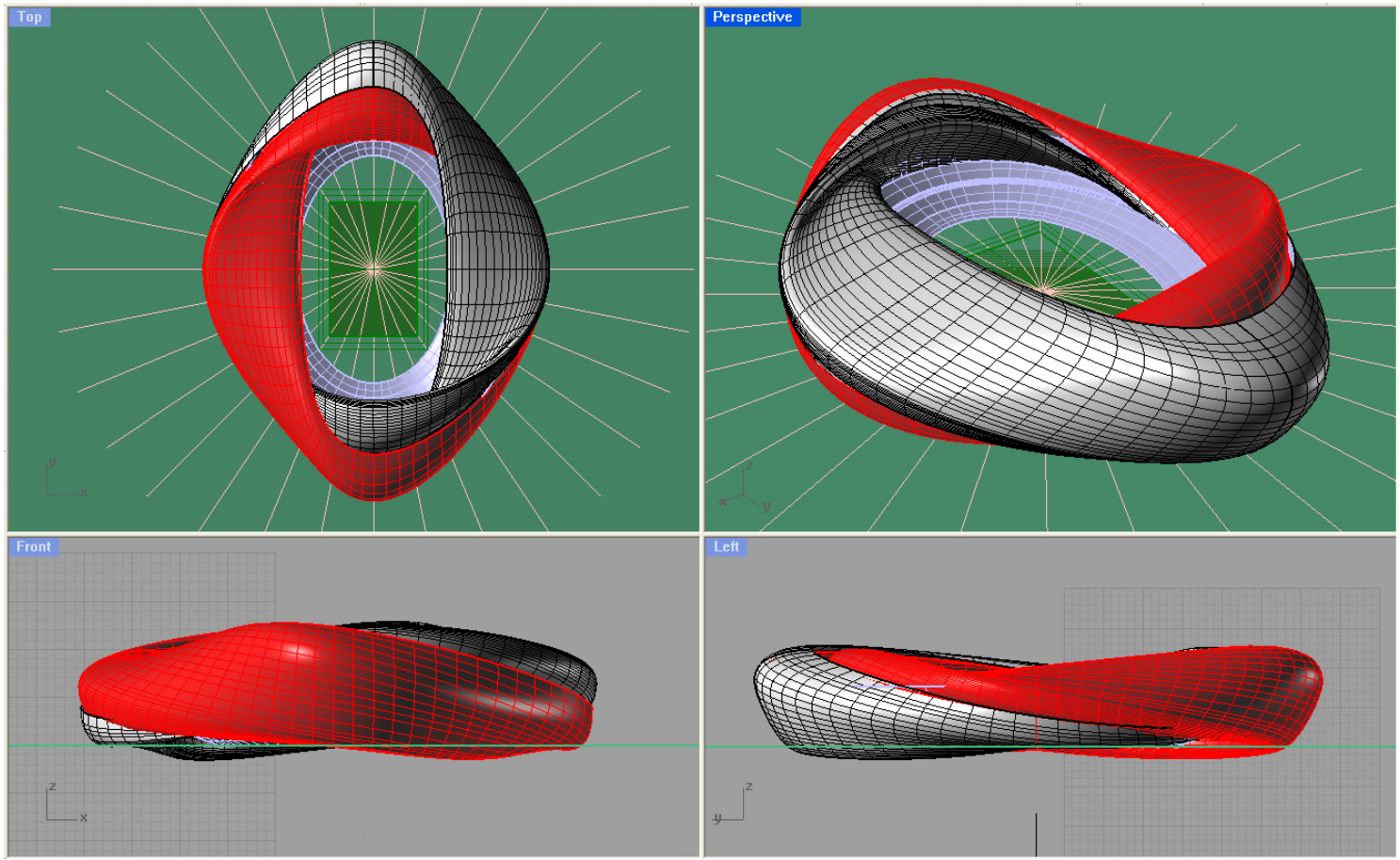
Subsequently, due to the structural necessity, the tribune was thought as a separate and indipendent element, based on a mathematical function with parameters concerning the “equivisibility”.

Afterwords the notions of the typological functioning of a stadium were known and the decision was to change considerably the initial idea, basing the coming project on the reqests of the FIFA (Fédération Internationale de Football Association).

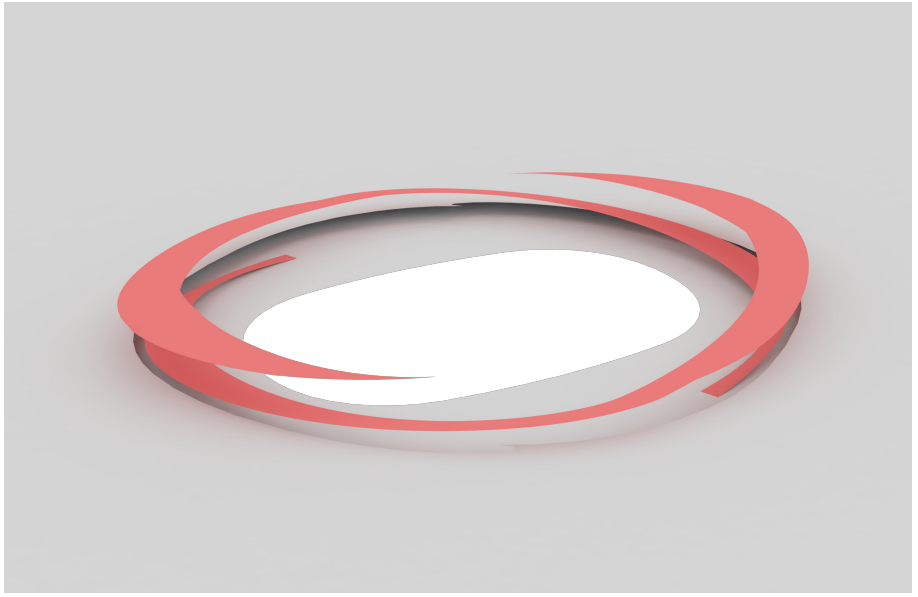
fisrt concept



first concept: internal view



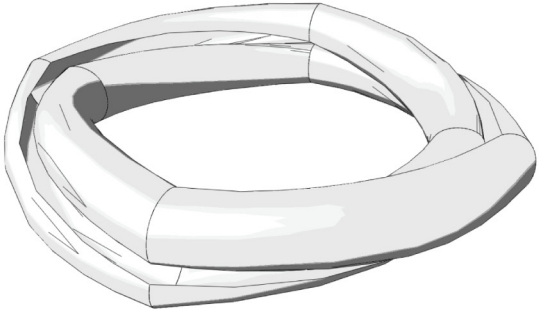
geometrical research

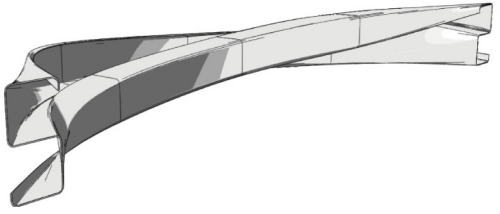


first concept: “never-meeting” circulation ramps

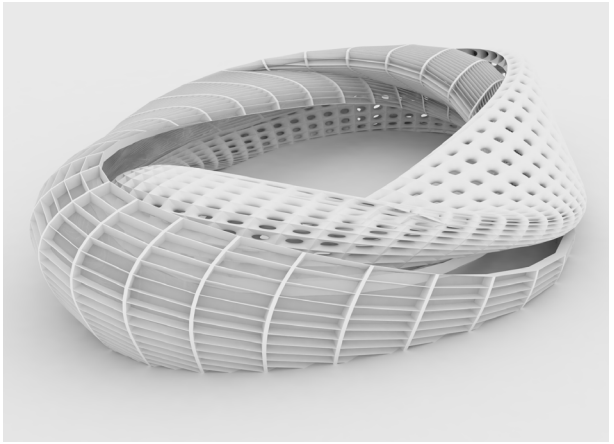
first concept: circulation system

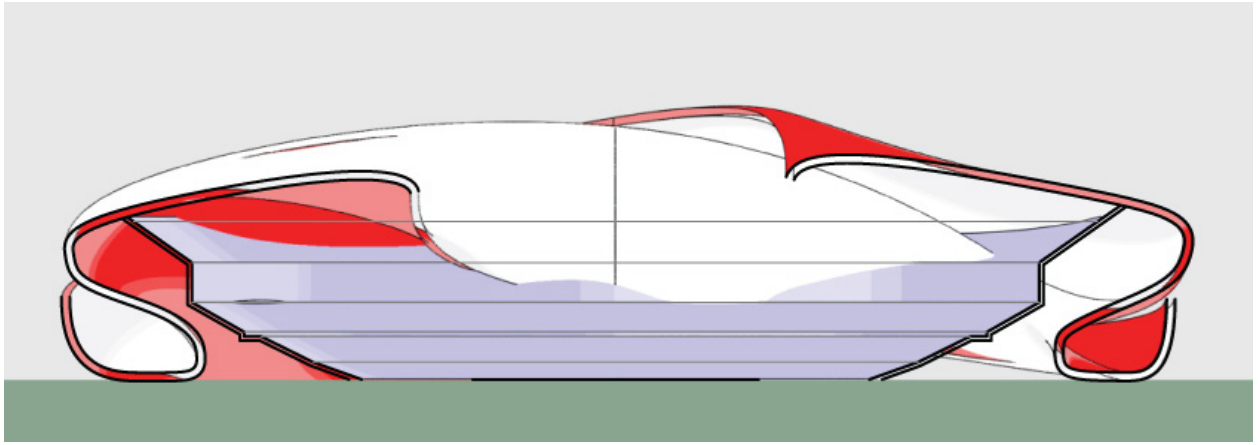
The first idea of the circulation system is based on two different paths/ramps: with this design, the supporters of one team will have an own and independent walking path, separated from the one of the other team. With the aim to integrate the circulation with the outside skin, the concept was geometrically translated with a moebius strip, creating a system of loop circulation.

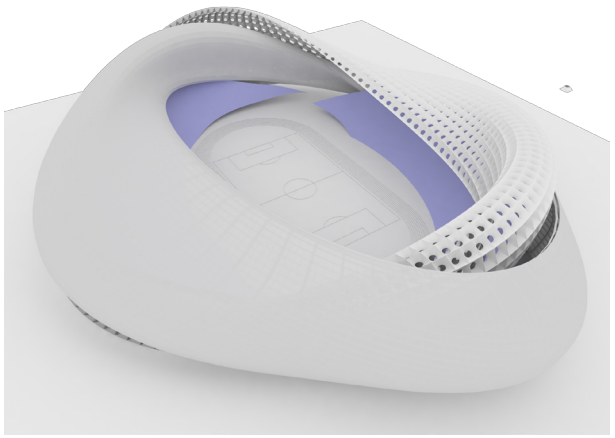




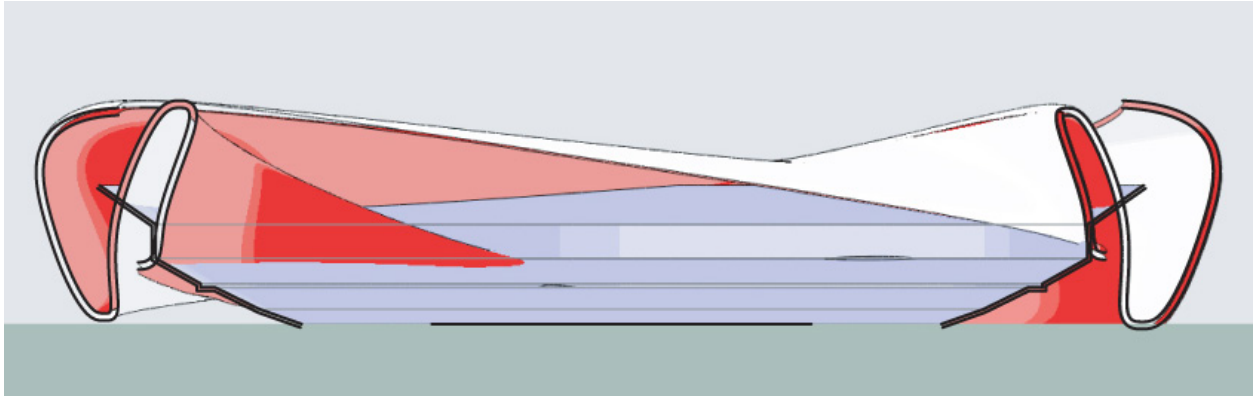
the loop system







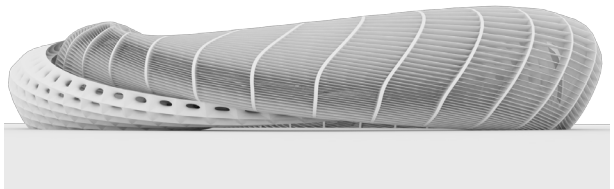
outside views

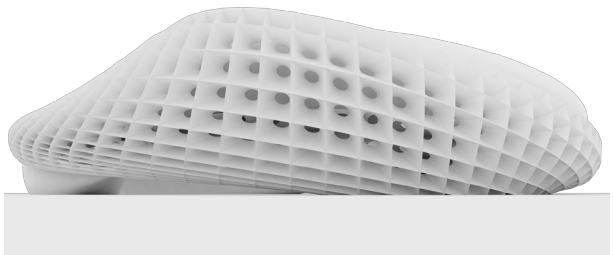


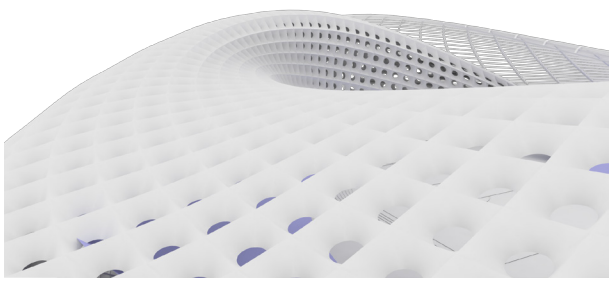
conceptual sections

first concept

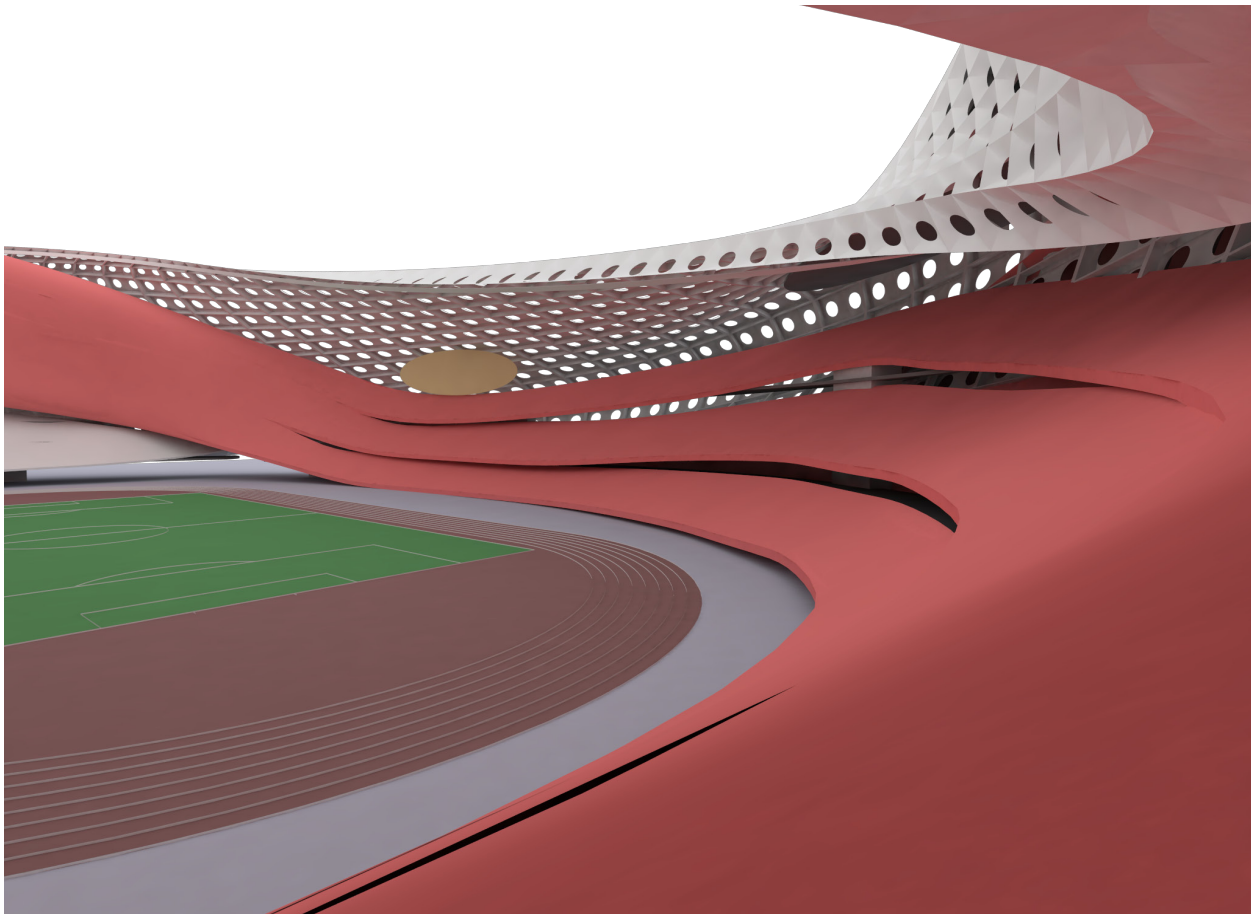
outside view of the structure system



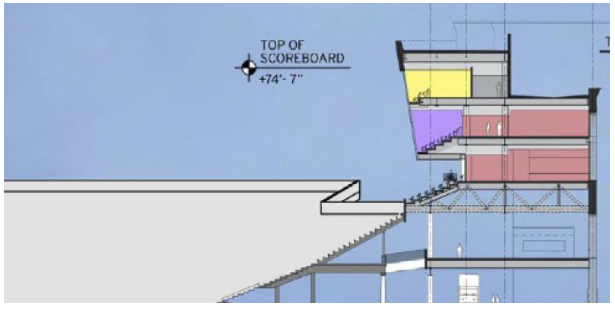




skin and roof views



internal view: the tribune is an unique element with the skin and the roof



michigan stadium

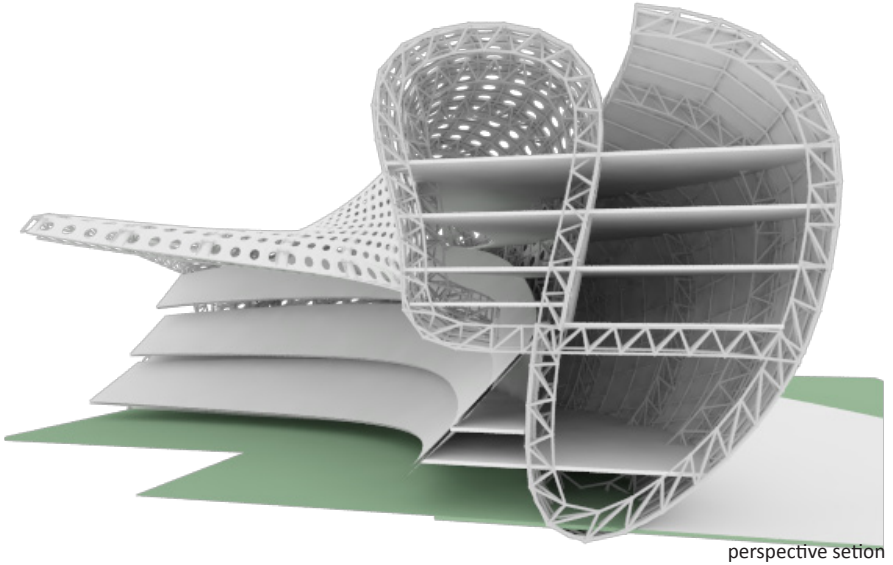
new stadium, siena

boca junior stadium, bueonos aires

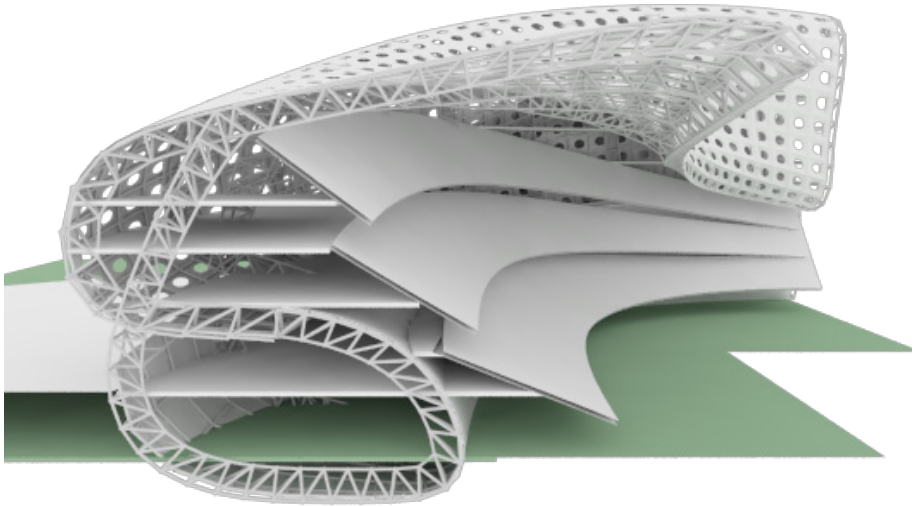
Some pictures of existing stadiums with loggias and boxes are proposed (left).

The inspiration images lead to create a closed area used for VIP boxes, loggias, hotel and restaurant, with the view on the inside of the stadium.

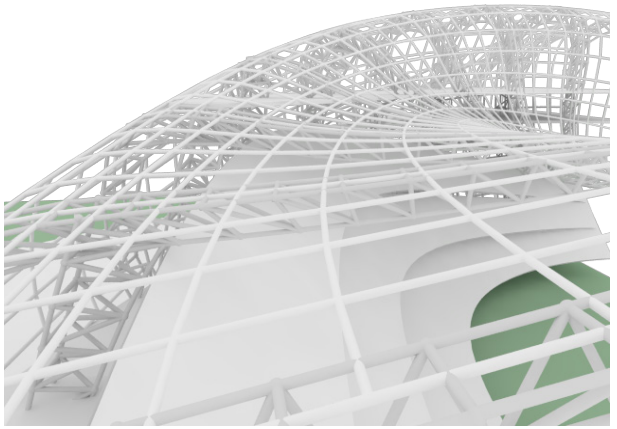
For this reason the skin is treated with openings and glass, giving the possibility to look at the pitch.



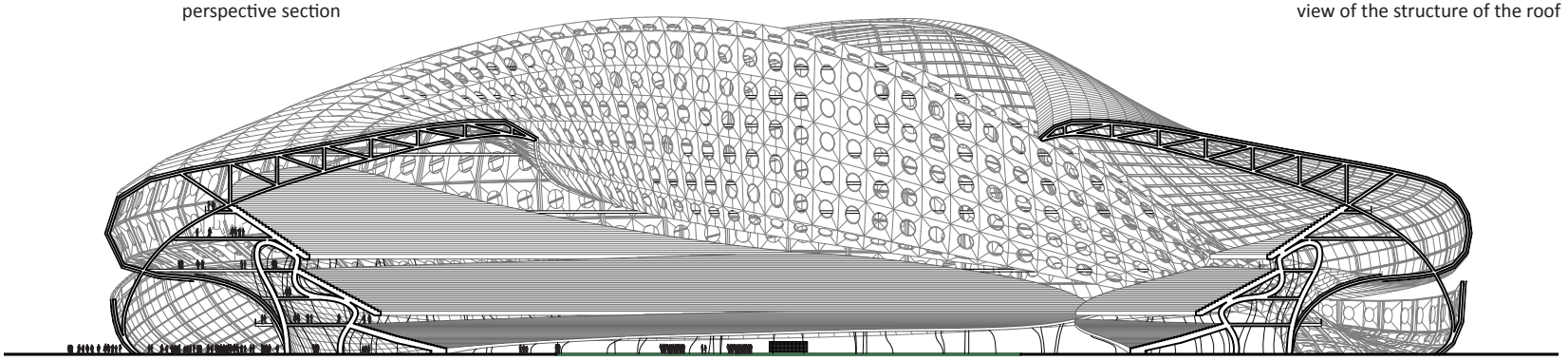
perspective setion



perspective section



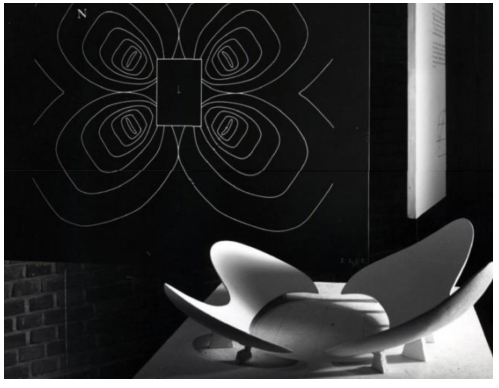
view of the structure of the roof



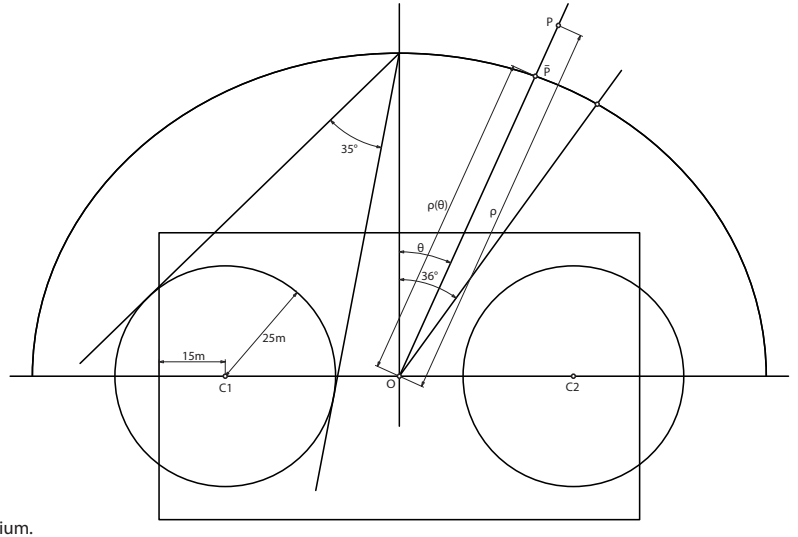
section: skin and tribune are definitively separated

TRIBUNE

"EQUIVISIBILITY"
With the aim of optimizing the visibility from the stands, Luigi Moretti defined the concept of "equivisibility" (or "visual desirability") through a mathematical function.
(Moretti Luigi, *Ricerca matematica in architettura e urbanistica*, "Moebius", n.1,1971)



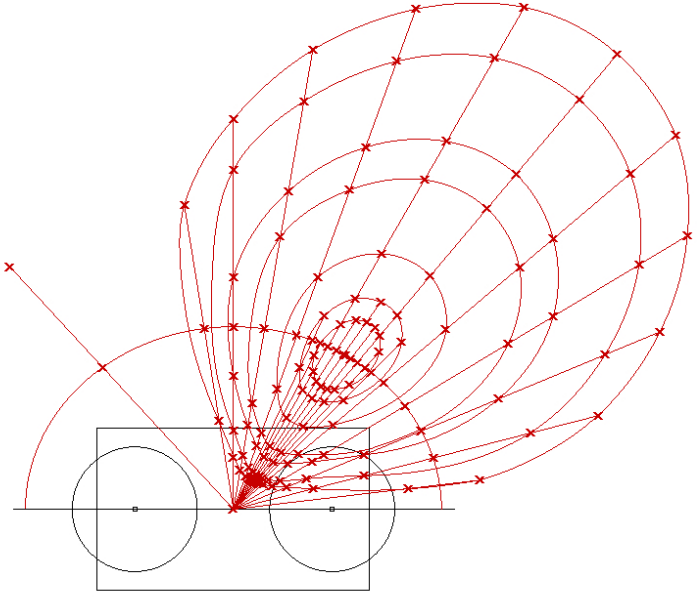
Curves of equivisibility and mockup of the soccer stadium, presented by Luigi Moretti in occasion of the 12th Triennial Exhibition of Milan, 1960.



"equivisibility" for the soccer stadium.

$W = x^{k(y)}\, e^{-k(y)x}$

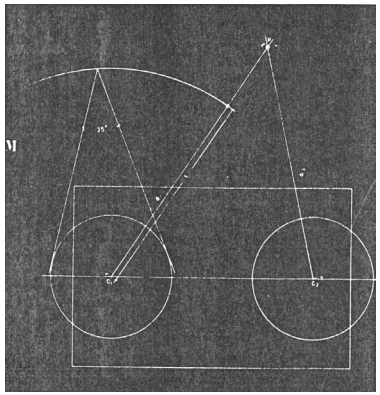
with: $k(y) = 3{,}5\, y^2 - 2{,}5\, y + 1{,}5$
$x = \rho/\rho(\theta)\,;\, y = 2\,\theta/\pi$

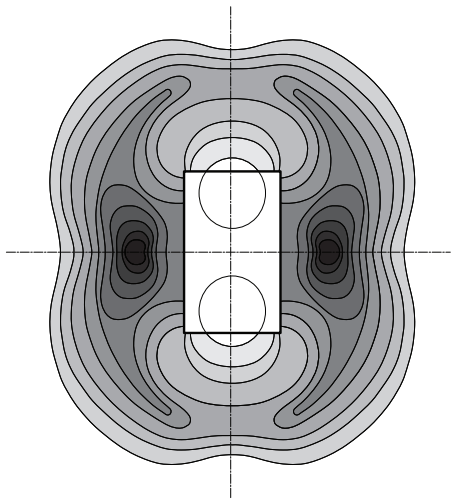


research: the "equivisibility"

SOCCER STADIUM I

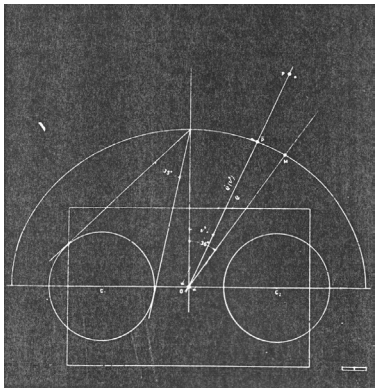
$W = d_1^{\,k}\, e^{-kd_1} + d_2^{\,k}\, e^{-kd_2}$
with: $k = 10$

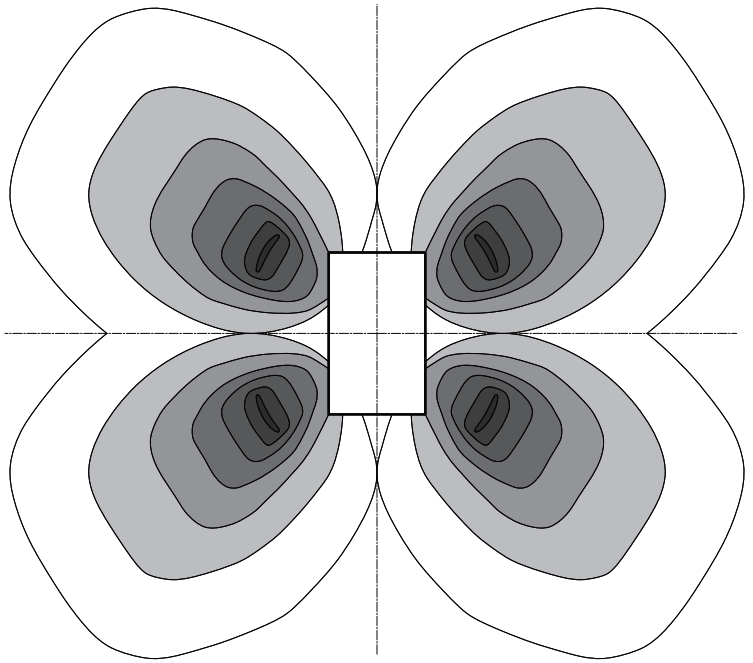




SOCCER STADIUM II

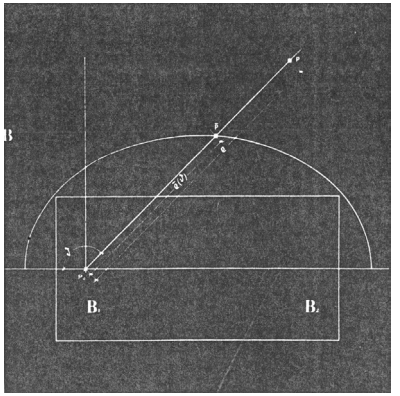
$W = x^{k(y)}\, e^{-k(y)x}$
with: $k(y) = 3{,}5\, y^2 - 2{,}5\, y + 1{,}5$
$x = \rho/\rho(\theta)\,;\; y = 2\,\theta/\pi$

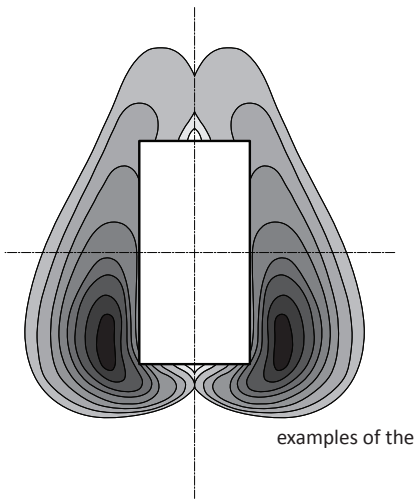




AQUATIC CENTRE

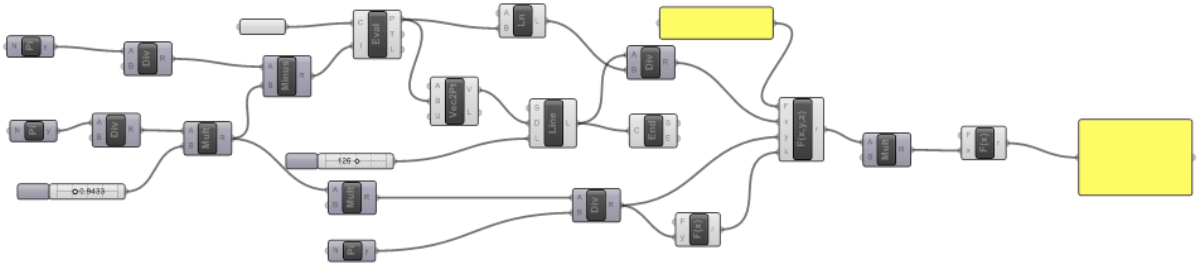
$W = e^{y(1-y)\,-\,k(y)\,(x-\log x)}$
with: $k(y) = 4\, y^2 - 4\, y + 2$
$x = \rho/\rho(\theta)\,;\; y = \theta/\pi$



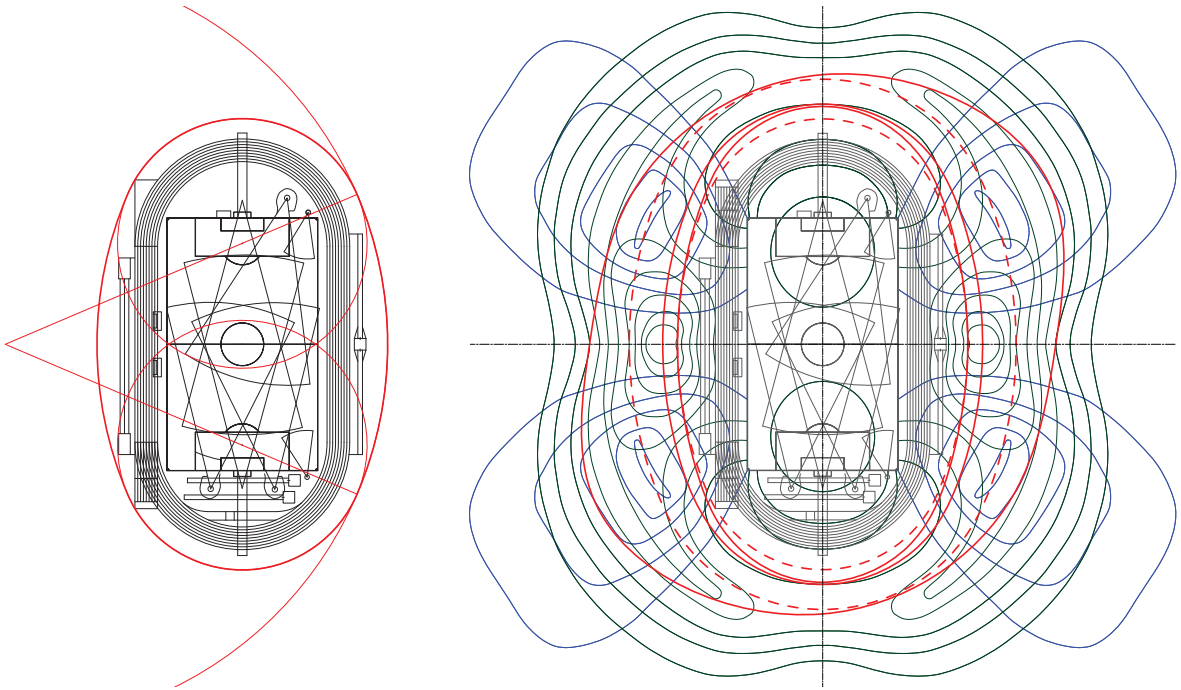


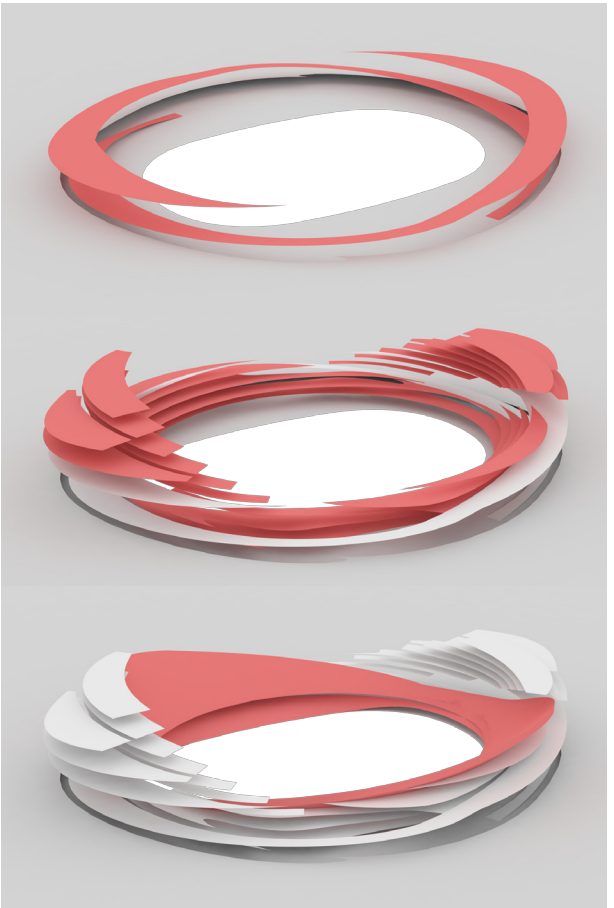
examples of the “equivisibility”

research: the “equivisibility”

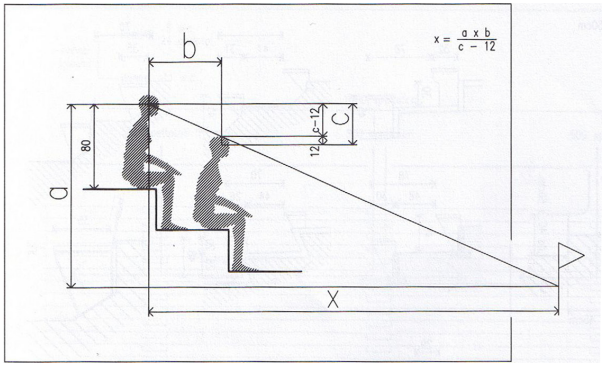


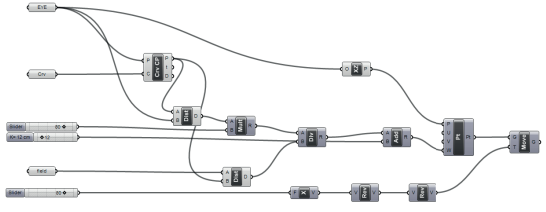
“equivisibility”parameteric system



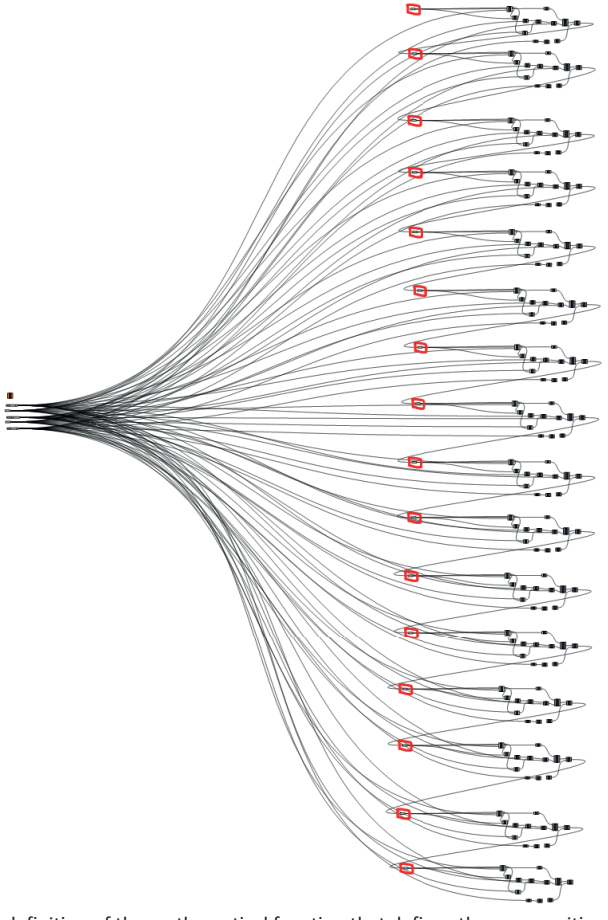


diagrams of the “adaptation” of the tribune considering the “equivisibility”parameter system





tribune definition



parametric definition of the mathematical function that defines the eyes position

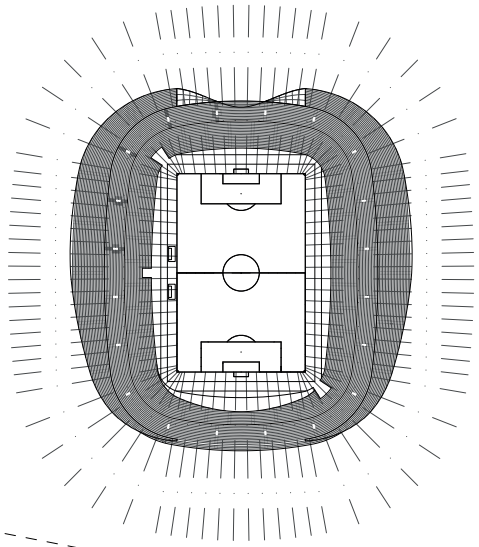
About the capacity of a stadium, the FIFA expresses the folowing words: “A club which normally attracts an attendance of around 20.000 and is thinking of building a new stadium with a capacity of 30.000 might find it preferable to think in terms of nearer 40.000. The capacity of each stadium will depend on whatever is required locally but if developers hope that the stadium will be used occasionally for major international football events, minimum capacities of 30.000 will need to be provided”.

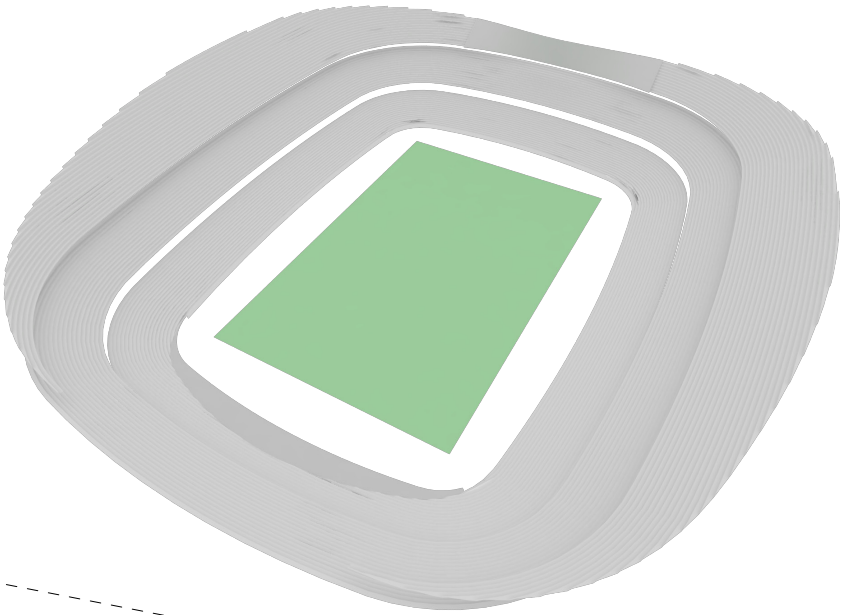
$$x = \frac{a \times b}{c - 12}$$

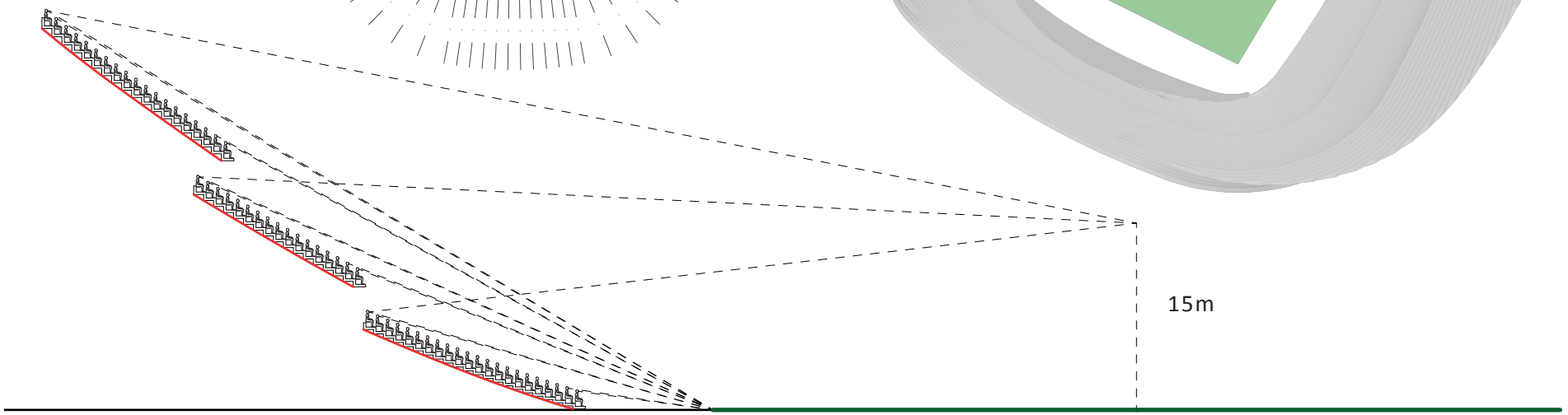
The mathematical function define the inclination and the curve of the tribune in section. It consents a correct visibility on the pitch for all the spectators from any position.

Another problem about the limitation of visibility is given by the standing above tier of seats; the international regulation in this specific case says that the spectator in the last row of the lower tier must be able to see the ball till a hight of 15 meters on the vertical line positioned at the center of the pitch.

capacity: 35.000







tribune diagrams

parameters

1. solar panels

Due the big amount of energy required, an energy efficient system is given; the larg solar powered roof could potentially generate more than 1 gigawatt hours of electricity every year.

2. natural grass turf

The playing field made of natural grass answers in the best way to the characteristic of the football game, but as a living plant, natural grass needs directed sun light.

3. transparent roof

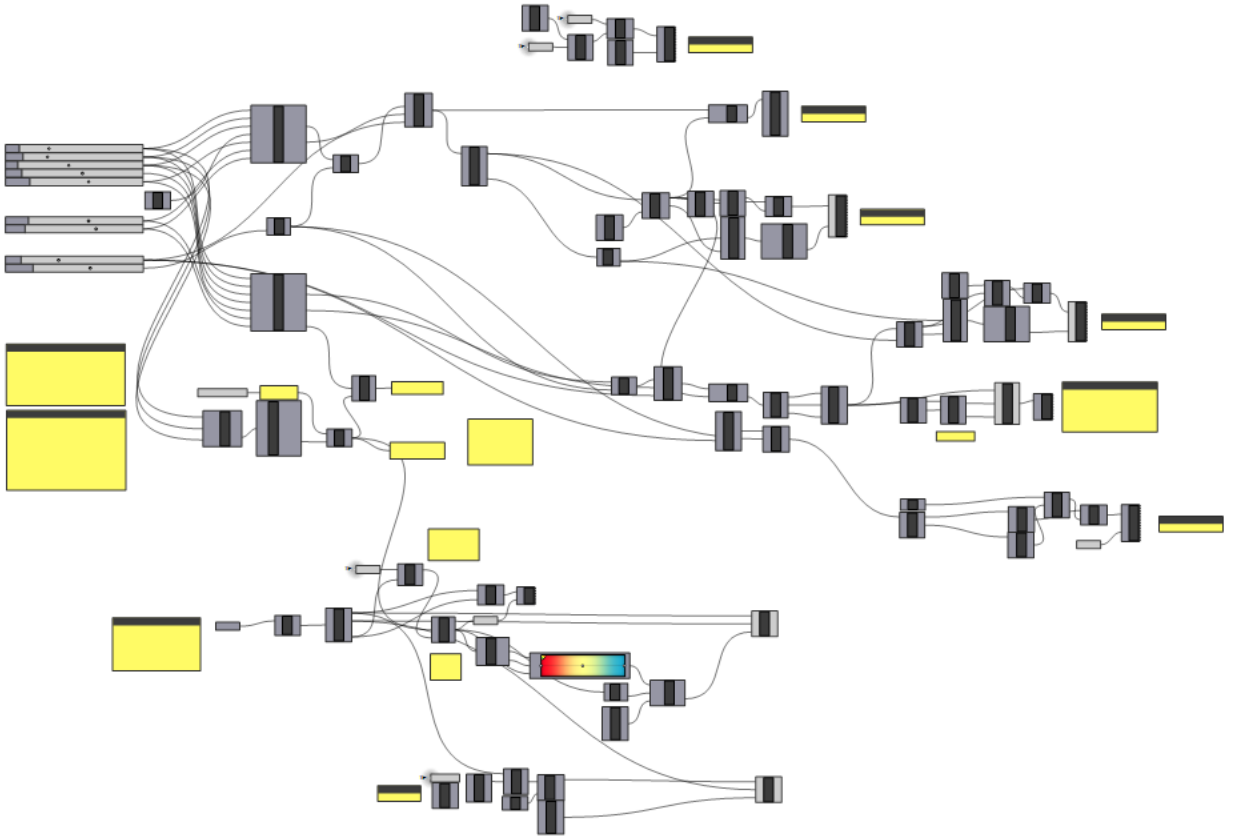
As the FIFA (Fédération Internationale de Football Association) asks, a modern stadium should avoid, at the same time, the shadow and direct sun light on the pitch during the match.

4. mistral wind

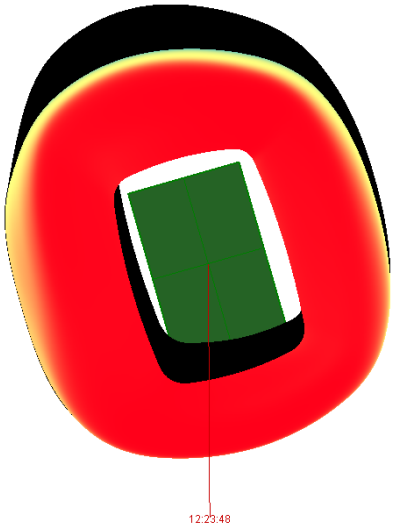
In the region of Sardinia the mistral wind can reach speeds of more than ninety kilometers an hour, creating inconvenience to the game and discomfort to the spectators

skin and roof

tools

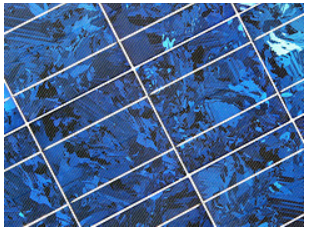


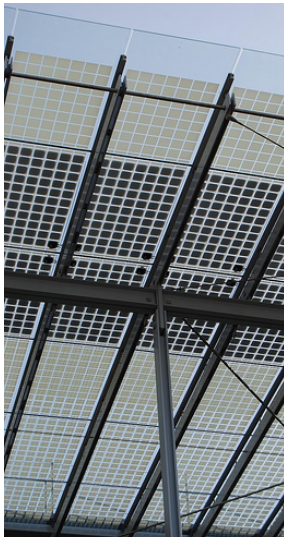
parametric definition tool



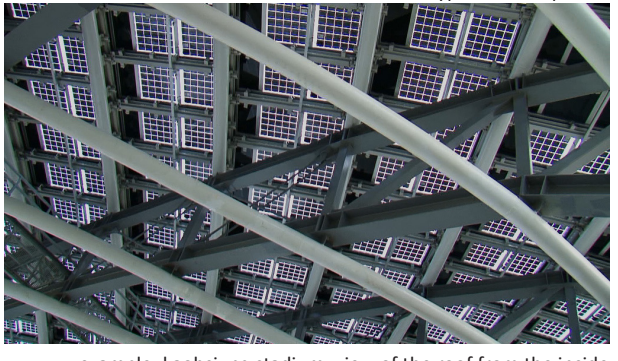
parametric definition output

1. solar panels





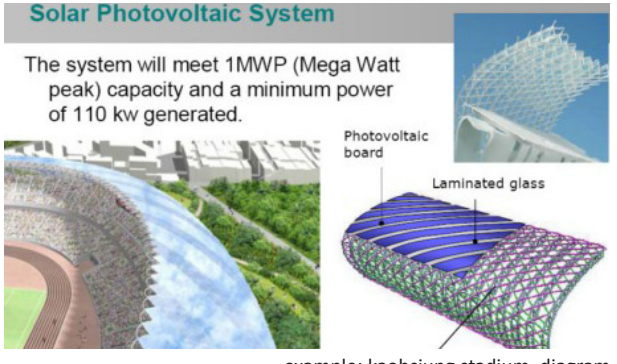
different types of solar panels



example: kaohsiung stadium, view of the roof from the inside

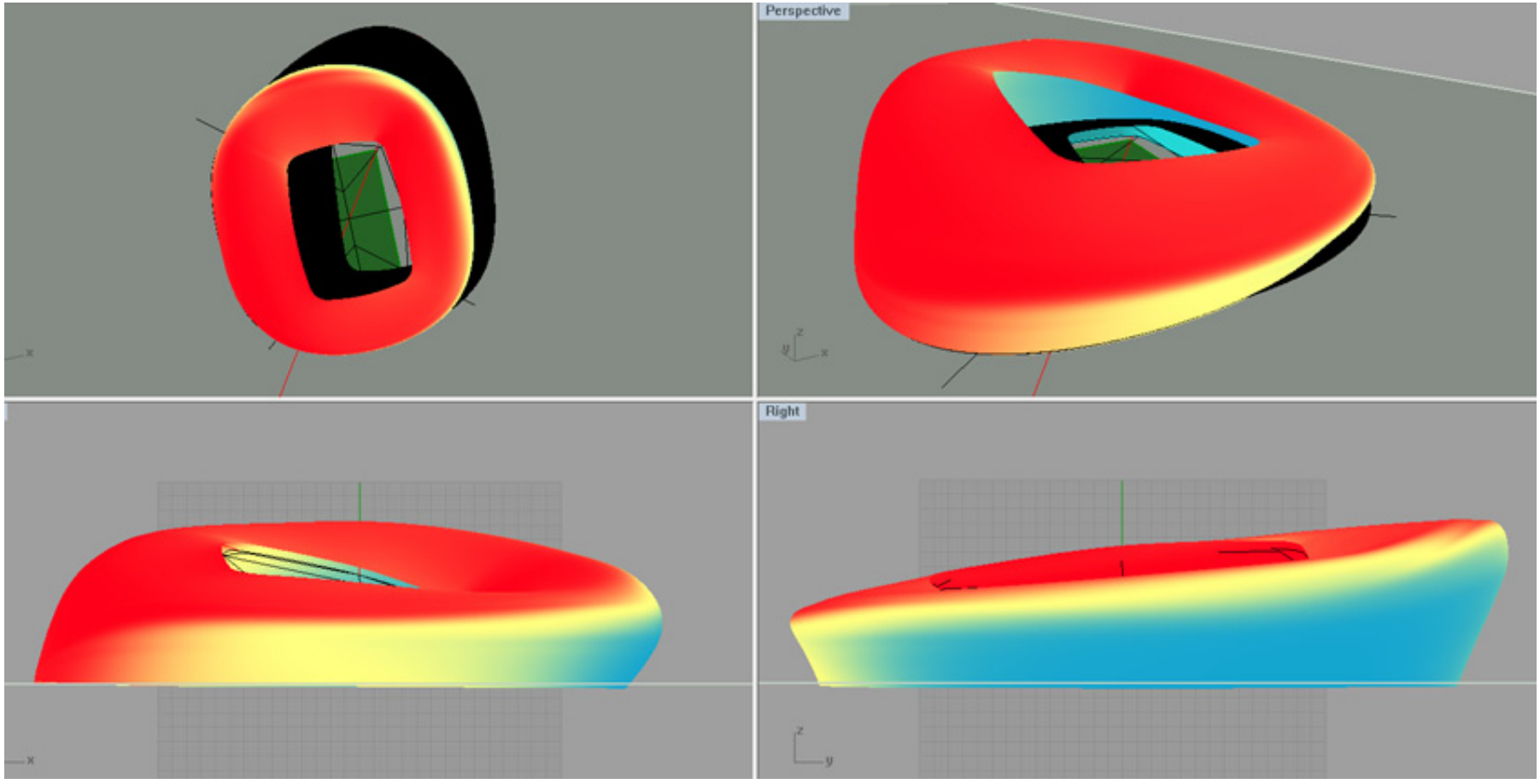
Due the big amount of energy requirement, an efficient system for investors and for the city is given; the larg solar powered roof could potentially generate more than 1 mega watt of electricity every year, enough not only for the energy needs of the stadium, but also to meet the annual requirements of around four hundred families.

The efficiency of a solar photovoltaic system is based on the angle of incidence of the sun with the singolar panel. To permit the roof to meet the peak of produced energy during the match (between 3pm and 5pm), a parametric system is used; it allows with a range of colours to control the incidence of the sun with the panels at a specific time, in a specific place.



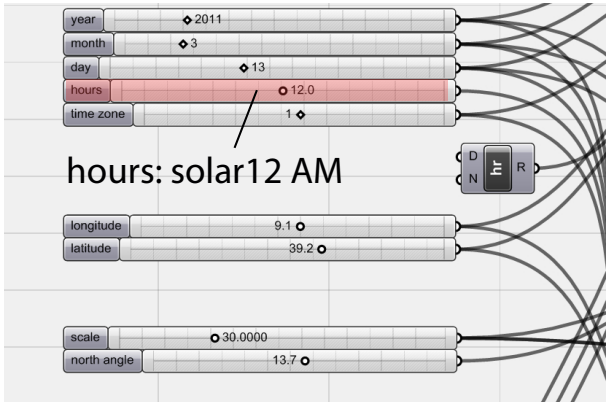
example: kaohsiung stadium, diagram

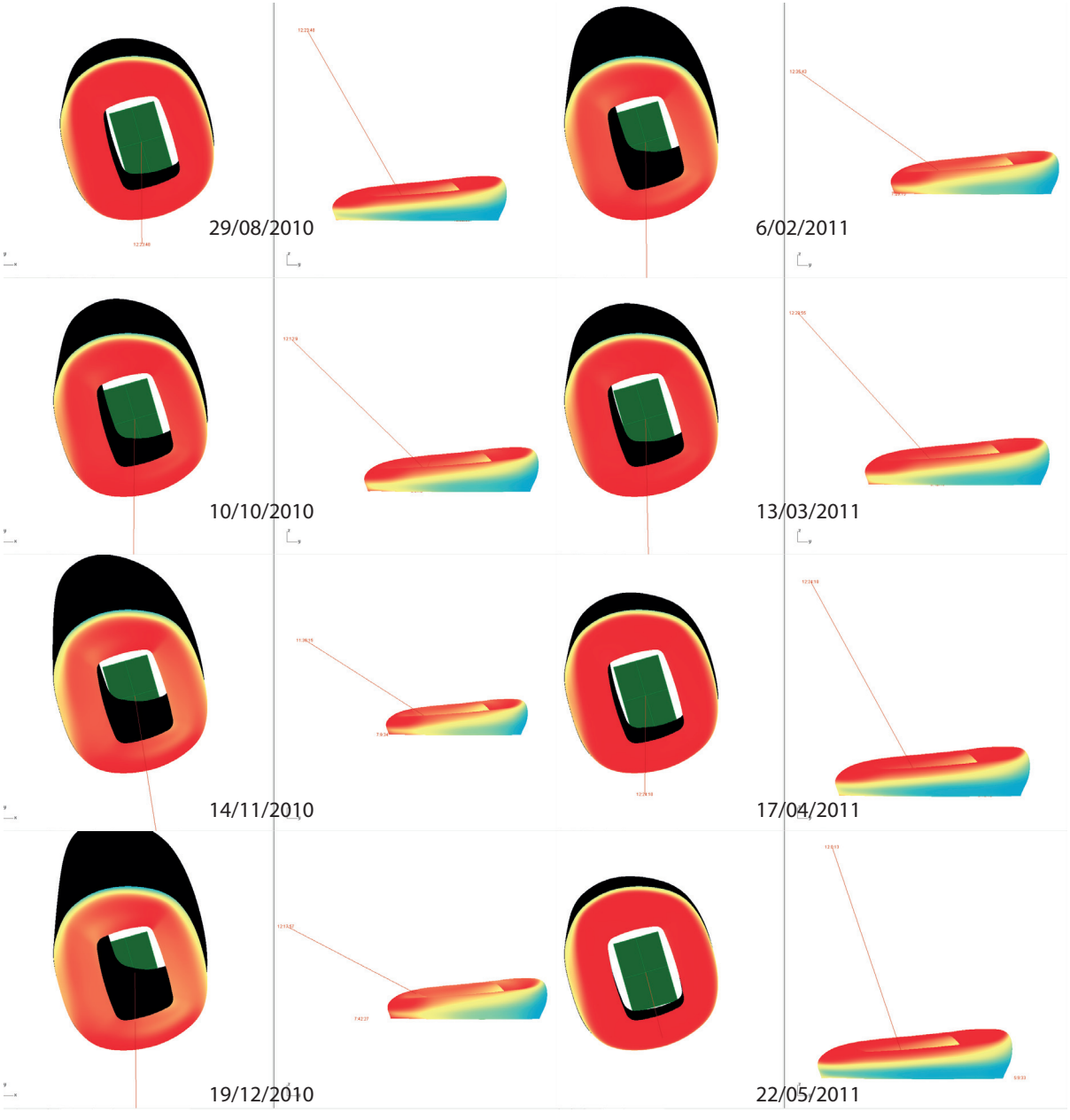
skin and roof



sun incidence/shape study

2. natural grass turf





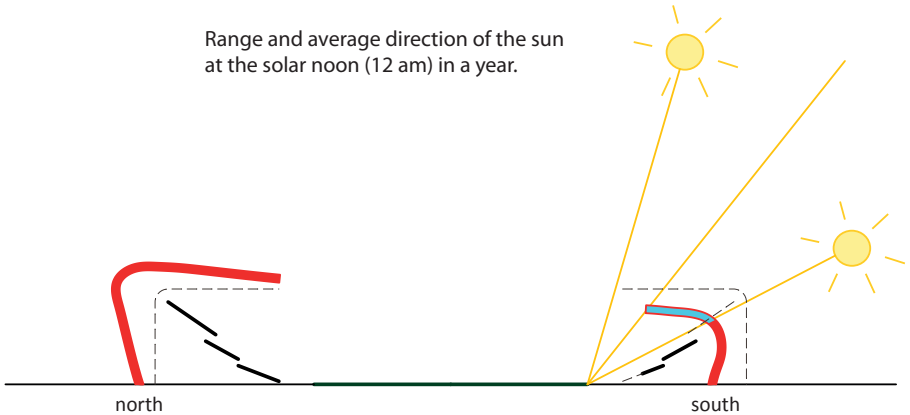
skin and roof

The playing field made of natural grass answers in the best way to the characteristic of the football game, but as a living plant, natural grass needs directed sun light.

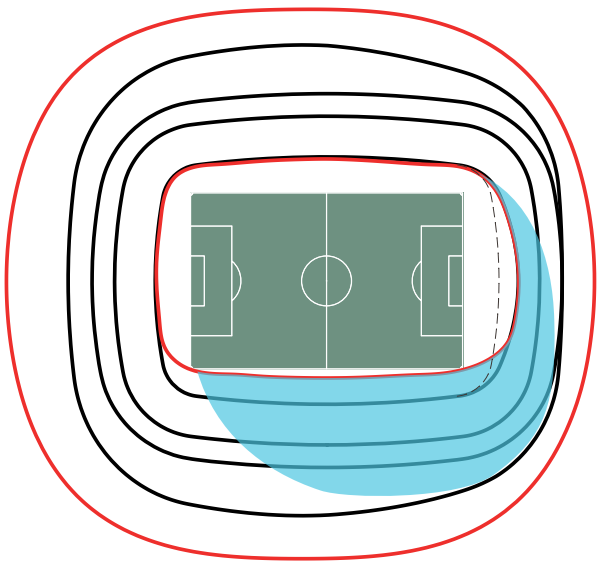
To allow as much as possible the pitch to be under directed sun light, the south section of the stadium has been reduced in its height and lenght.

The not covered part of the tribune (cause of the reducing of lenght of the roof), will be used as a club-refectory at the level of the pitch for the players and for “special fans”.

Range and average direction of the sun at the solar noon (12 am) in a year.



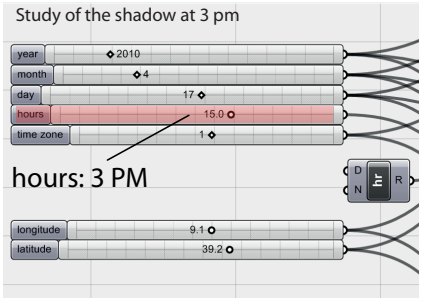
Transparent part of the roof

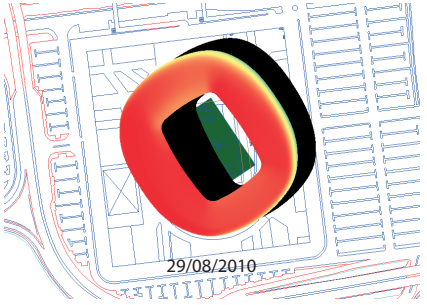


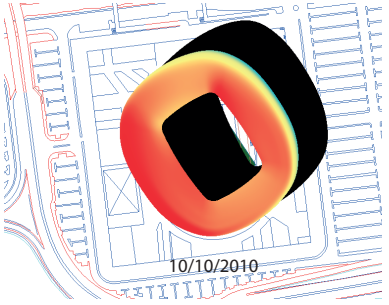
3. transparent roof

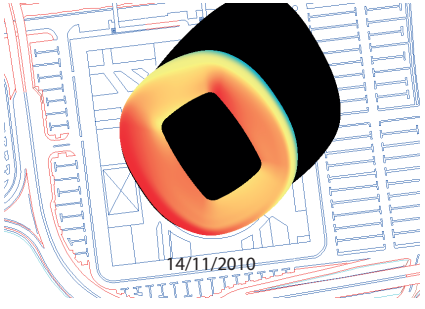
CALENDARIO SERIE A CALCIO CAMPIONATO 2010/2011

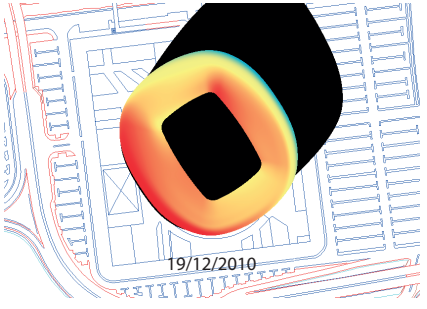
1. 29 / 08 / 2010
2. 12 / 09 / 2010
3. 19 / 09 / 2010
4. 22 / 09 / 2010
5. 26 / 09 / 2010
6. 03 / 10 / 2010
7. 07 / 10 / 2010
8. 24 /10 / 2010
9. 31 / 10 / 2010
10. 07 /11 / 2010
11. 10 /11 / 2010
12. 14 / 11 / 2010
13. 21 / 11 / 2010
14. 28 / 11 / 2010
15. 05 / 12 / 2010
16. 12 / 12 / 2010
17. 19 / 12 / 2010
18. 06 / 01 / 2011
19. 09 / 01 / 2011
20. 16 / 01 / 2011
21. 23 / 01 / 2011
22. 30 / 01 / 2011
23. 02 / 02 / 2011
24. 06 / 02 / 2011
25. 13 / 02 / 2011
26. 20 / 02 / 2011
27. 27 / 02 / 2011
28. 06 / 03 / 2011
29. 13 / 03 / 2011
30. 20 / 03 / 2011
31. 03 / 04 /2011
32. 10 / 04 / 2011
33. 17 / 04 / 2011
34. 23 / 04 / 2011
35. 01 / 05 / 2011
36. 08 / 05 / 2011
37. 15 / 05 / 2011
38. 22 / 05 / 2011

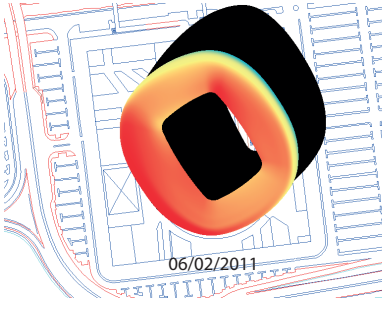


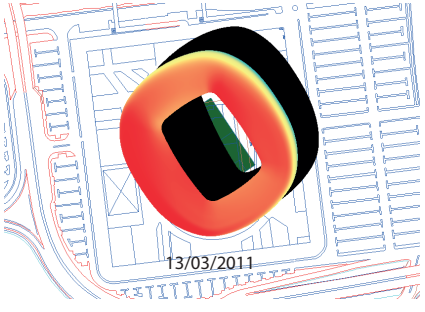


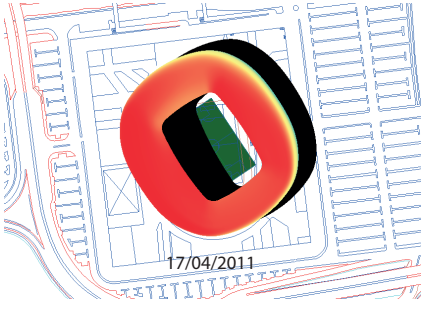


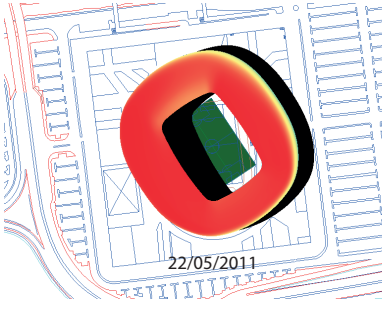






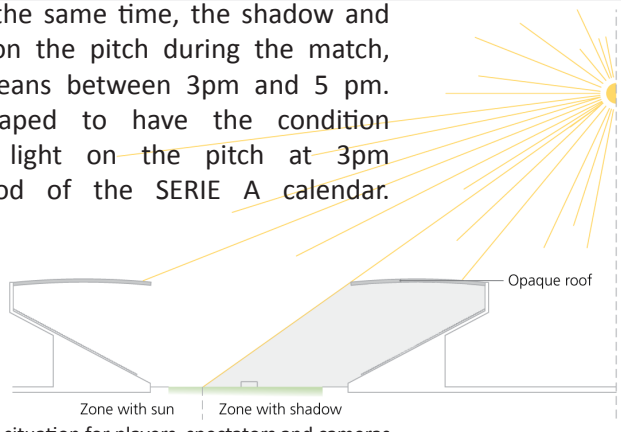




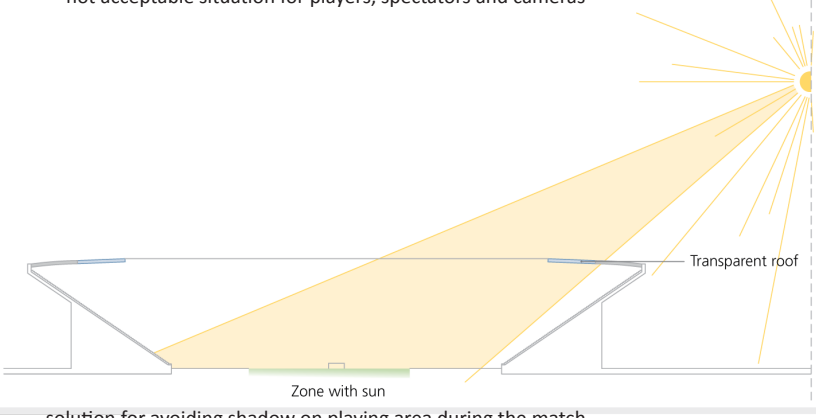


skin and roof

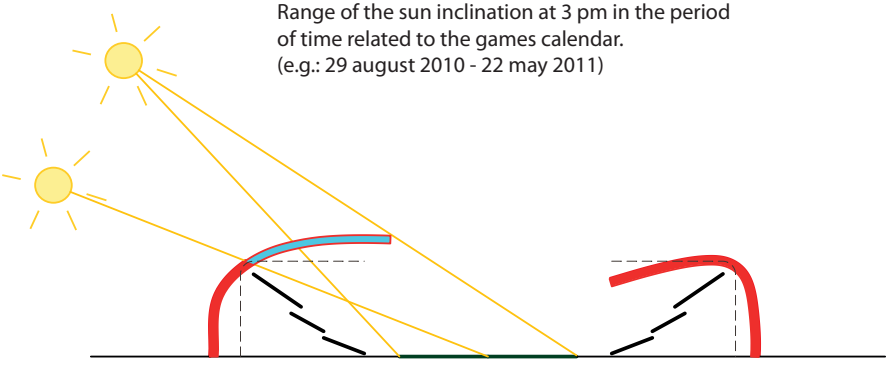
As the FIFA (Fédération Internationale de Football Association) asks, a modern stadium should avoid, at the same time, the shadow and direct sun light on the pitch during the match, which in italy means between 3pm and 5 pm. The roof is shaped to have the condition of filtered sun light on the pitch at 3pm during the period of the SERIE A calendar.



not acceptable situation for players, spectators and cameras



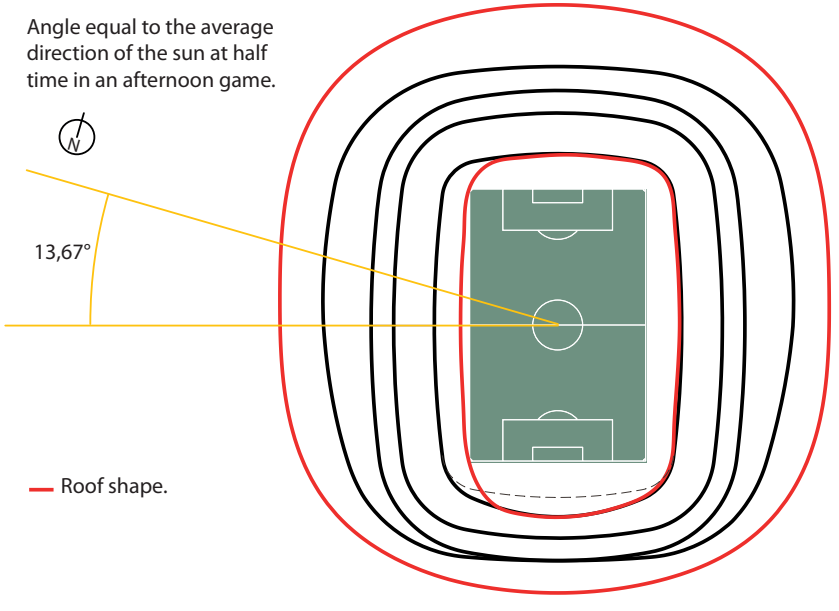
solution for avoiding shadow on playing area during the match



Range of the sun inclination at 3 pm in the period of time related to the games calendar.
(e.g.: 29 august 2010 - 22 may 2011)

Playing field orientation.

Angle equal to the average direction of the sun at half time in an afternoon game.



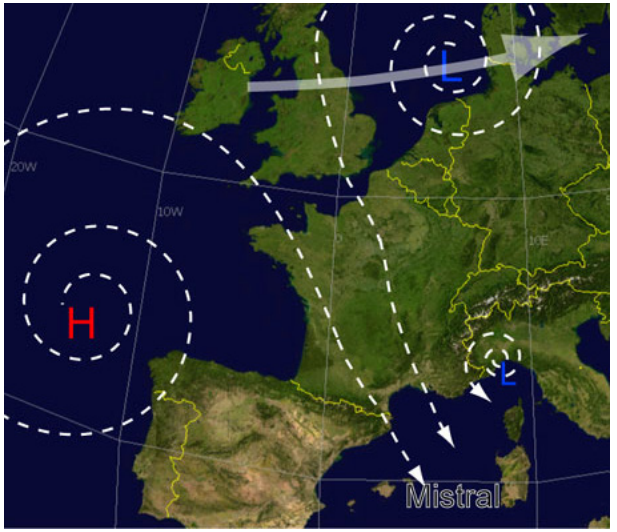
— Roof shape.

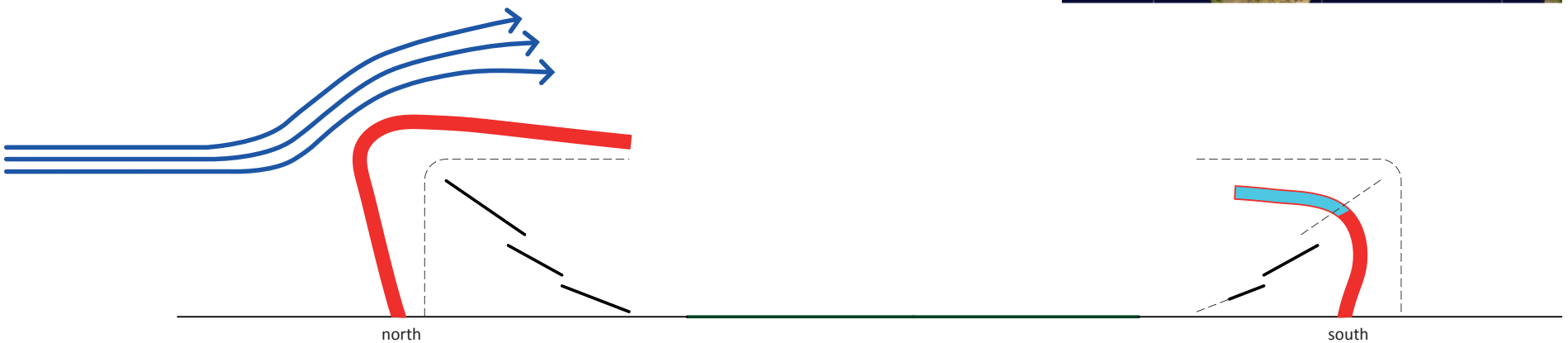
4. mistral wind

skin and roof

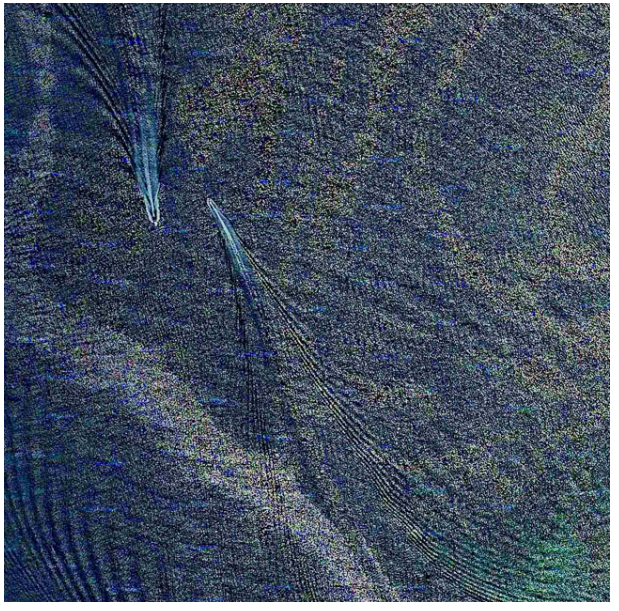
In the region of Sardinia the mistral wind, comeing from the north or northwest, can reach speeds of more than ninety kilometers an hour, creating inconvenience to the game and discomfort to the spectators.

To avoid the interference of the wind, the north side of the stadium will be higher, protecting the spectators and the players.

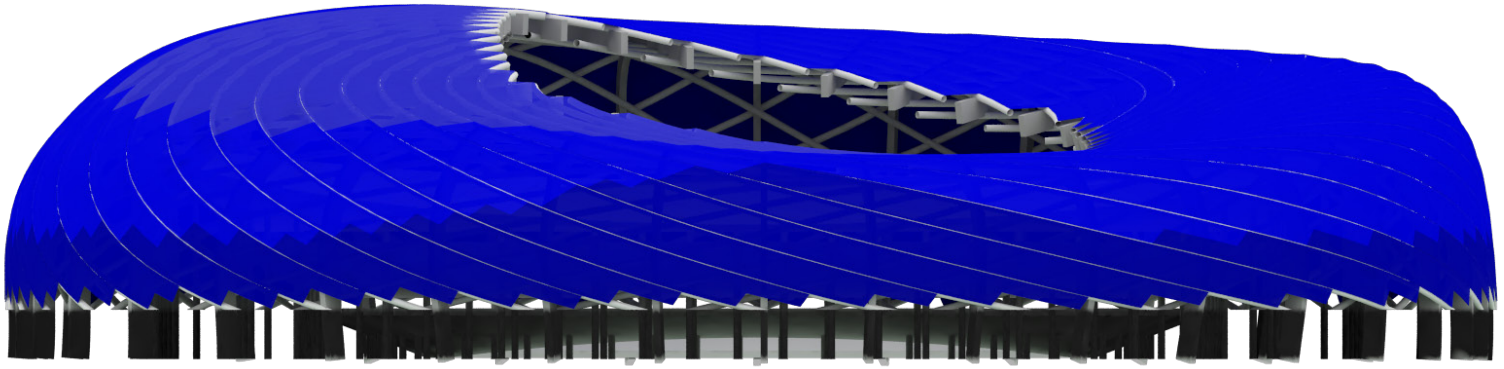




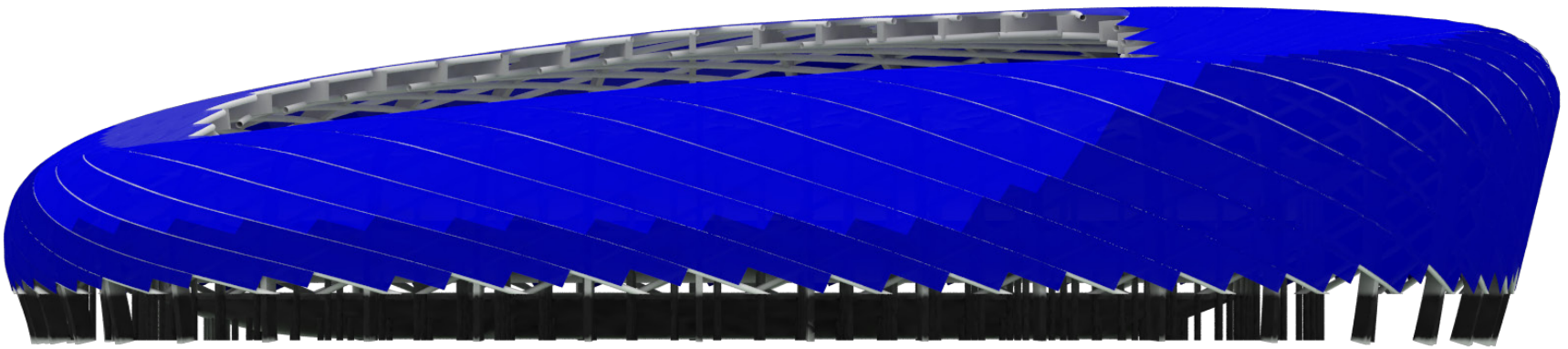
design



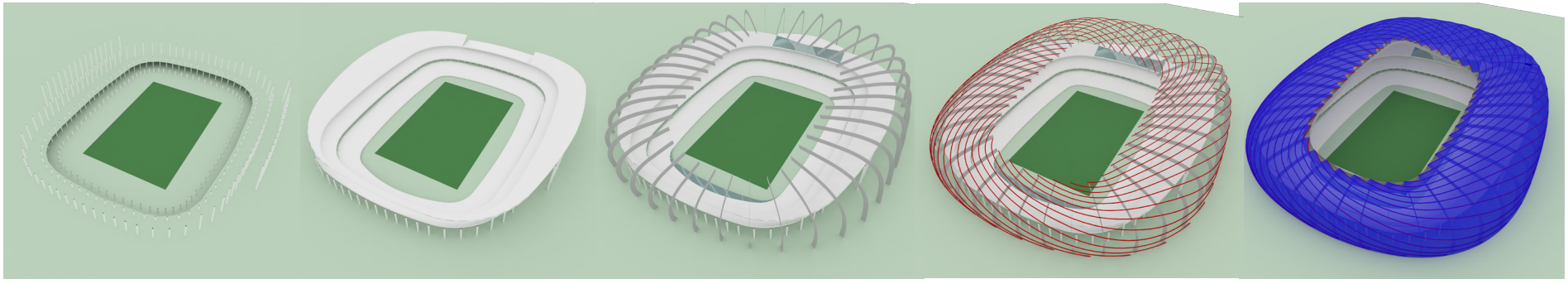
Considering the nearness to the sea, and the blue color of the solar panels, the idea is to create an effect similar to the waves, which changes moving around the building, due also to the different inclination of the panels and therefore the different reflection and transparency.



south facade



east facade



structure elements

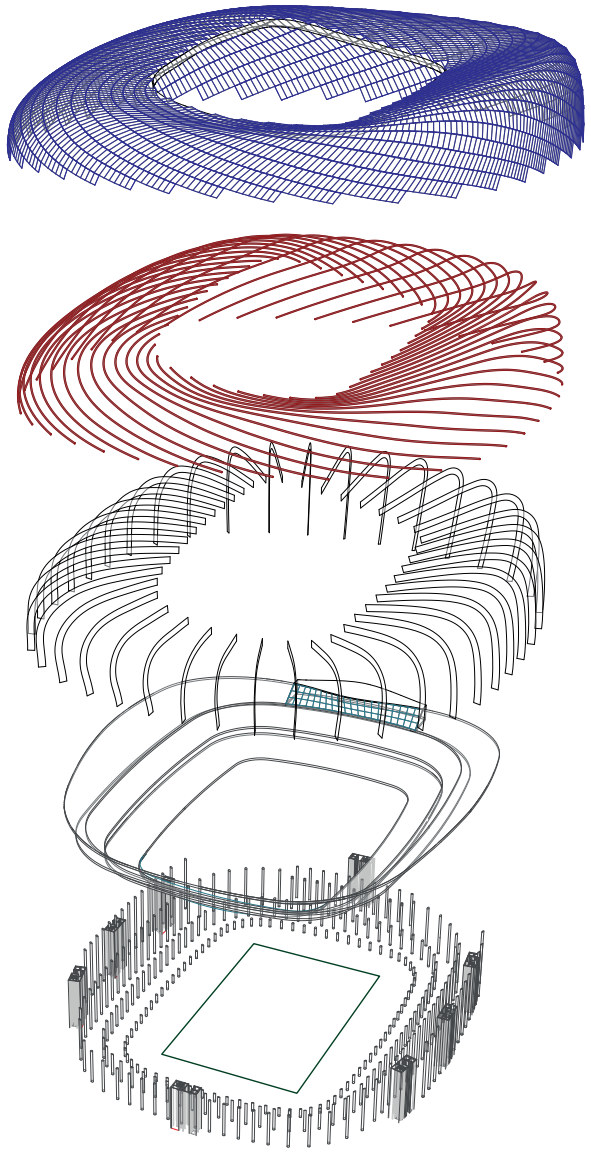
solar panels

“rails-structure” for the panels

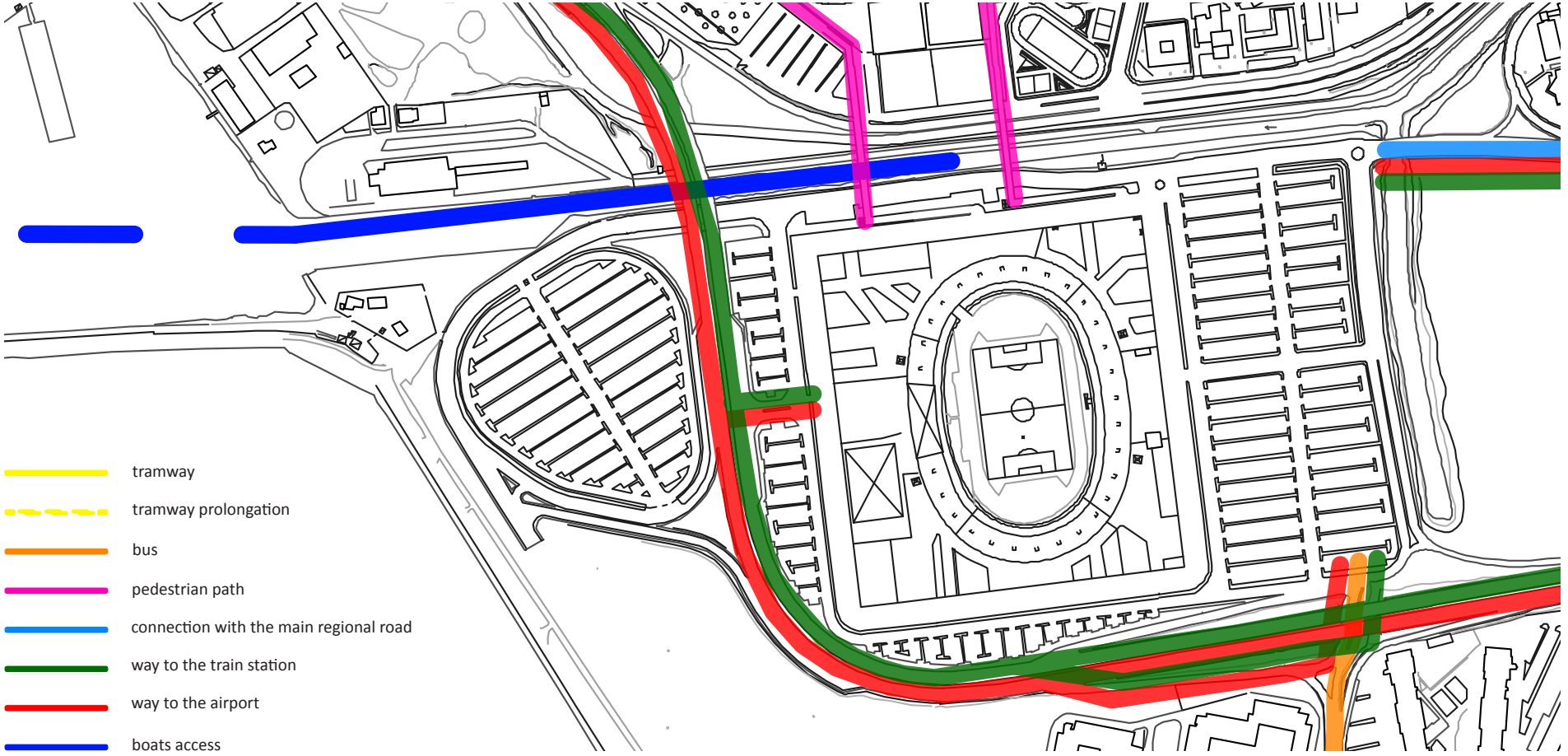
beams

tribune

columns



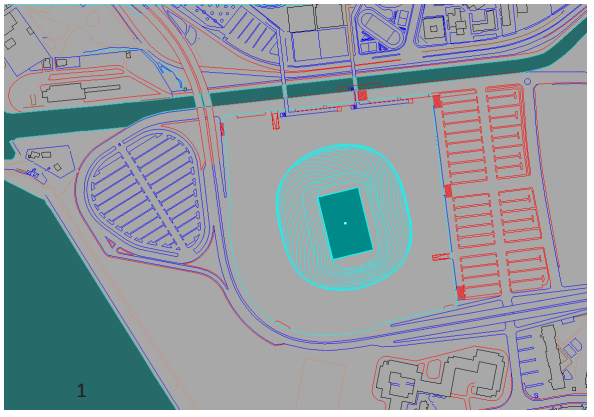
existing traffic networks

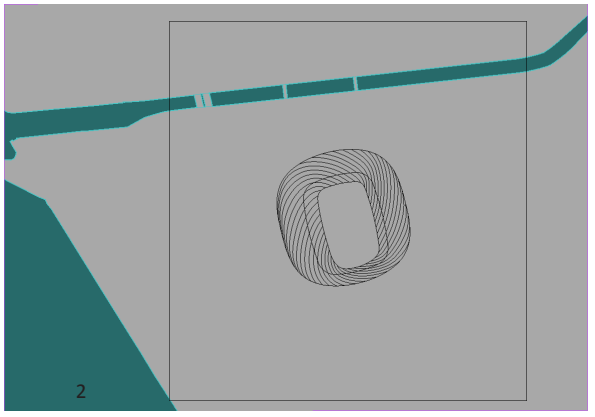

tramway
tramway prolongation
bus
pedestrian path
connection with the main regional road
way to the train station
way to the airport
boats access

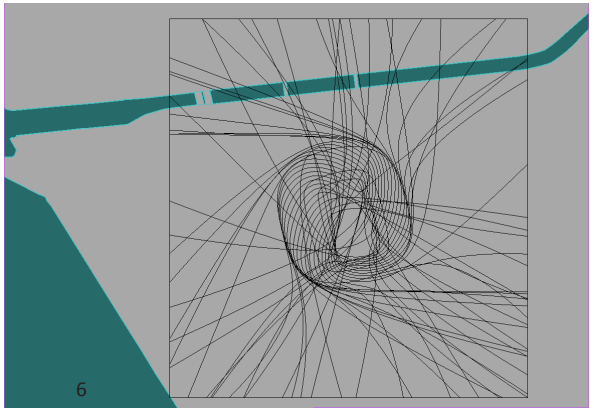
siteplan analysis

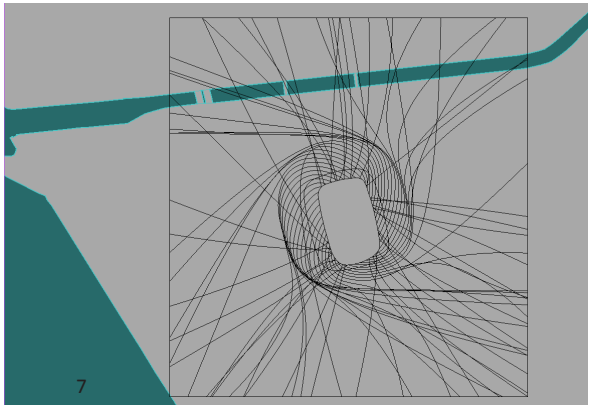
The design of the site considers the flows of the pedestrians arriving from different directiones because of the different possibility of transport.

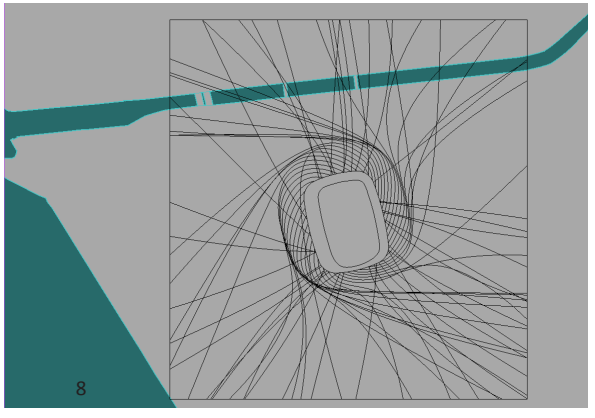
The pedestrian paths are generated starting from the curves of the skin which are the axes-lines of the structure where the panels are fixed.

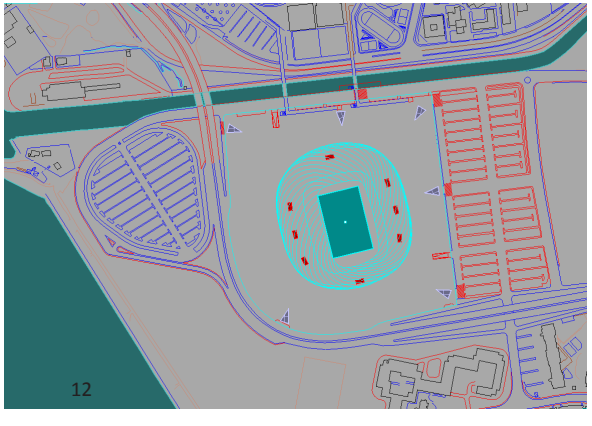


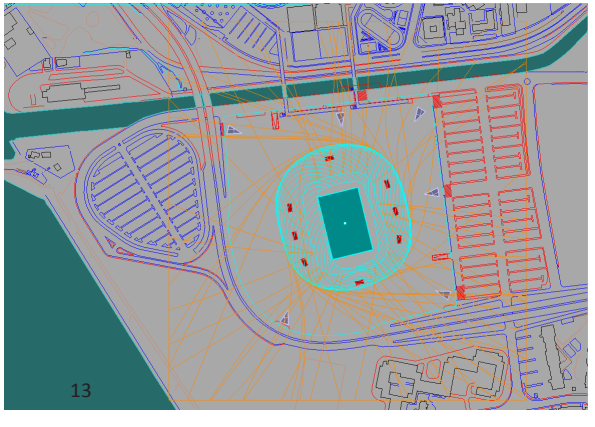


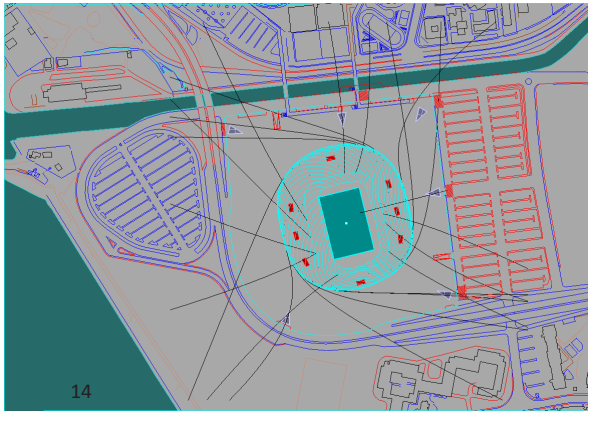


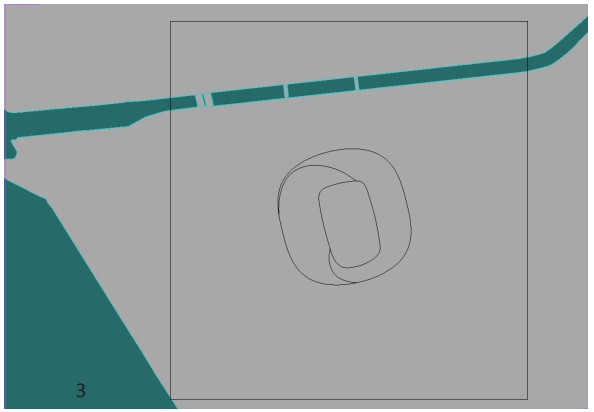








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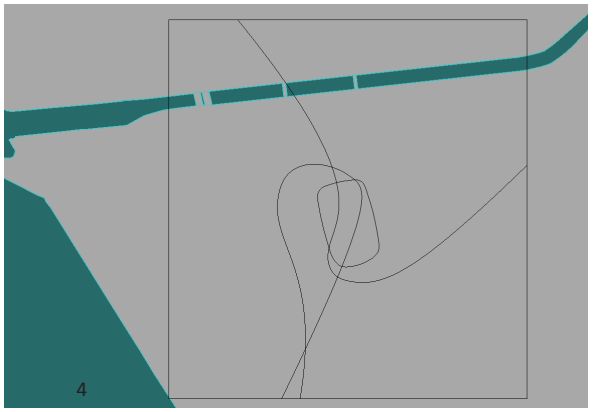
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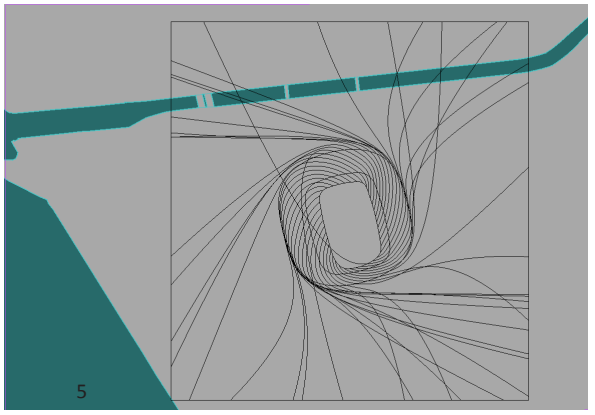
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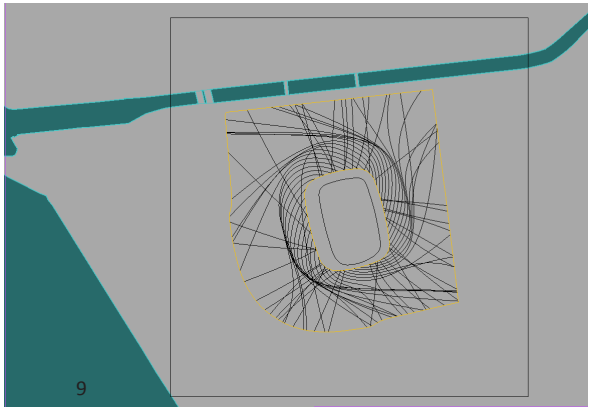
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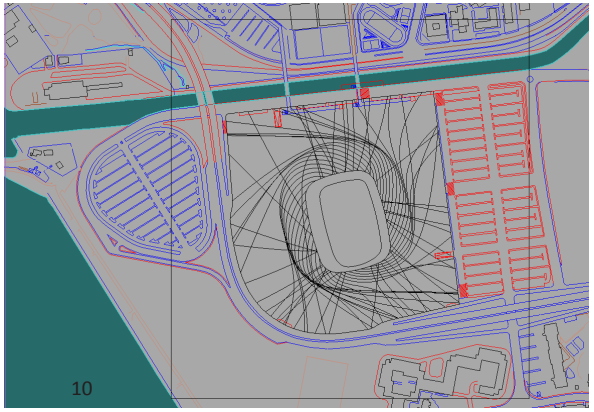
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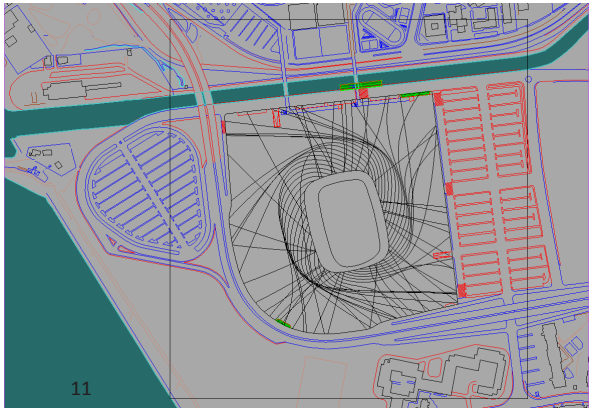
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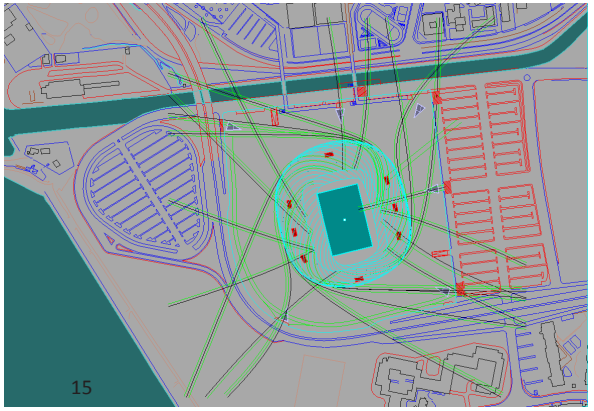
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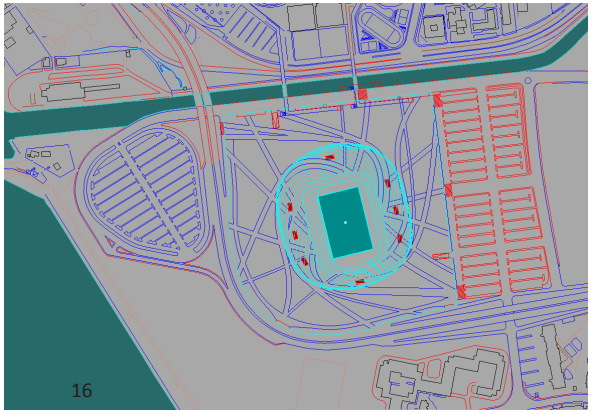
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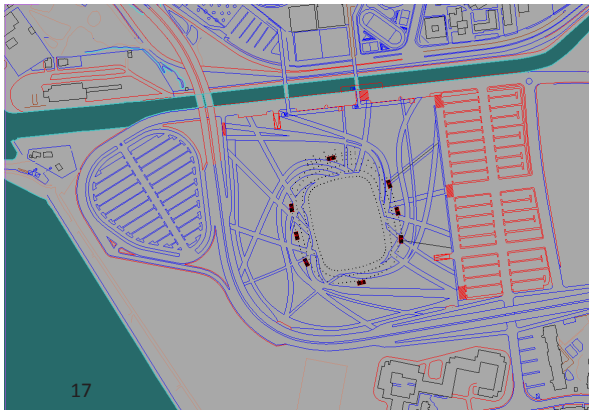
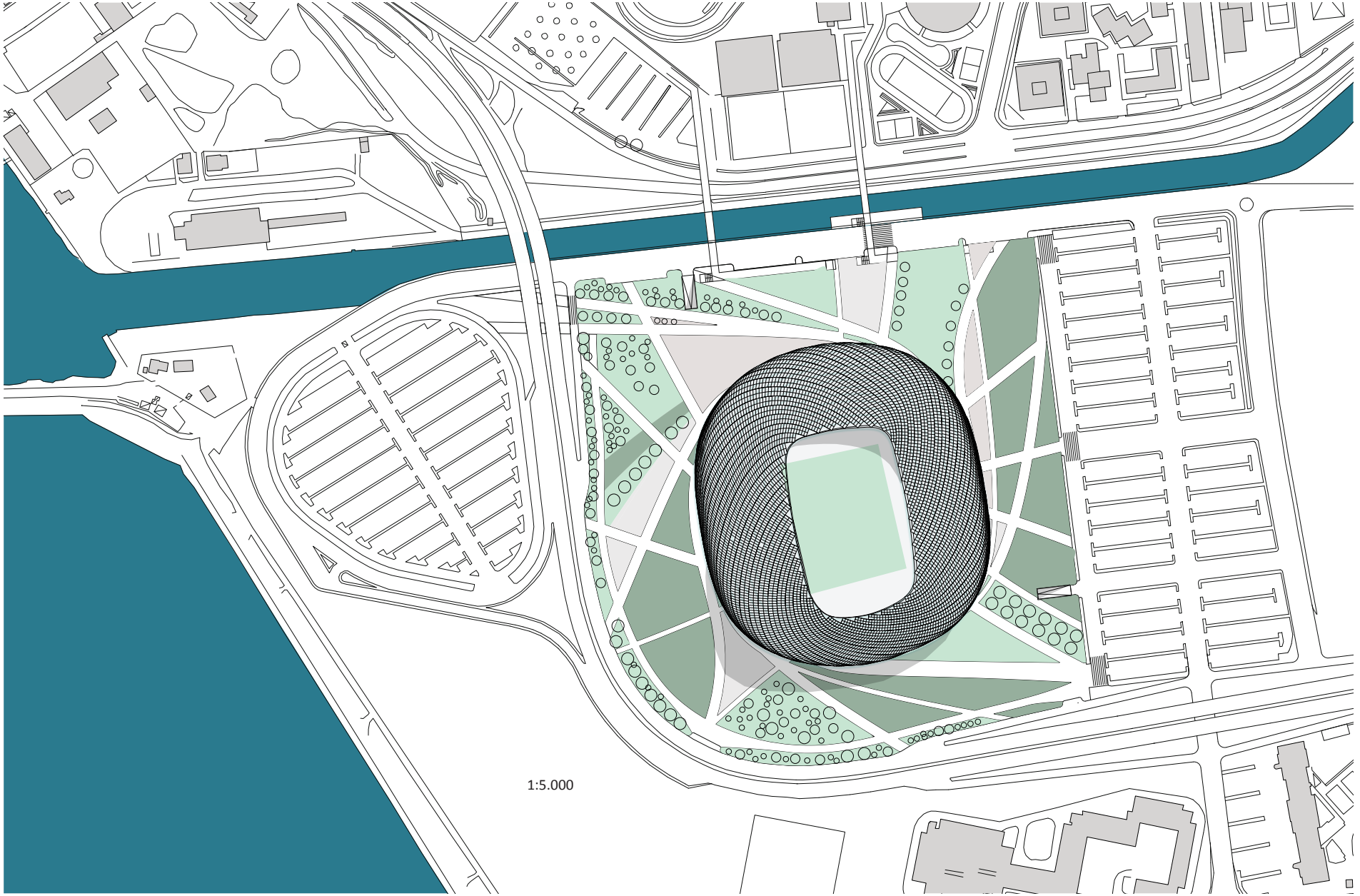

17

plan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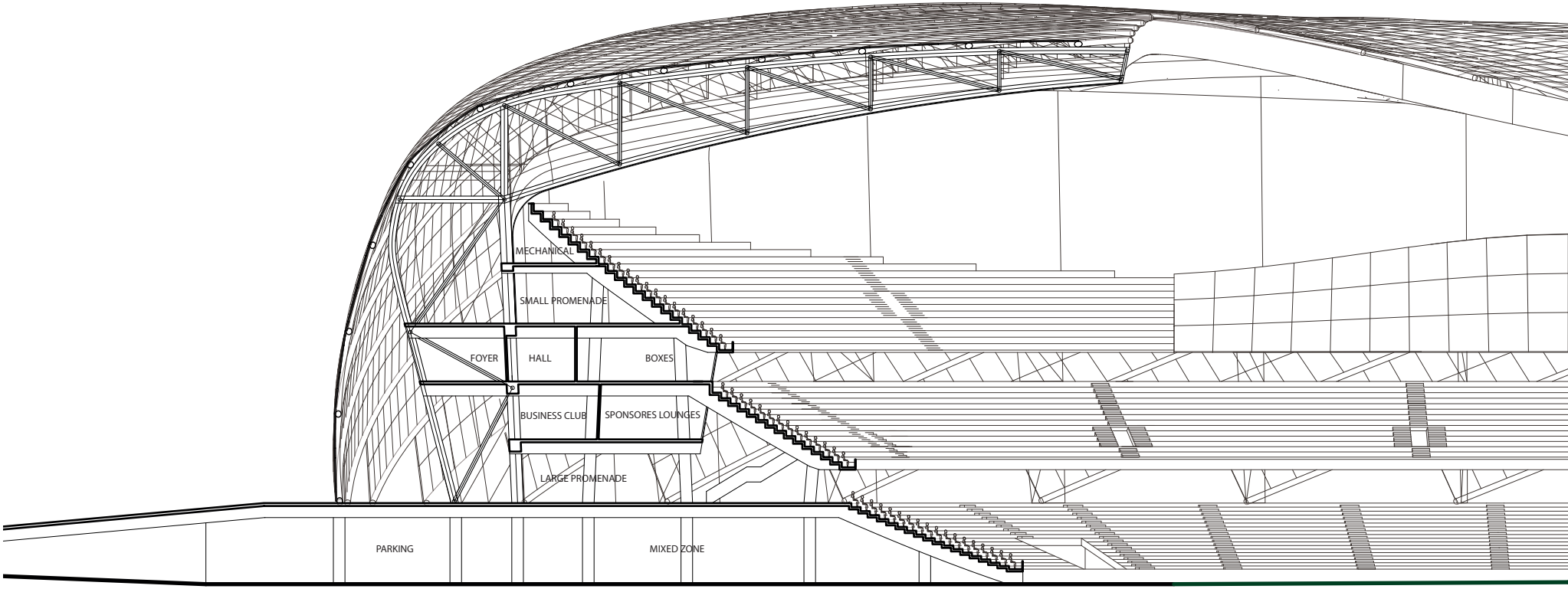
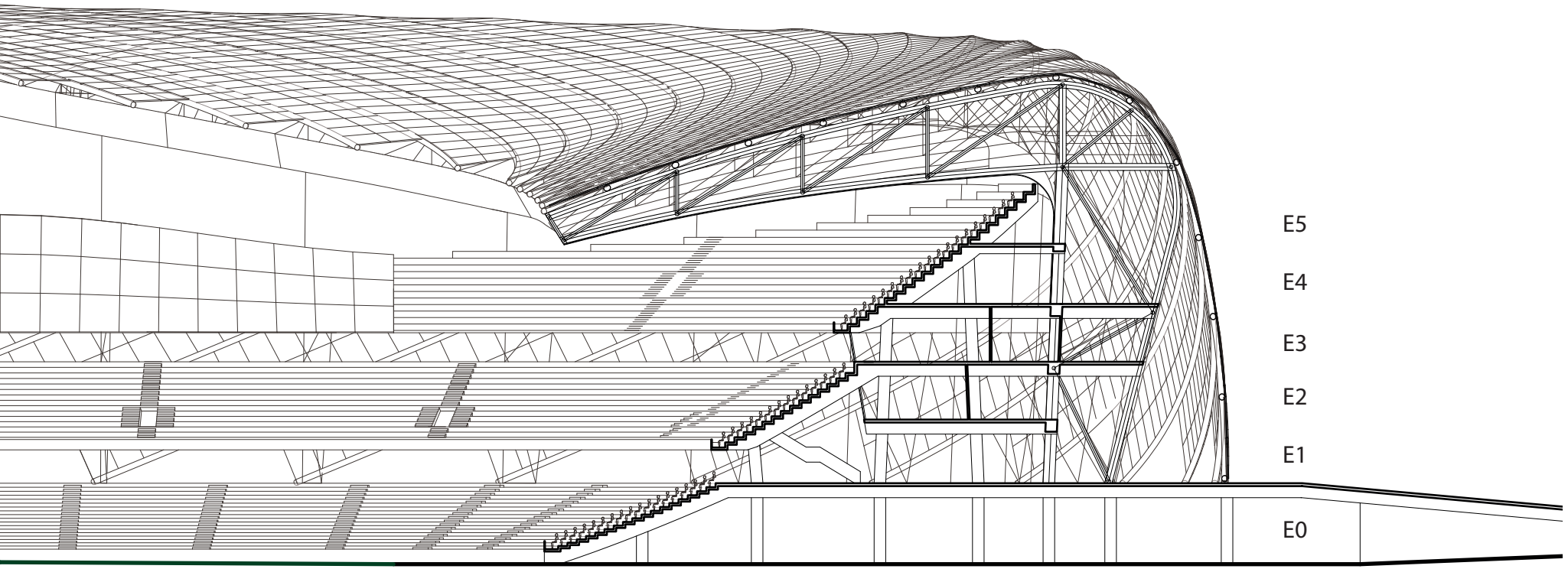

MECHANICAL
SMALL PROMENADE
FOYER
HALL
BOXES
BUSINESS CLUB
SPONSORES LOUNGES
LARGE PROMENADE
PARKING
MIXED ZONE



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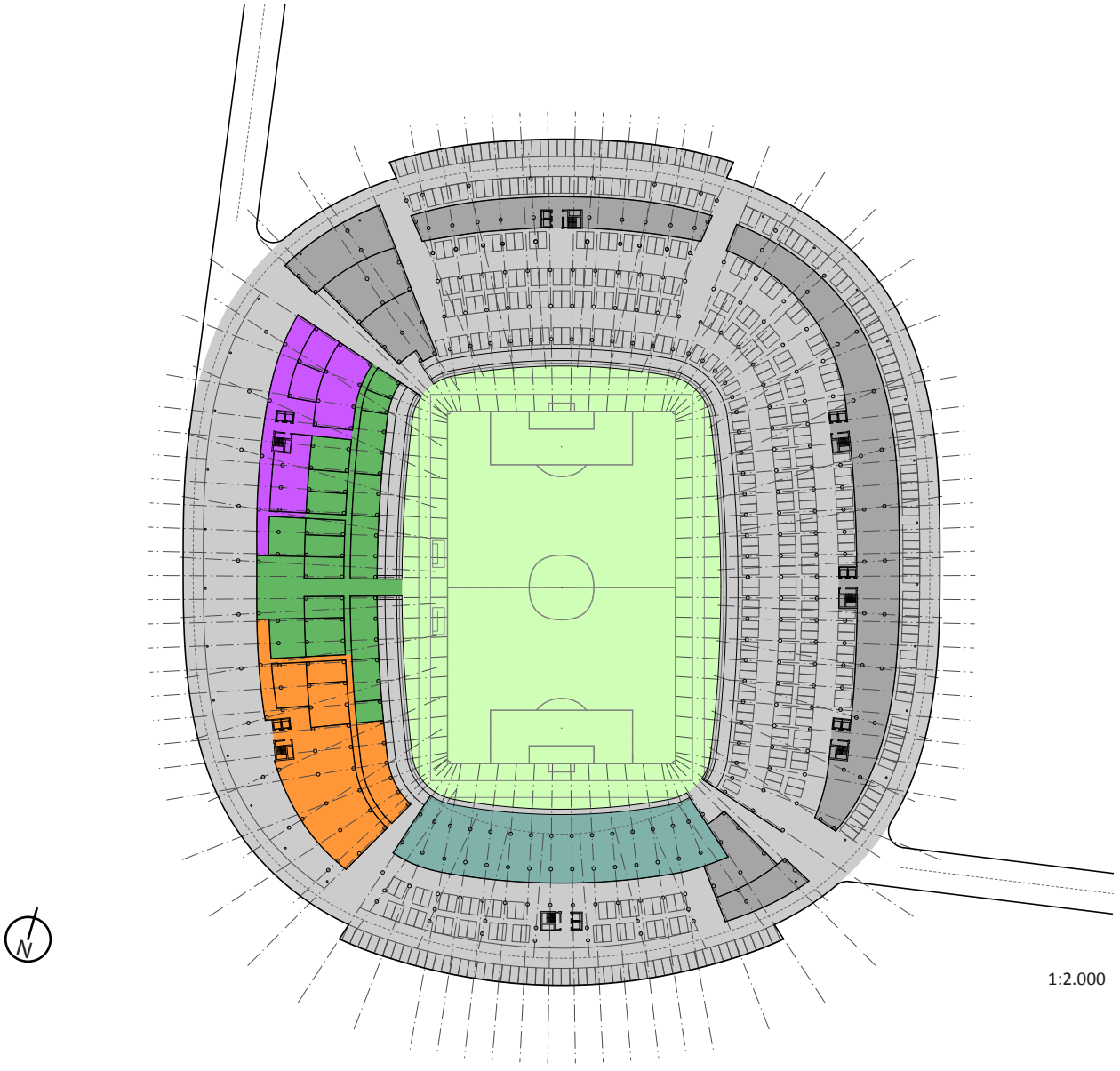
E0

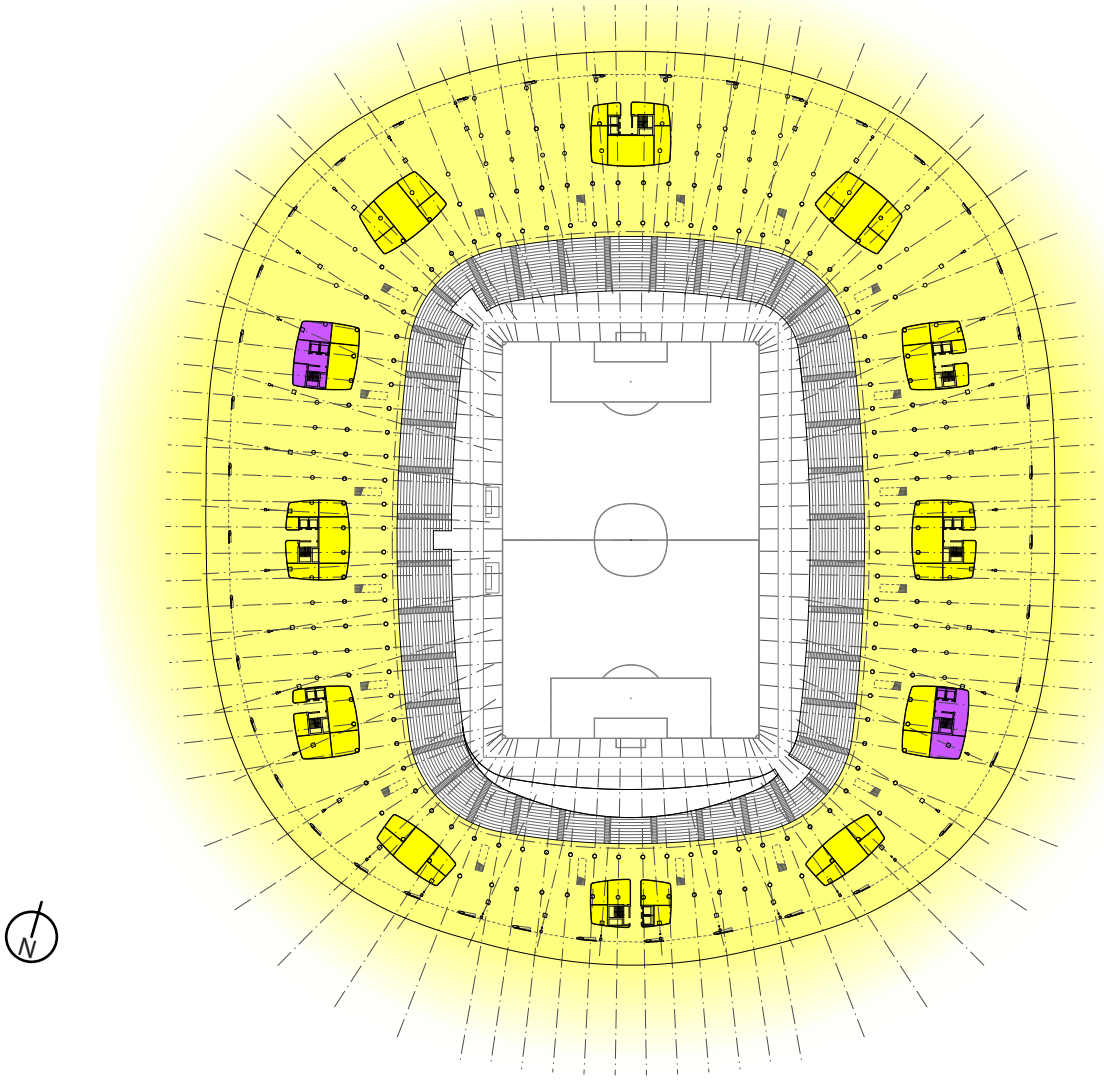
- VIP AreasBoxes
- Players zone
- Media facilities
- Catering zones, Restaurant, Club
- Esplanade, Promenade
- Kiosk, Fan shop
- Parking
- Mechanical, Security



1:2.000

E1

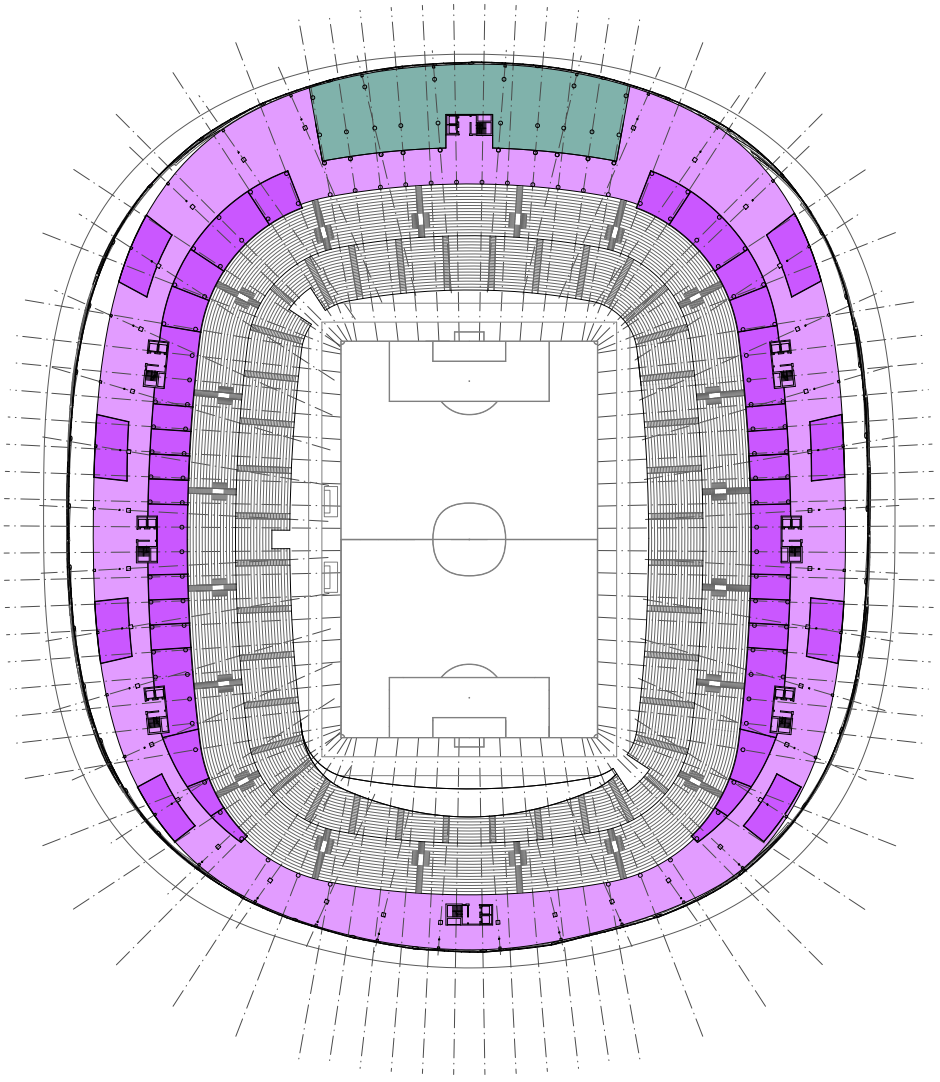
- VIP AreasBoxes
- Players zone
- Media facilities
- Catering zones, Restaurant, Club
- Esplanade, Promenade
- Kiosk, Fan shop
- Parking
- Mechanical, Security



1:2.000

E3

- VIP AreasBoxes
- Players zone
- Media facilities
- Catering zones, Restaurant, Club
- Esplanade, Promenade
- Kiosk, Fan shop
- Parking
- Mechanical, Security



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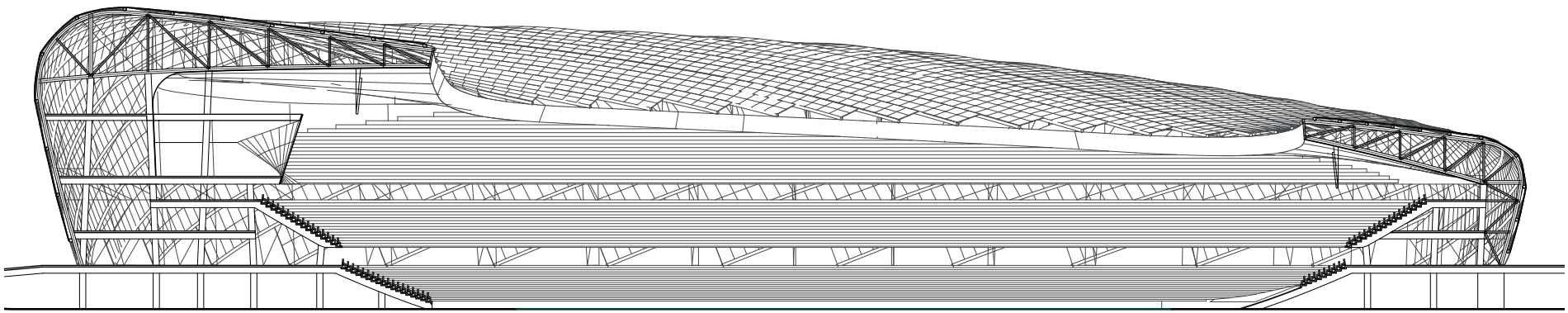

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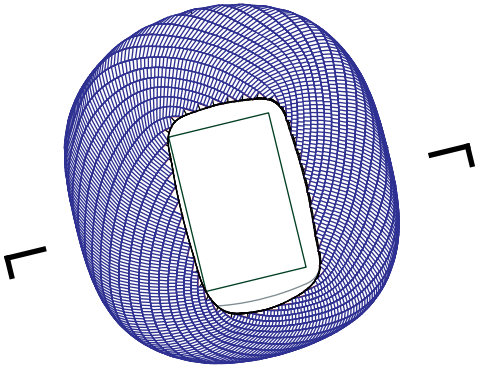

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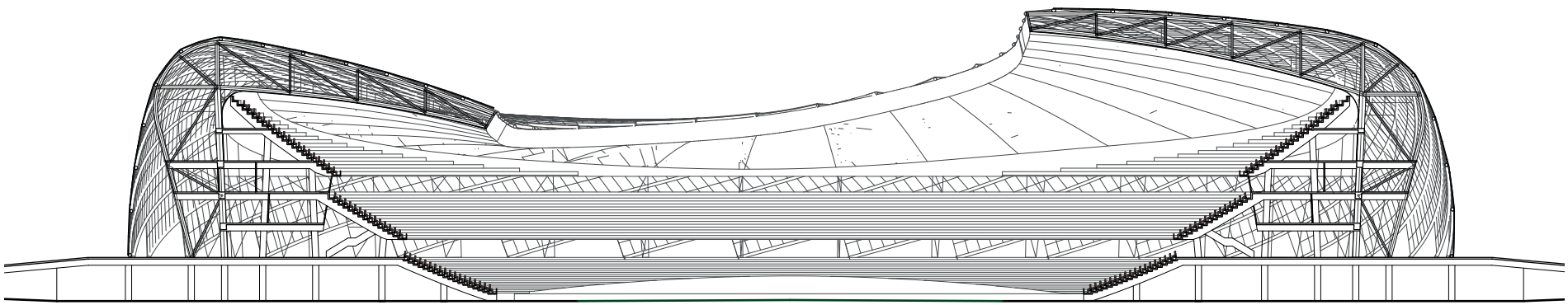

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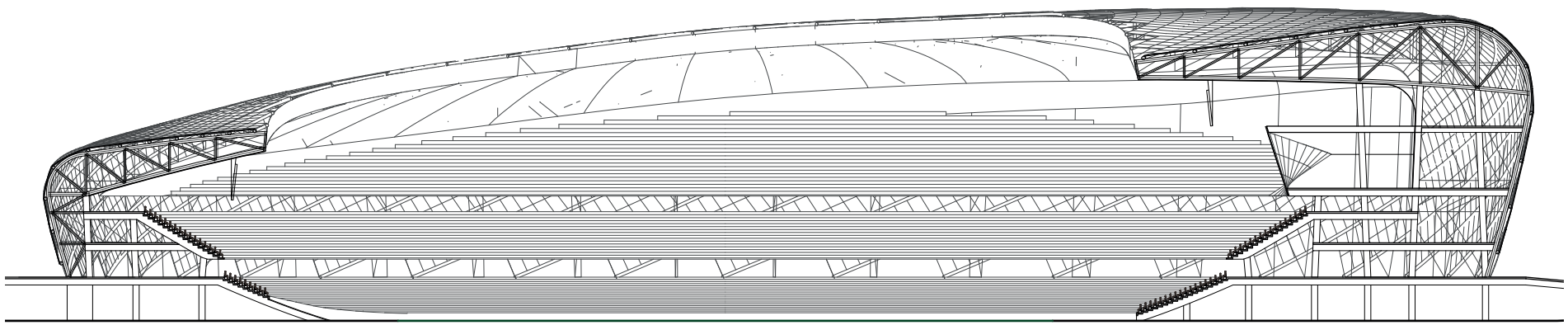

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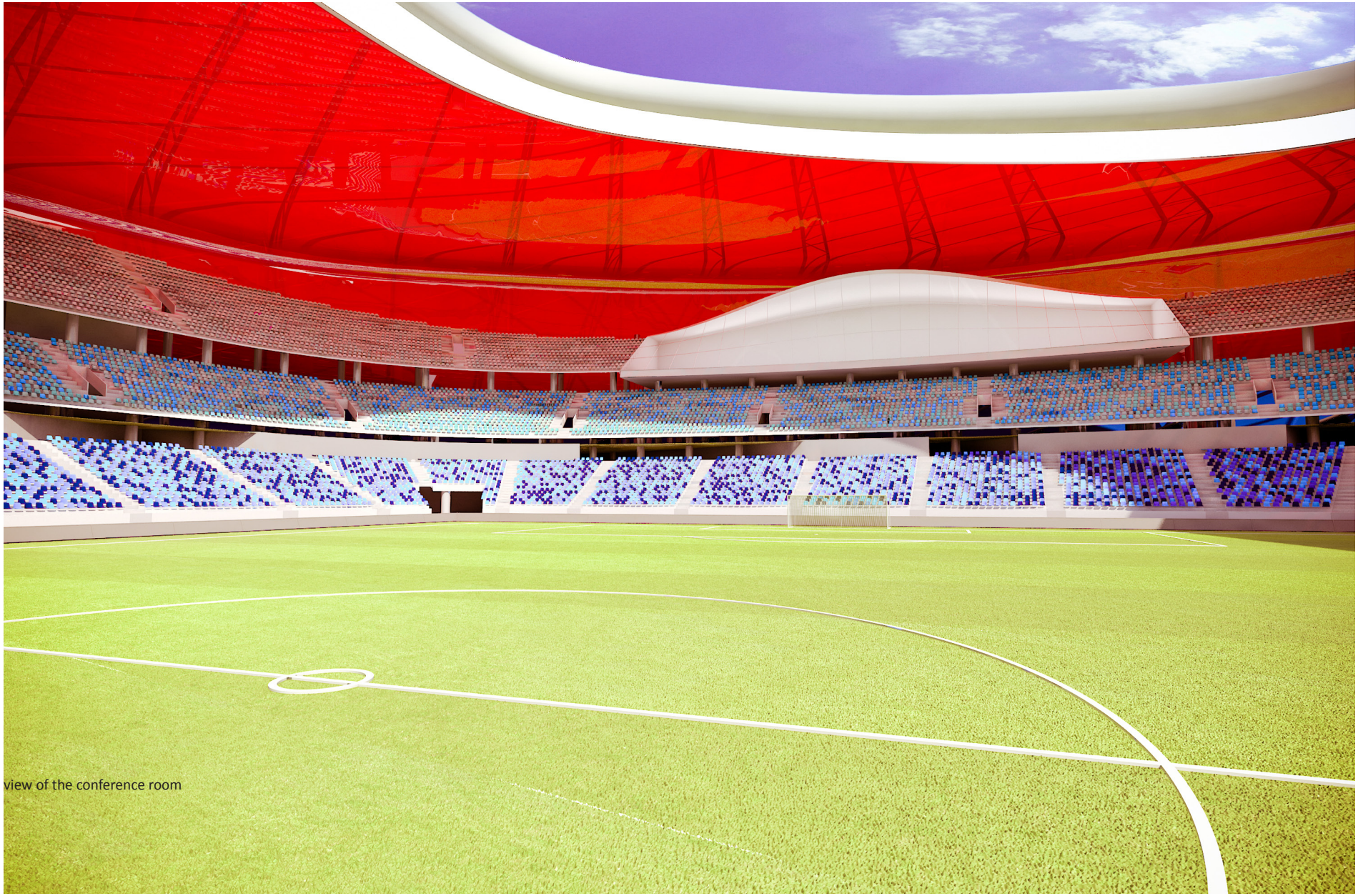
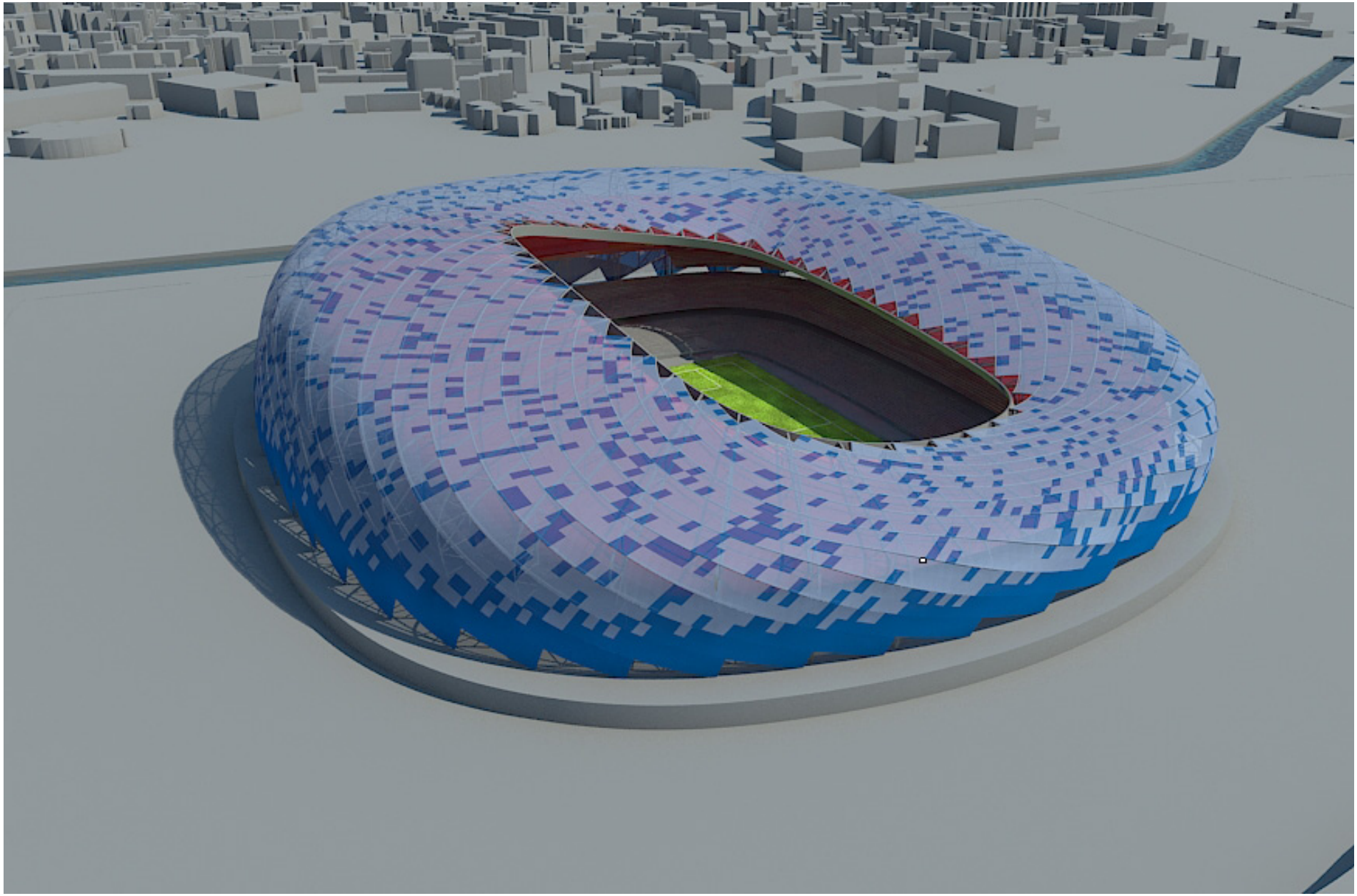


view of the conference room

facade studies



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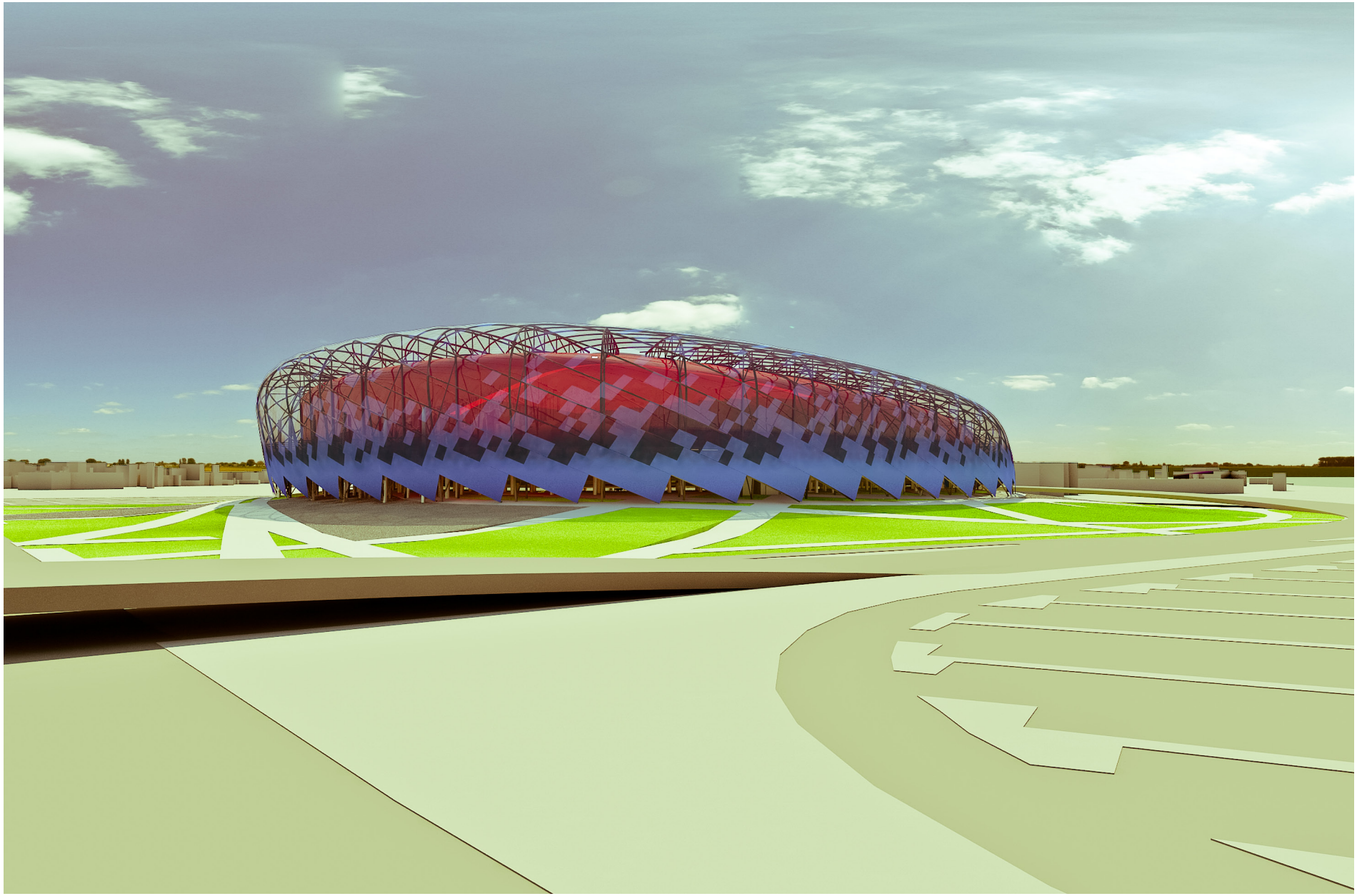

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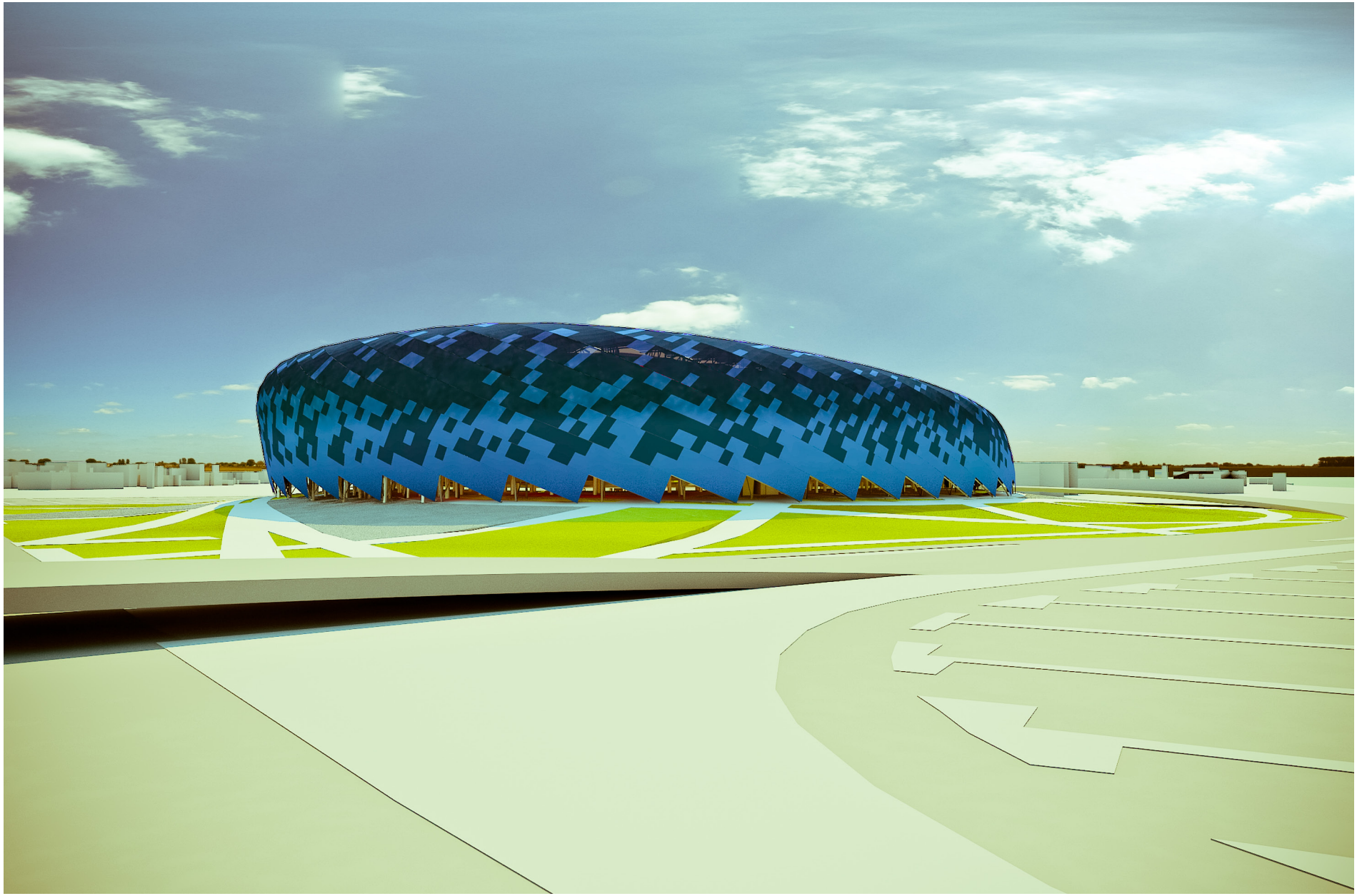

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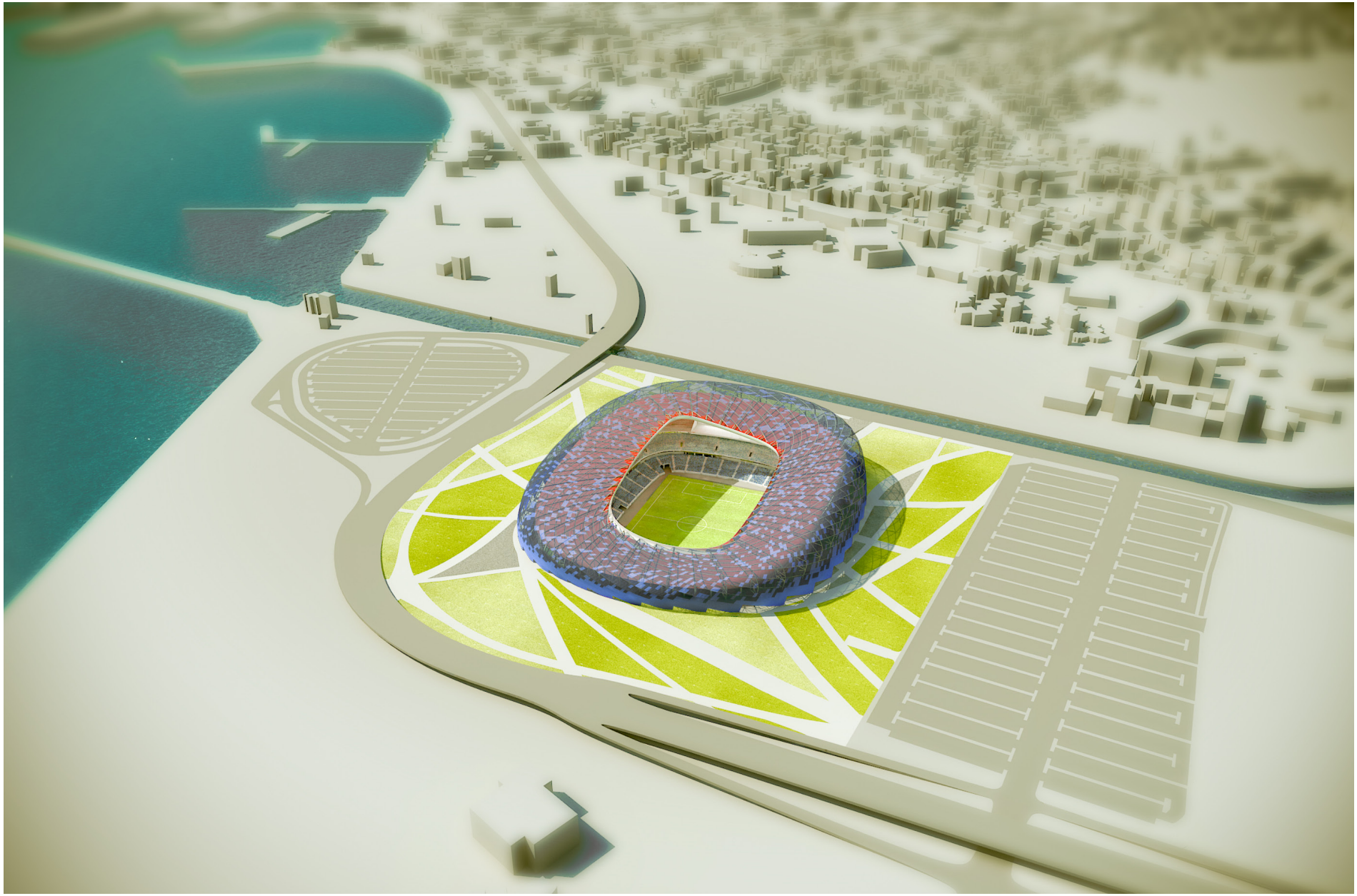

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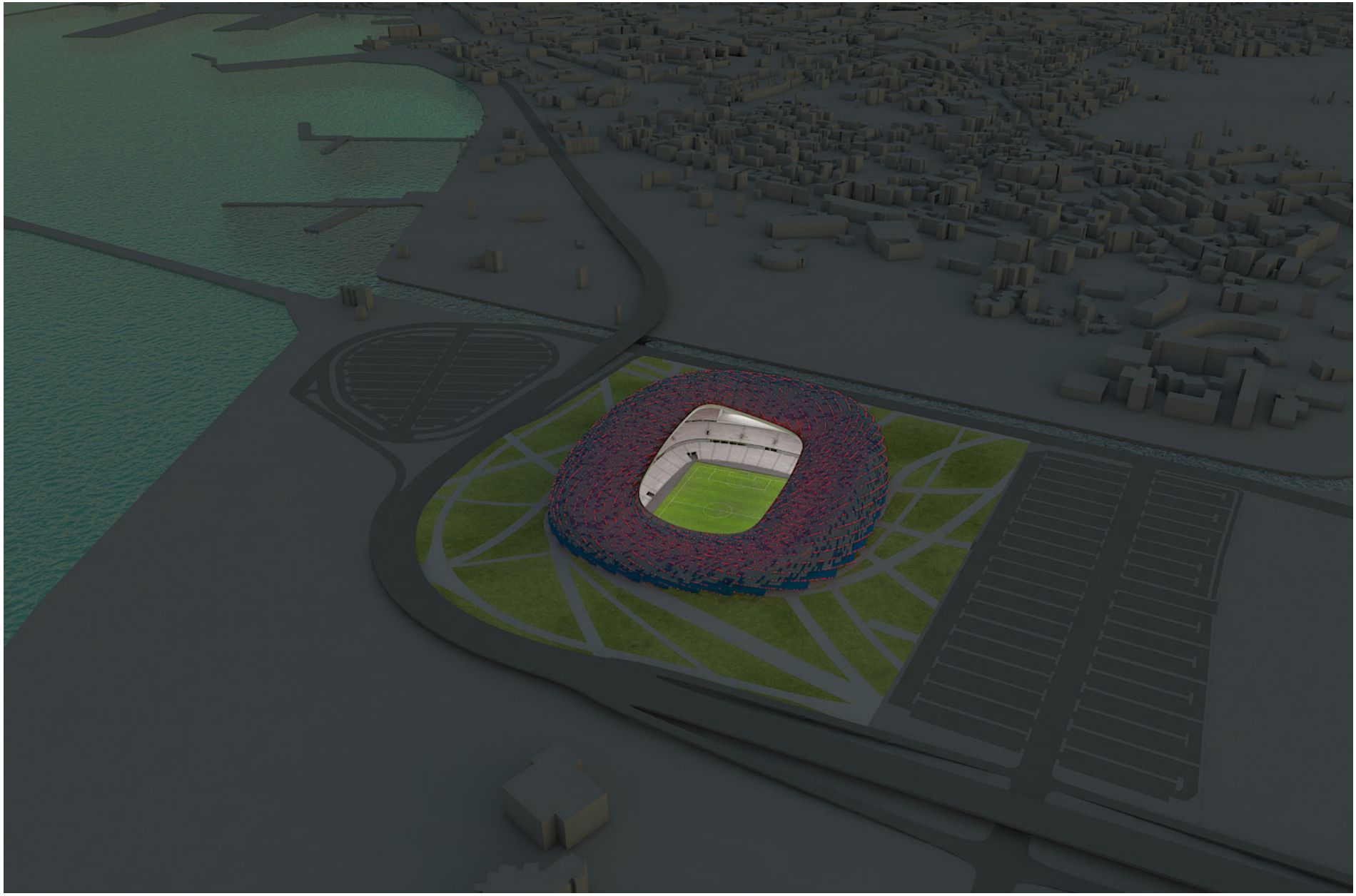

renderings

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a. storari