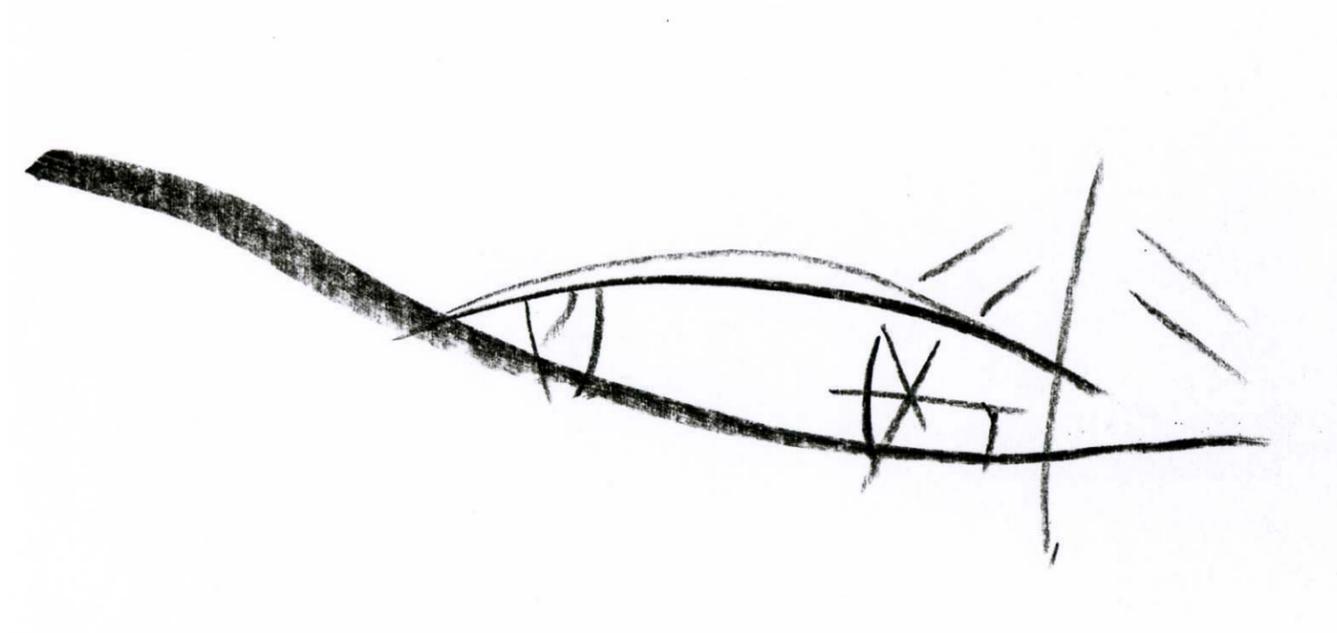




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STEEL IN AN ARCHITECTURE OF PERFORMANCE: INDOOR SOCCER FACILITY
JASON M. HUBER

THESIS SUBMITTED TO THE FACULTY OF VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY IN PARTIAL
FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF ARCHITECTURE

MAY 3, 2007
BLACKSBURG, VA

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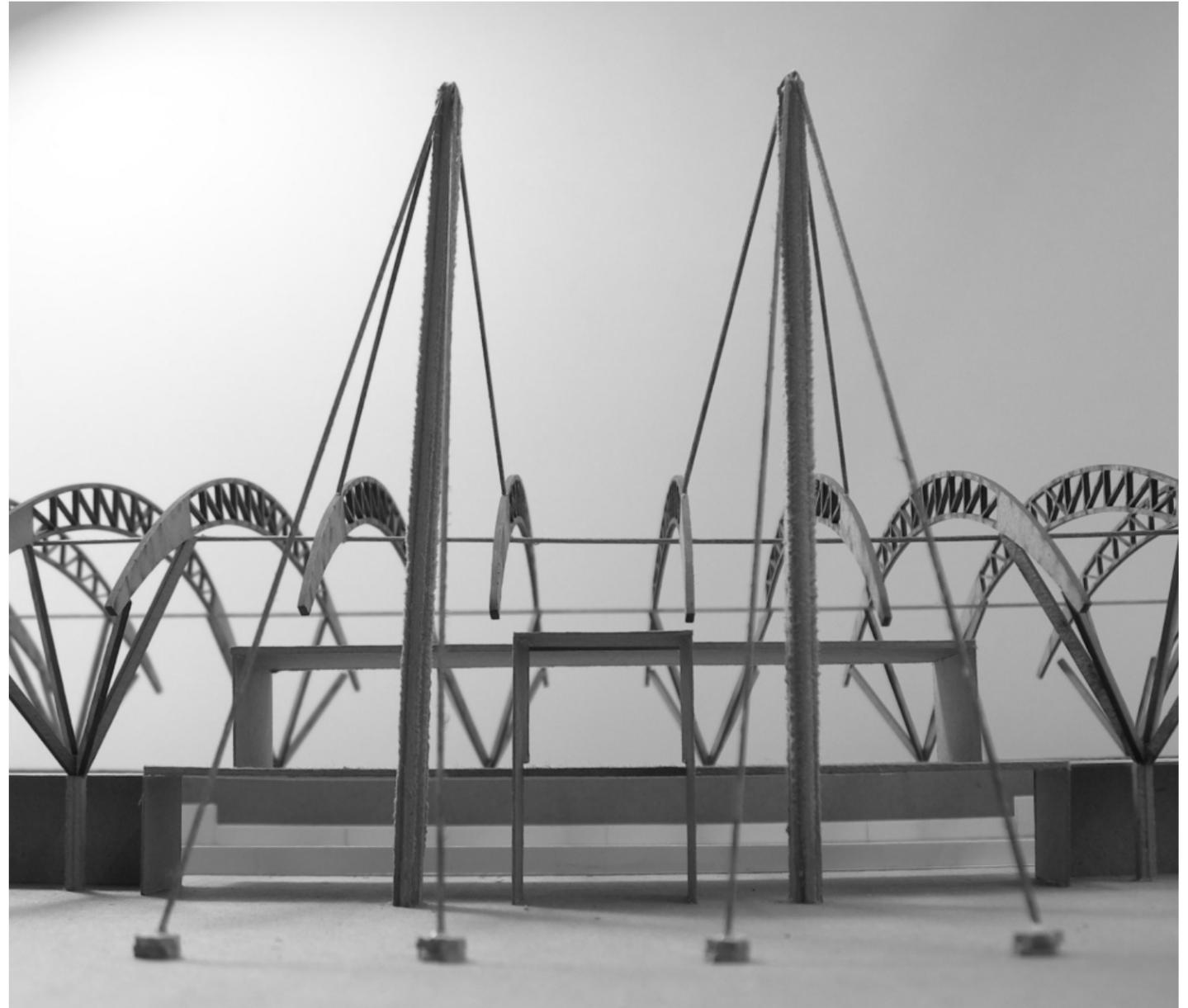


MY PARENTS, KENT AND LAURIE HUBER, HAVE GIVEN ME THE STRENGTH TO GET WHERE I AM TODAY AND I WOULD LIKE TO THANK THEM FOR ALL OF THEIR LOVE AND SUPPORT.

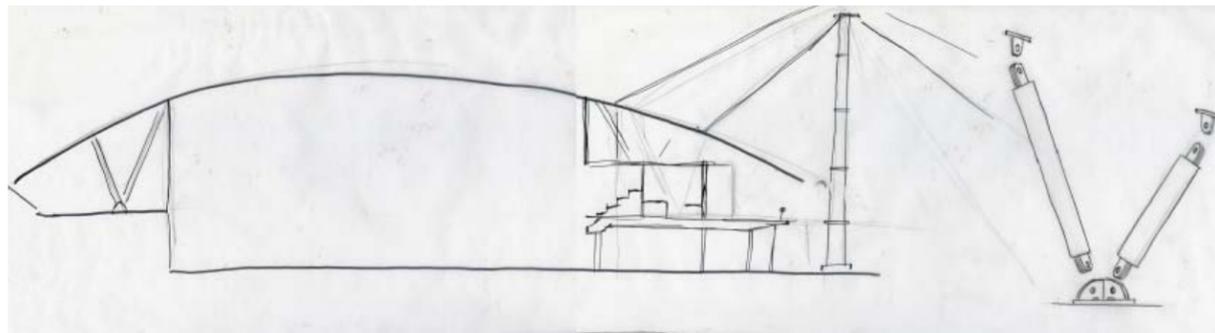
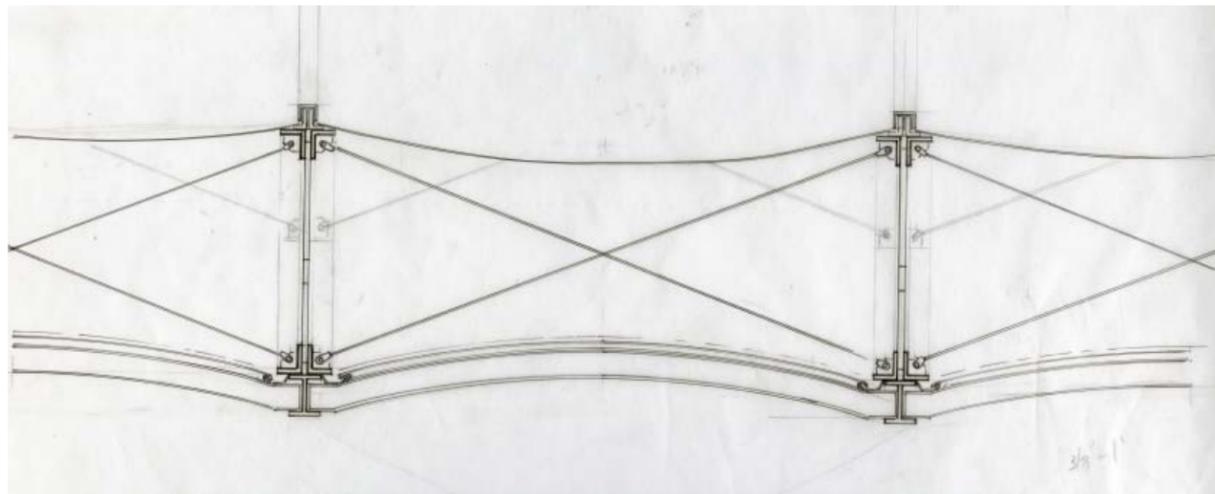
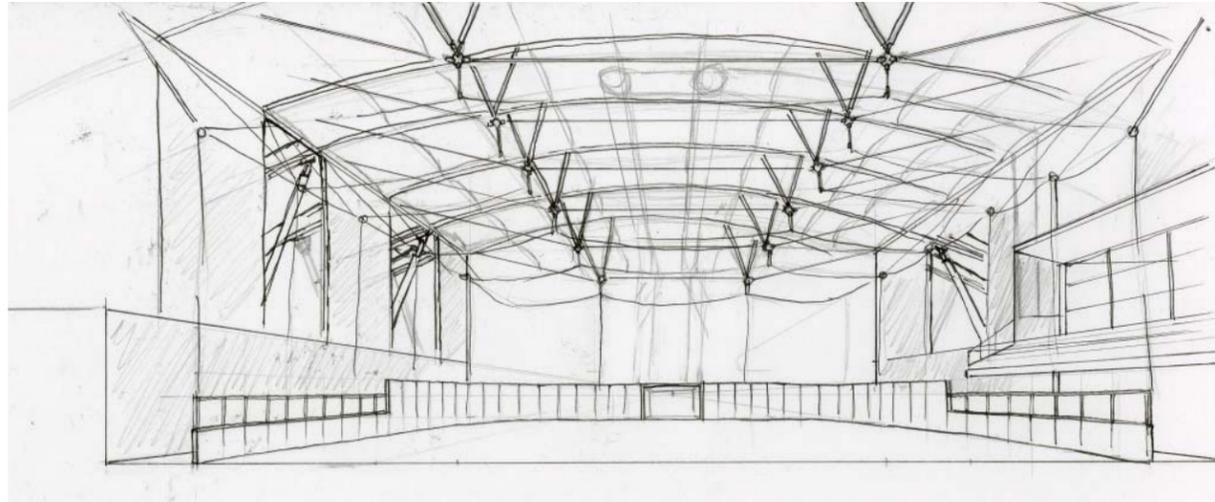
I WOULD LIKE TO THANK KIMBERLY FOR ALL OF HER LOVE AND SUPPORT FROM THE DAY WE MET.

I WOULD LIKE TO THANK MY ADVISING COMMITTEE, JIM JONES, HANS ROTT, AND BILL GALLOWAY, FOR ALL OF THEIR TIME AND VALUED LESSONS. I CANNOT BEGIN TO DESCRIBE THE AMOUNT I HAVE GROWN AS AN ARCHITECT AND A PERSON THROUGH THEIR TEACHINGS IN MY TIME HERE AT VIRGINIA TECH.

I WOULD ALSO LIKE TO THANK ALL OF MY FELLOW CLASSMATES AND FRIENDS FOR THEIR TIME AND OPINIONS. THEY MADE FOR AN ENJOYABLE STUDIO ENVIRONMENT AND ALSO CONTRIBUTED A GREAT DEAL TO MY GROWTH AS AN ARCHITECT.



ABSTRACT ABILITIES OF STEEL AND THE CONNECTION TO THE OUTDOORS



STEEL IN AN ARCHITECTURE OF PERFORMANCE:
INDOOR SOCCER FACILITY

JASON HUBER

ABSTRACT

This thesis explores the opportunities and limitations of steel construction and connection to the outdoors through a sports facility for the city of Blacksburg, Virginia.

The program being that of an indoor soccer facility allows for the steel to express its ability to span great distances with a very fine and visually delicate structure. Cables express the steel's strength in tension. The structure is clearly expressed and easily understood by anyone who enters the facility.

The building's indoor connection to the

outdoor environment is achieved through the study and implementation of several strategies that not only enhance the visual and thermal comfort levels of those people in the facility but will also reduce the building's operating costs. One of the main strategies utilized to achieve this enhanced comfort level is that of natural ventilation. This will contribute to the overall air quality of the interior space and bring a refreshing breeze to the athletes and spectators of the facility. A second important design strategy is the utilization of natural light brought through and interacting with the translucent roof and steel structure.



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INTRODUCTION

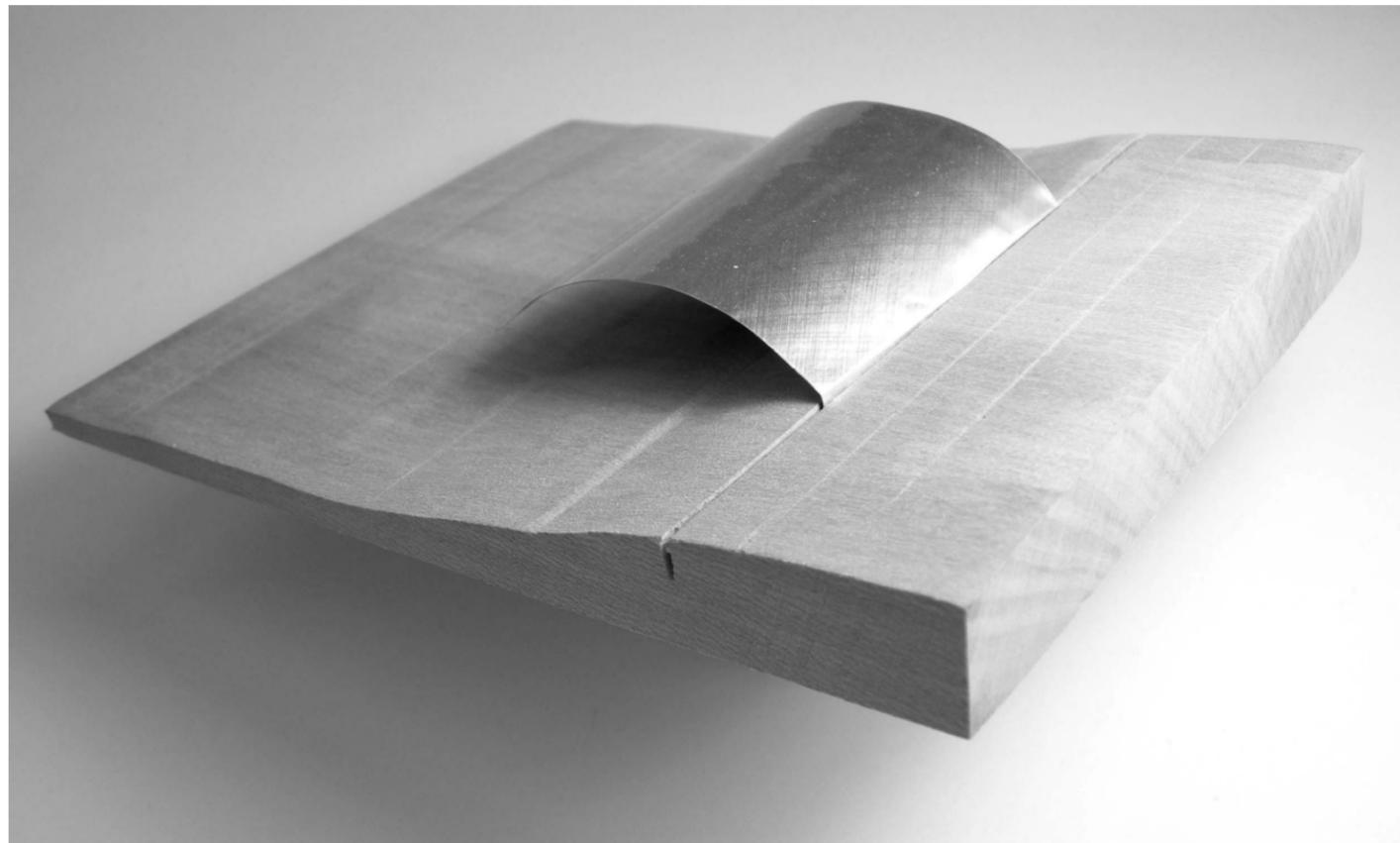
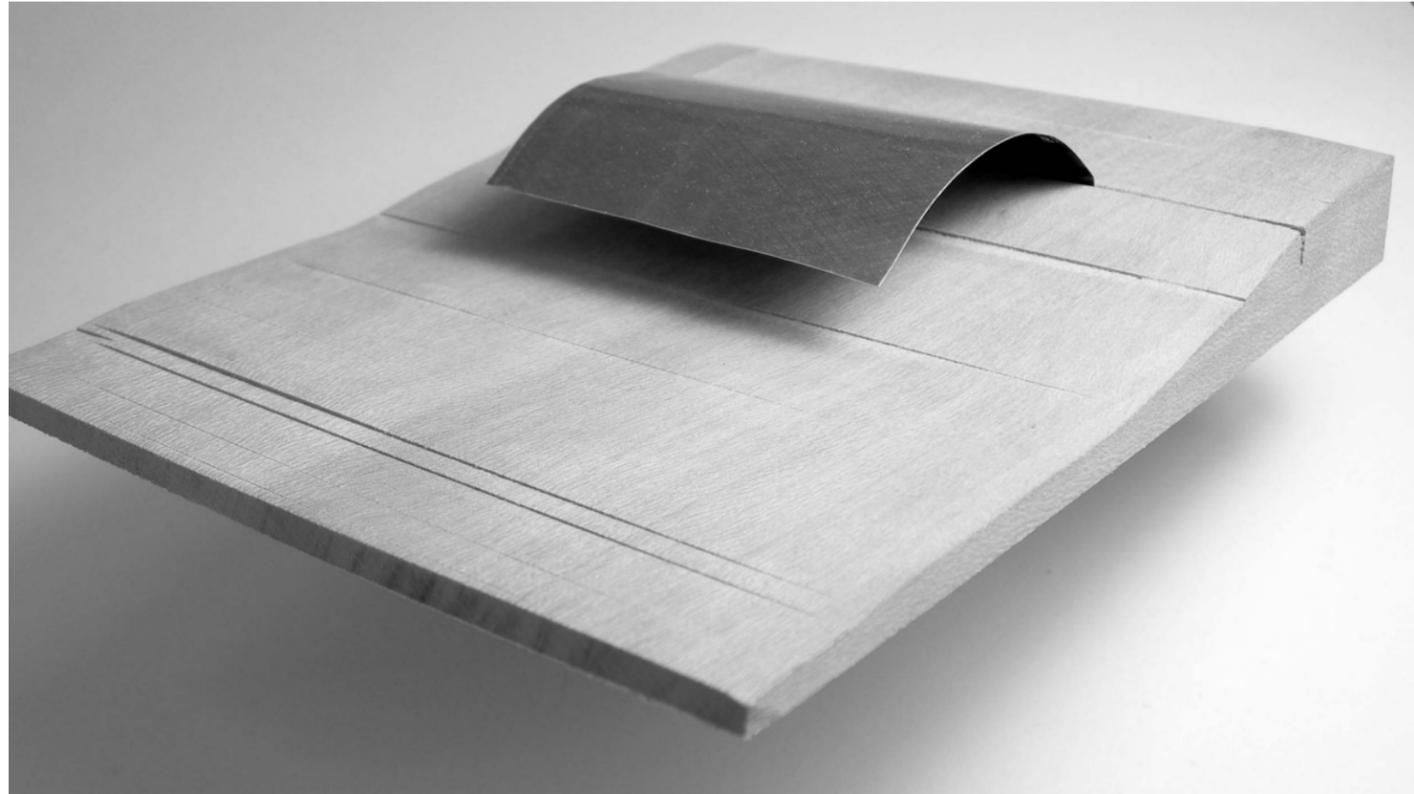
SITE - MATERIAL - STRATEGY - FORM

The proposition is for a soccer facility to house one full-size indoor soccer pitch, concessions, training area, support and storage for the facility and seating for up to 600 spectators. The entire New River Valley area could benefit from the construction of an indoor soccer facility. This facility will provide local schools with a place for winter and inclement weather training or competition as well as for year round recreation. With the proposed replaceable floor a building such as this could also house a number of other events including basketball, box lacrosse, box football, tennis, volleyball, horse shows, car shows, boat shows, and much more. Presently, there are no other public facilities like this one in the area other than some of those on the Virginia Polytechnic Institute and State University campus.

The site for this proposed soccer facility is adjacent to the existing Blacksburg Recreational Center and

the Blacksburg Aquatic Center (Page 7). The proposed building will be accessible from Patrick Henry Drive across from the Blacksburg High School in Blacksburg, VA. Sitting just behind the facility is the office of the Blacksburg parks director. Also in the surrounding area are a number of outdoor sporting fields, multiple playgrounds, and tennis courts. The site is sloped from the south down to Patrick Henry with an elevation change of roughly twenty feet.

A number of factors were involved while deciding on the form of this building. One of the earliest studies involved exploring the opportunities from responding to the sloped site. The form of the building would need to respond to the hill on which the building would sit. A large vaulted form seemed to speak to the site most pleasantly. The form also provided a nice opportunity for steel to show its ability to span the long distances that



the soccer facility would require.

A large driving force in the design of this building was the connection to the environment around the building while remaining an indoor facility. The first of the strategies utilized in connecting the building to its environment is natural ventilation. This vaulted building form worked well with the intention to naturally ventilate the space from air intakes in the adjacent park. The vault of the building will span from south to north to allow the summer breezes to run up and over the curved structure. This form will assist in the movement of air throughout the competition space in the building, which is explained in more depth later.

Another idea to tie the interior of the facility to the outdoors is to use natural daylight to illuminate the competition floor and walls. The proposed translucent roof structure will reduce the need for artificial lighting during daytime events and reduce

electric consumption and maintenance costs as a result of longer life of the lighting fixtures and lamps. To reduce the intensity and the glare from the sun a shading device is integrated into the roof structure. This shading device will be made of a glass fiber cloth coated with polytetrafluorethylene (PTFE). One common brand of this material is Teflon. I chose this material over its commonly used alternative; polyester cloth coated polyvinylchloride, because it is considered non-combustible and has a longer life span, according to Eduard Allen and Joseph Iano in their book Fundamentals of Building Construction. This Teflon coated glass fiber will be stretched over the steel trusses that span the pitch. It will act as a rain shield and a sun shade as it diffuses the light and controls glare that might otherwise be encountered in a competition or in the viewing of the event.



6-1

SITE WORK

1 Sketch of building sitting on proposed site

PAGE 7 Site plan and adjacent buildings

PAGE 7 SITE PLAN

- 1 View to north from proposed site
- 2 Existing Access road to office of the parks director
- 3 Blacksburg High School
- 4 Blacksburg Recreation Center
- 5 Blacksburg Aquatic Center
- 6 Office of the parks director



1



2



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4

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2

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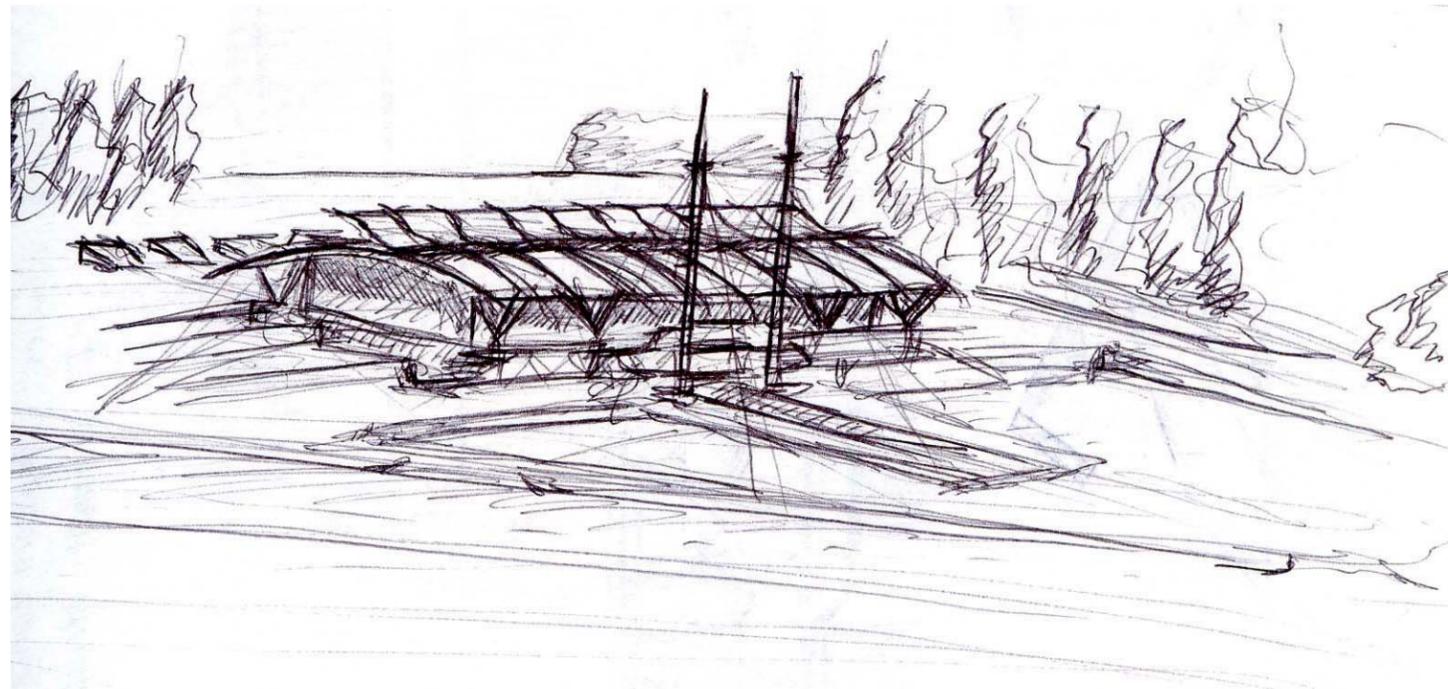
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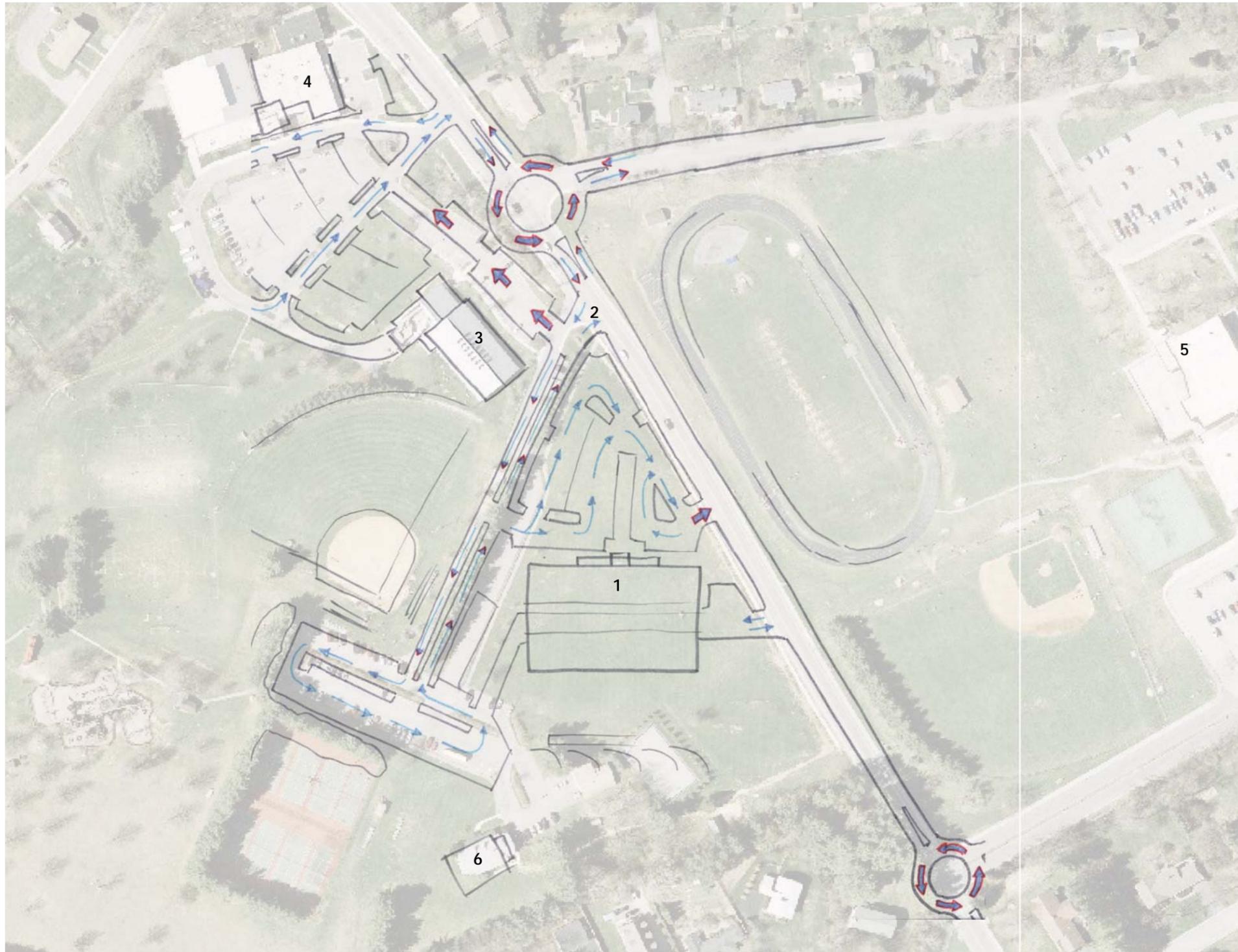


THE APPROACH EXPRESSIONS IN STEEL

It's a little after noon on a Saturday as a family makes their way out to the new indoor soccer facility off of Patrick Henry Drive for a winter league soccer game. As the family turns onto and makes their way down Patrick Henry Drive they notice four structural towers peeking slightly over the tree line just beyond the Blacksburg Aquatic Center. They soon arrive at one of two proposed traffic circles for Patrick Henry at the first entrance to Blacksburg High School (Page 9). The other traffic circle is proposed for the second entrance to the student and gymnasium parking. These additions will assist in the overloaded intersections when school lets out and will help regulate the traffic during large events at the new indoor soccer facility.

After the family makes their way around the traffic circle, the visitors to the new facility turn down the main entrance to the recreation complex.

This entrance is found between the existing aquatic center and the proposed facility. This entrance road will also serve as the access road to the back athletic fields and the office of the parks director. Upon entering the complex, the family will find the parking for the new facility on the left. Now the towers that they had seen from down the street are right in front of them (figures 11-1 & 11-2). These towers express the opportunities with steel showing its ability to work in compression as well as its strength in tension with the cables coming off of the peak. The visitors will also notice the large white roof structure and main entrance. If the visitors were coming to see an event starting after sunset then they would have easily spotted the building as a lantern sitting on top of the dark hillside (Page 10).



TRAFFIC PATTERN

- 1 Soccer Facility
- 2 Main entrance to park
- 3 Blacksburg Aquatic Center
- 4 Blacksburg Recreation Center
- 5 Blacksburg High School
- 6 Office of the parks director

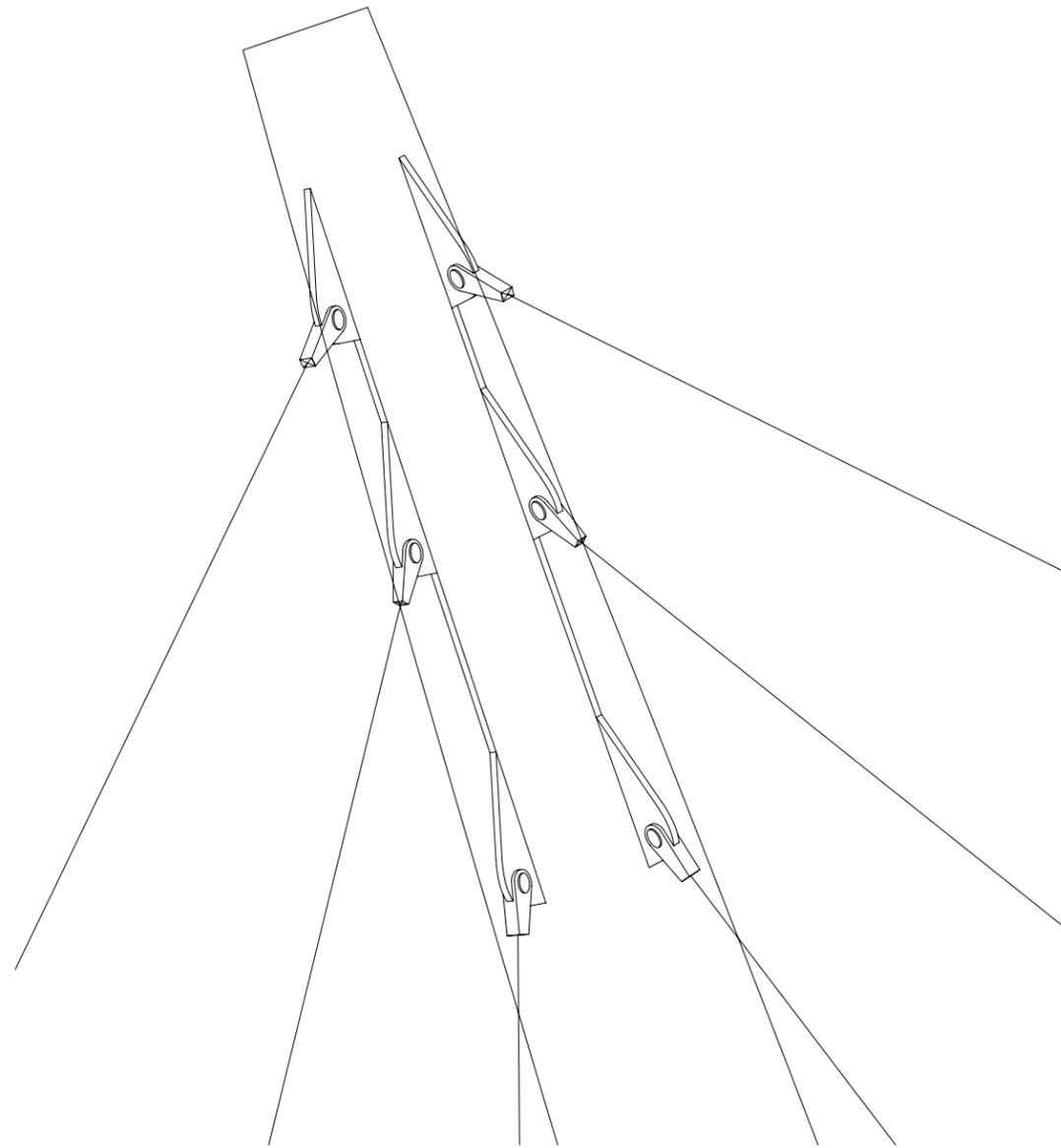
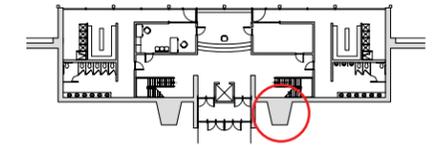


TOWER DETAILS

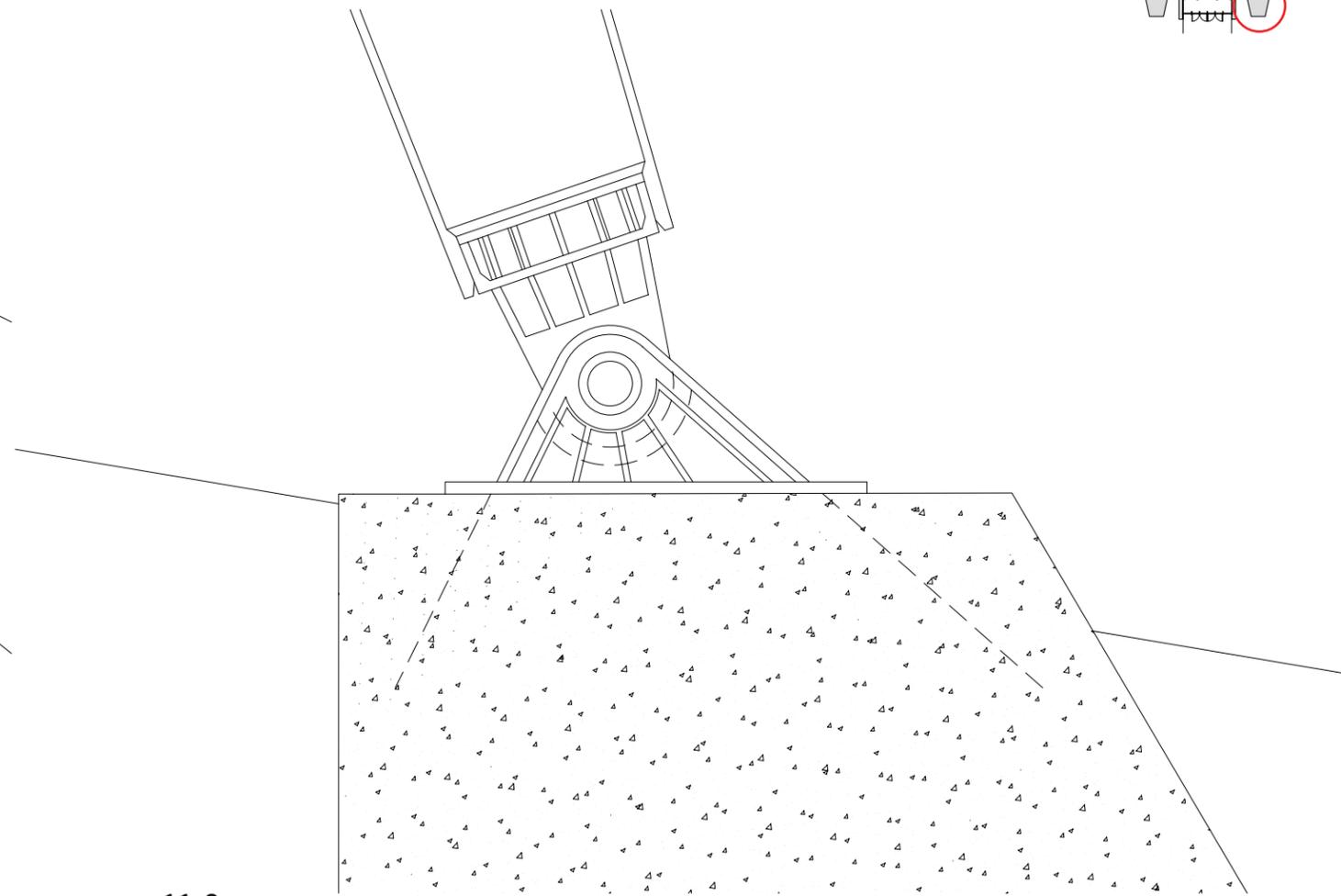
PAGE 10 Image of the approach to the building at night

1 Tower top and cable connections

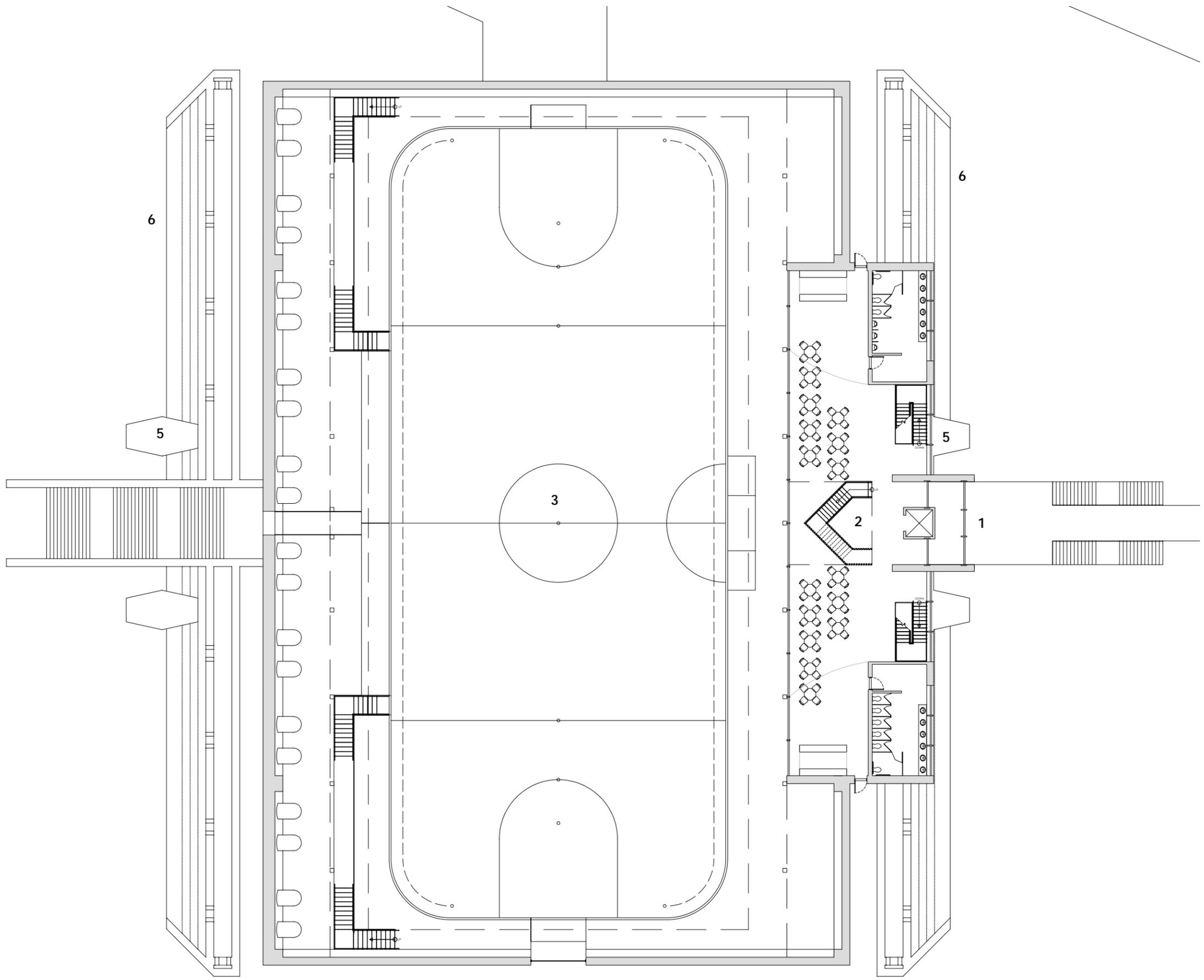
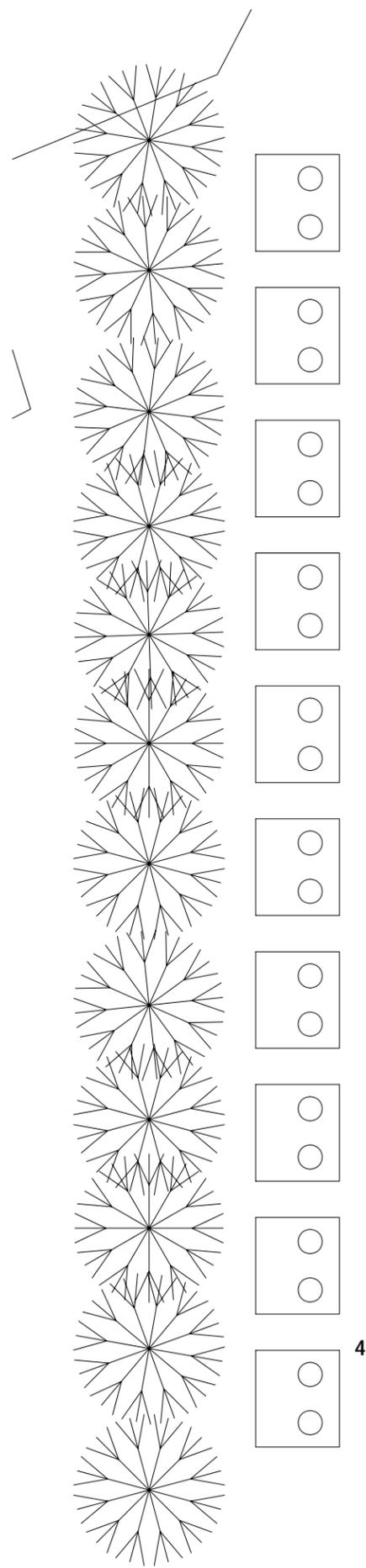
2 Pinned tower connection to the concrete footing



11-1



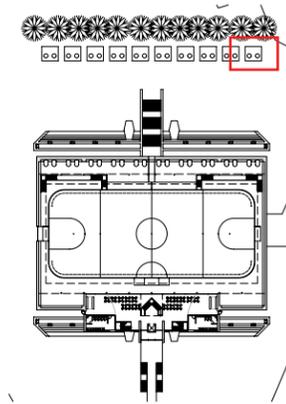
11-2



BUILDING PLAN

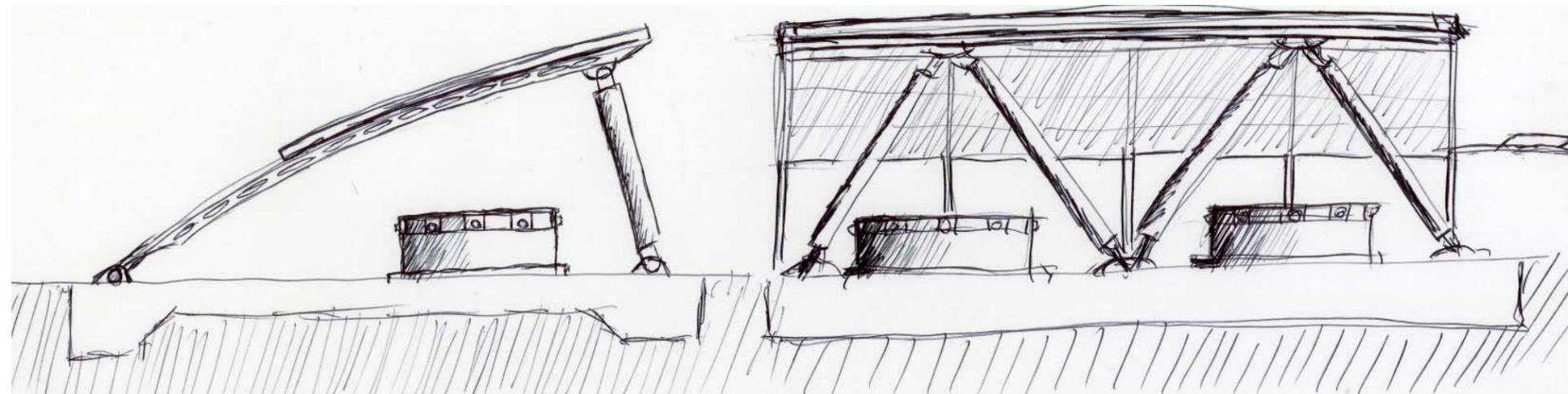
PAGE 12 Ground level floor plan of the entire site

1 Air intakes for the natural ventilation system



PAGE 12 BUILDING PLAN

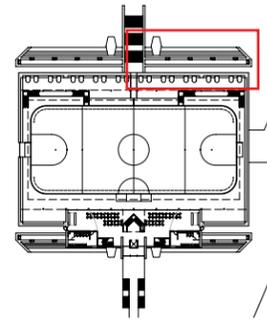
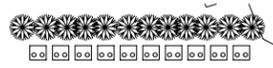
- 1 Building Entrance
- 2 Support Space
- 3 Competition Pitch
- 4 Air Intakes
- 5 Tower Footings
- 6 Water Drainage System



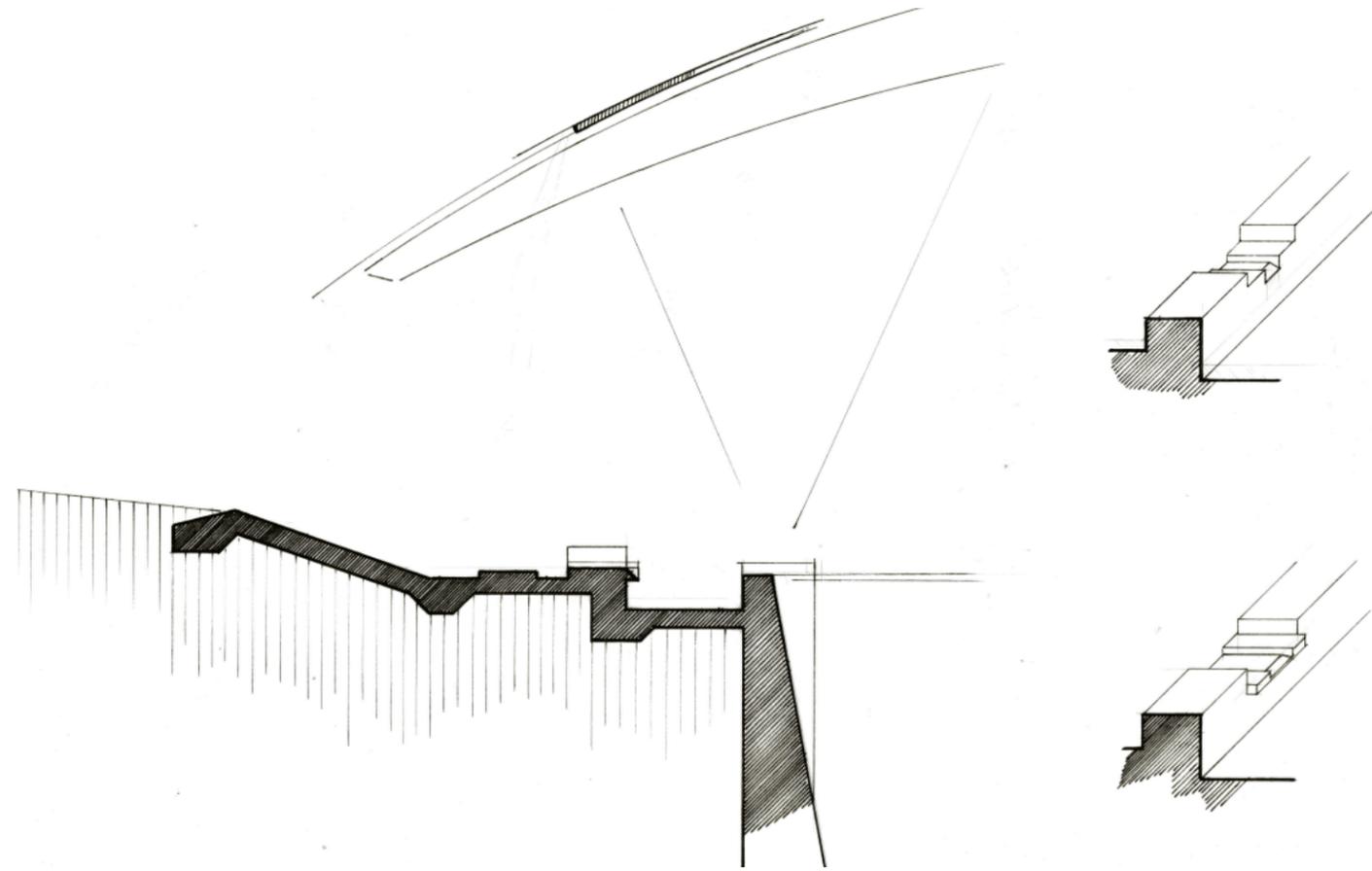
13-1

AIR INTAKE & WATER DRAINAGE

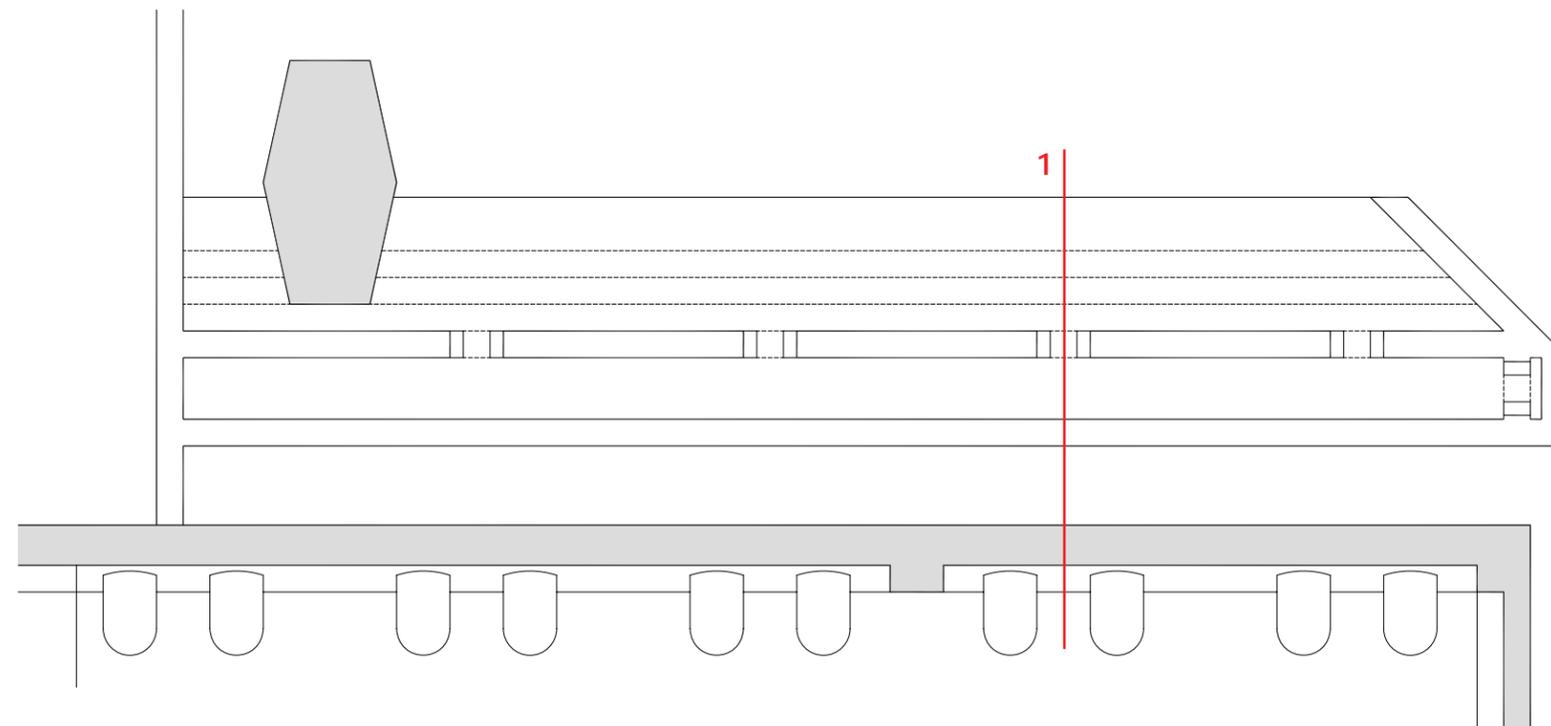
- 1 Drainage section
- 2 Drainage plan



14-1



14-2





15-3

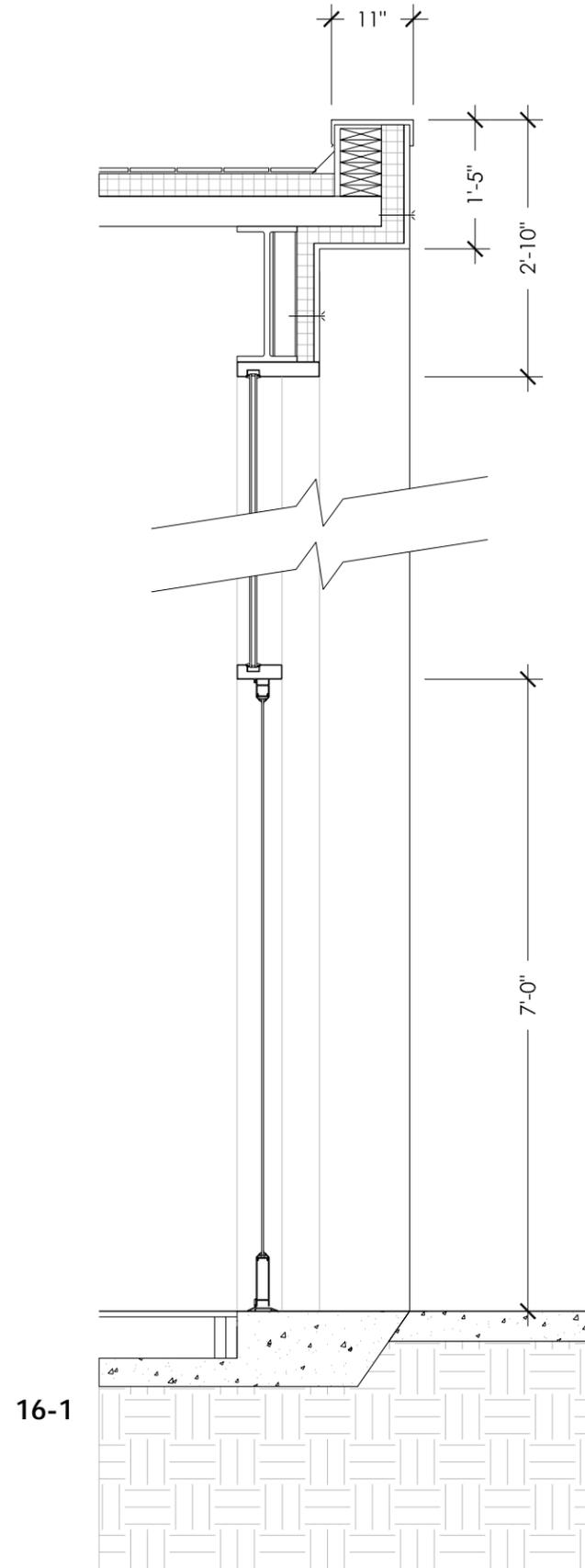
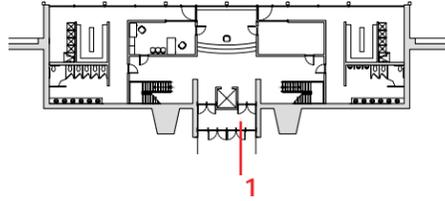
Once the family has parked their car they realize that they have a little time to spare before the event. The visitors decide to make their way around to the south side of the building (Page 12). Here, they find a park where the air intakes to the sports facility's natural ventilation system are located (figure 13-1). The character of these intakes closely follows that of the building itself where the structure is expressed through the steel. The visitors may notice the drainage system for the large tensile roof structure. The visitors will also notice the new skate park located just behind the building. If any of the family members had visited the site before construction of the new facility then they would notice that the skate park had been relocated to its current position from where it can be used to rest on the other side of the access road. Now they can sit back and enjoy the show that the local boarders and bikers put on for them.

The visitor may also take a look at the structure while they wait to enter the building. There are columns clusters that hold up the roof structure at every other bay (figure 15-3). In the center portion of the building they notice that the columns have been removed and replaced with the large towers that were seen from down the road. These towers have been pulled out away from the building to lead the visitor and mark a grand entrance to the facility. The towers also create a space to house the support spaces for the facility.

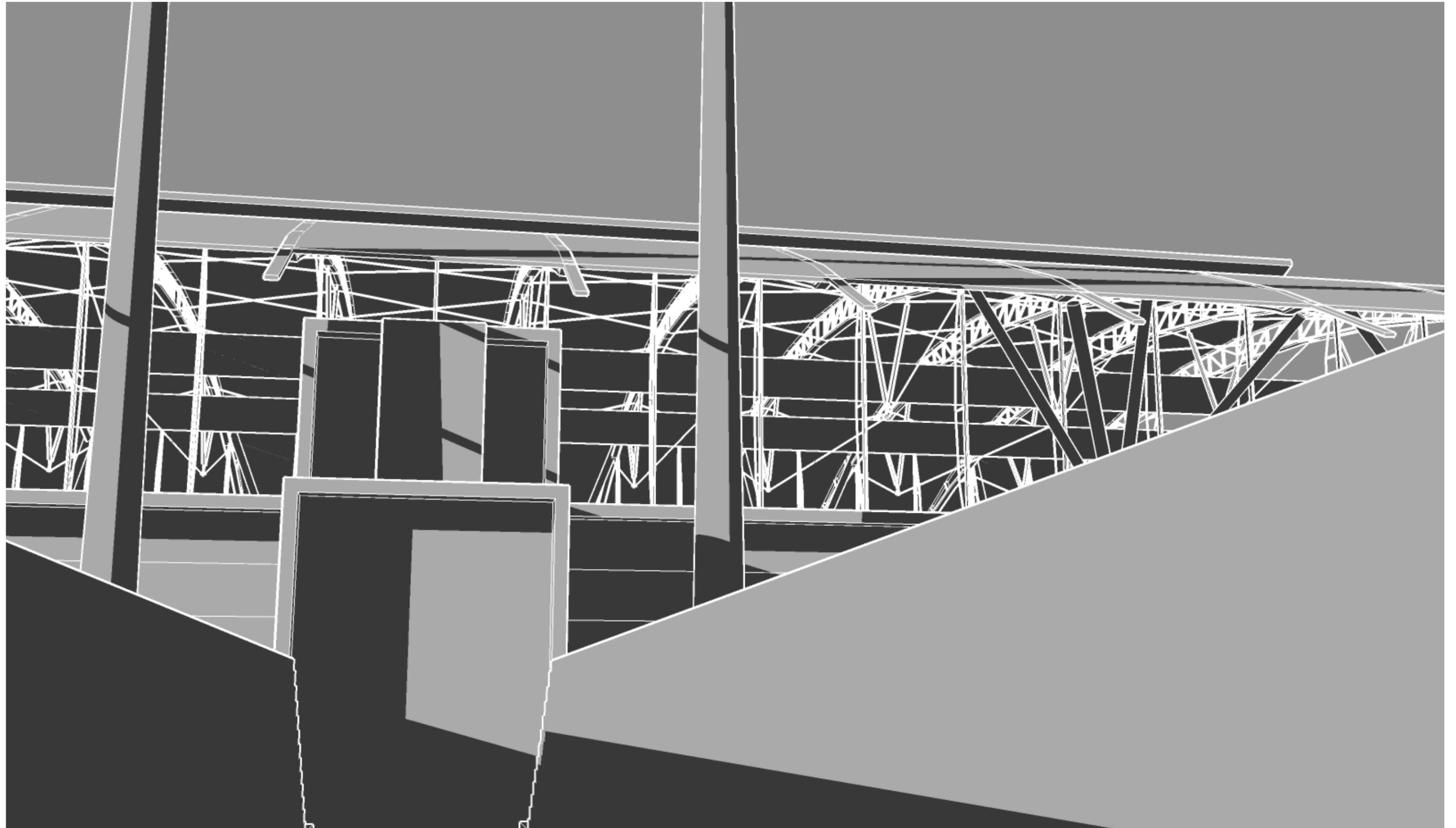
MAIN ENTRANCE

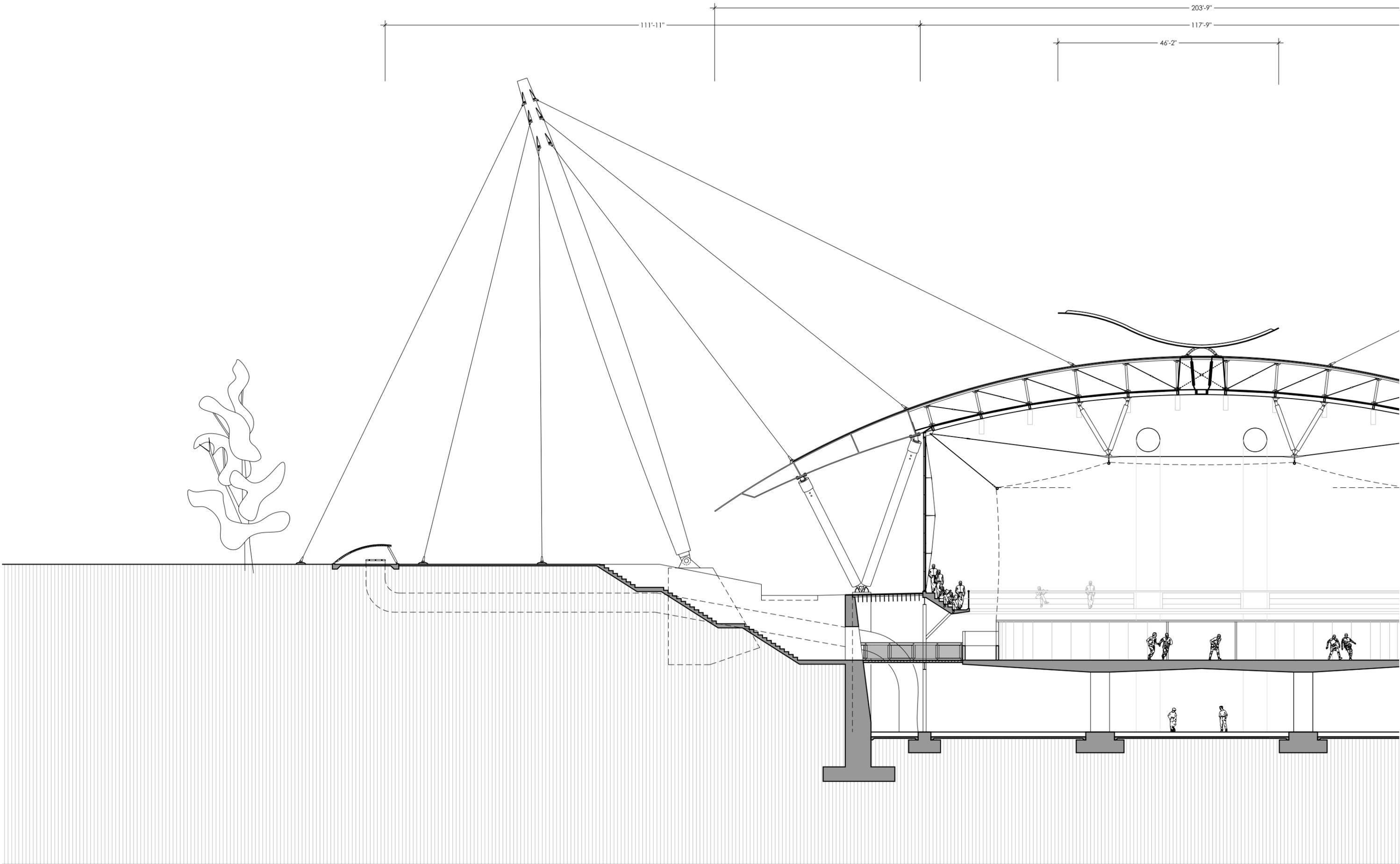
1 Glass wall turning the corner to a flat steel pan roof with insulation and pavers to hold the membrane in place

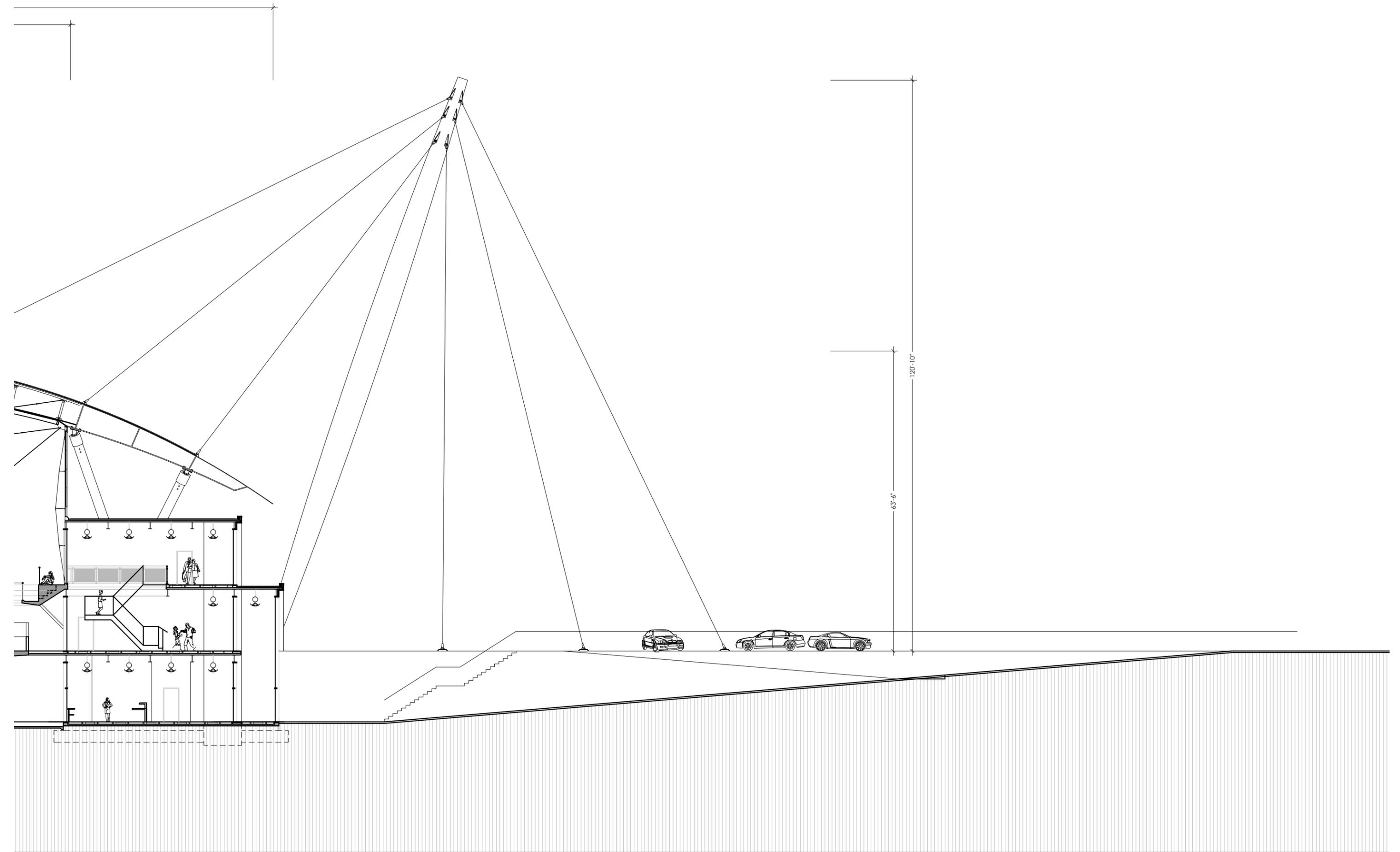
PAGE 17 Image descending the ramp to the entrance of the building

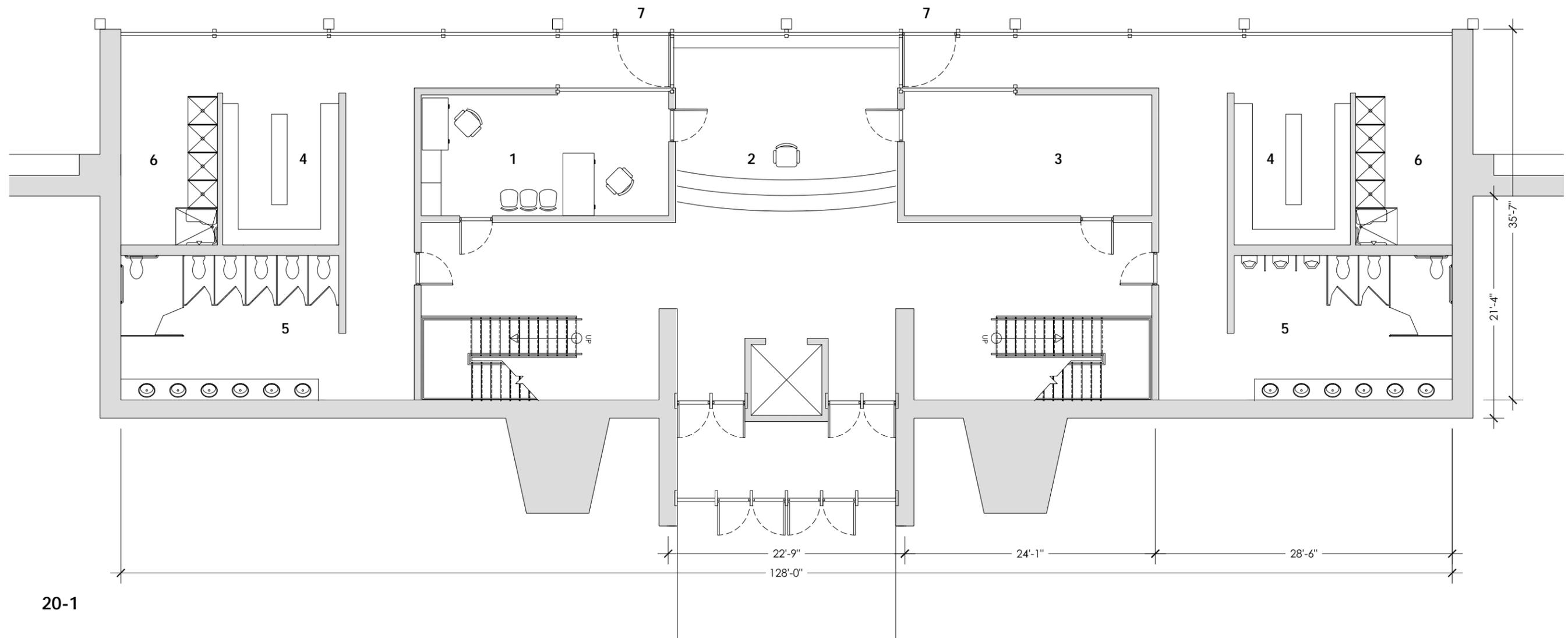


At this point the family will make their way down to the main entrance between the two towers at the north side of the building. The entrance is found on the lower level by taking a long ramp from the north end of the parking lot. If the visitors were rushed they could take a set of stairs down to the entrance to either side of the ramp. By entering the building from below, a controlled approach is achieved where emphasis is placed on the heroic nature of this grand steel structure (Page 17). At the end of the ramp the family will continue through a set of glass doors within a large double height window wall (figure 16-1). Through a second set of doors the patron will find the reception desk. From this point, the athletes and spectators will separate and enjoy two different experiences focused on their specific needs.





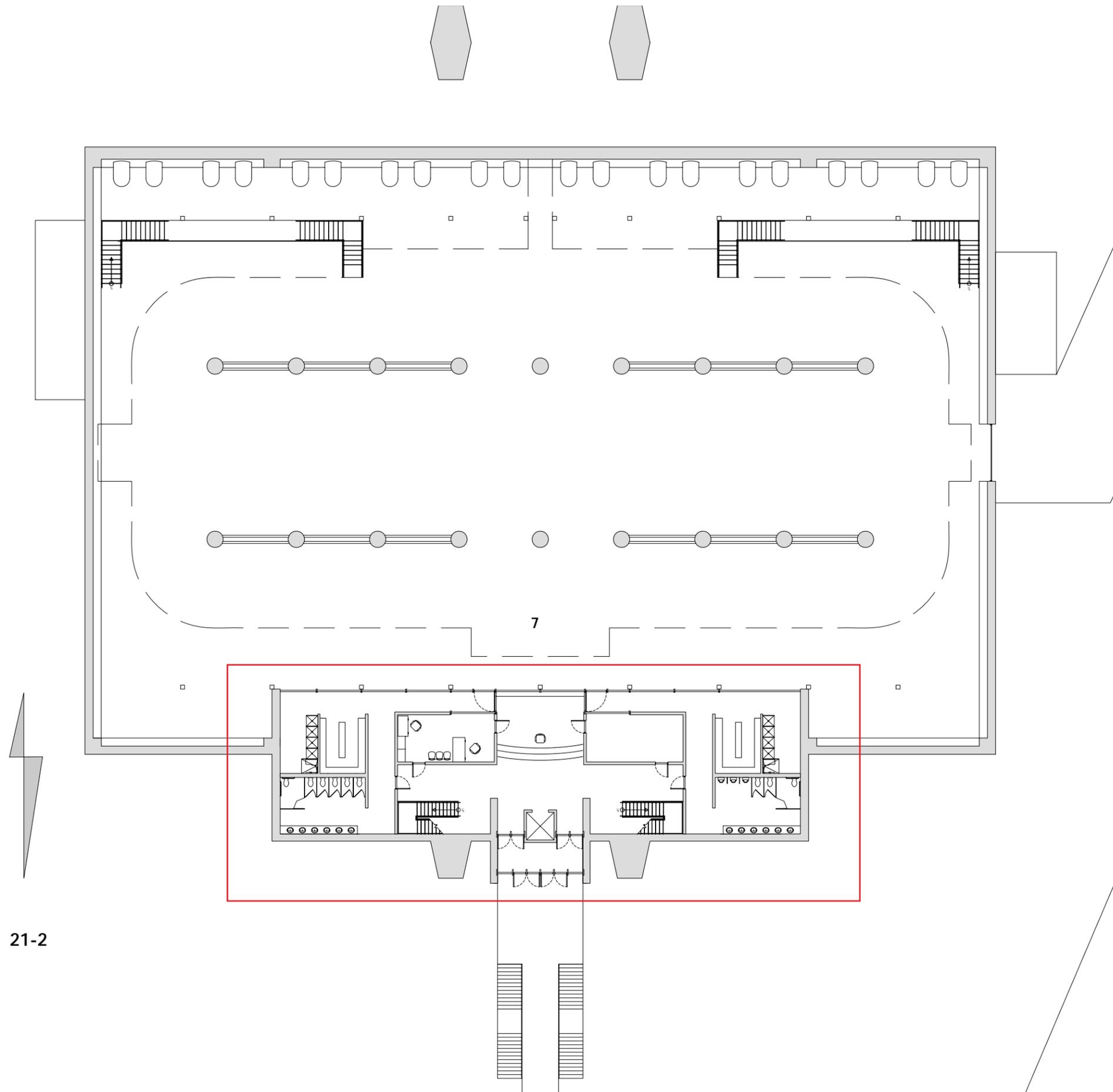




20-1 FIRST FLOOR PLAN

- 1 Office
- 2 Reception
- 3 Storage
- 4 Locker rooms
- 5 Restrooms
- 6 Showers
- 7 Warm-up space

THE ATHLETE A PROLOGUE TO A PERFORMANCE

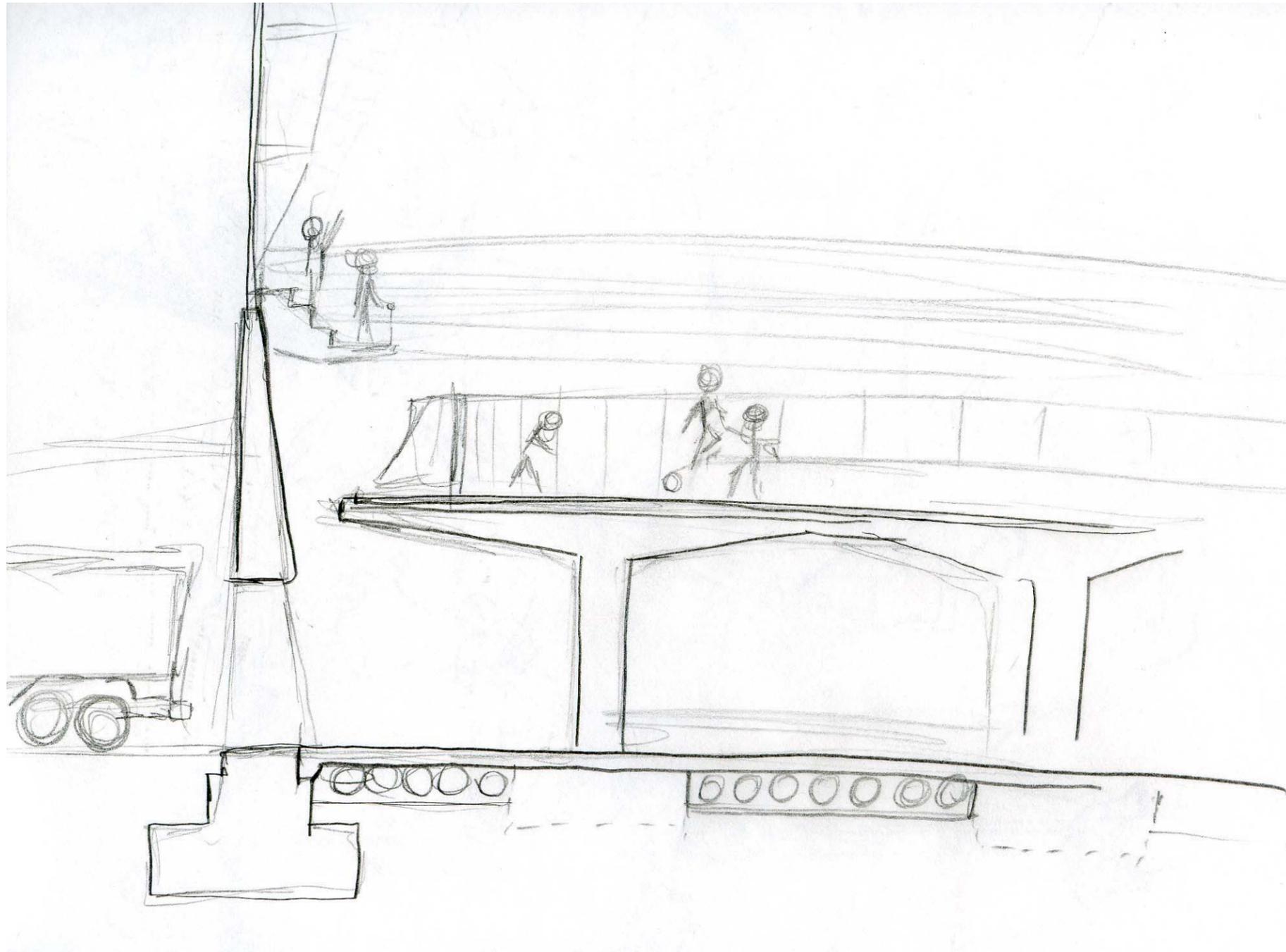


21-2

The athlete is greeted by the receptionist. The athlete will continue down the hallway to their respective locker room (figure 20-1). Here they will find the lockers, restrooms, and showers where they may prepare for their game. Once the athletes are prepared then they may continue out the back entrance of the locker room into the warm-up area located beneath the competition pitch (figure 21-2).

Once the players step out into the warm-up space they will notice the light pouring into the space through openings surrounding the entire concrete shelf of the field (Page 22). Simultaneously, they will notice a cool fresh breeze coming from air vents located between the columns that hold up the competition pitch as though it were placed on a pedestal.



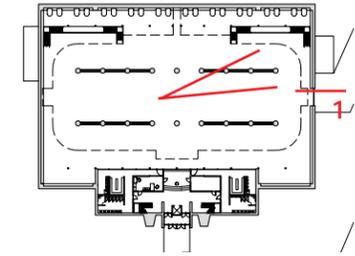


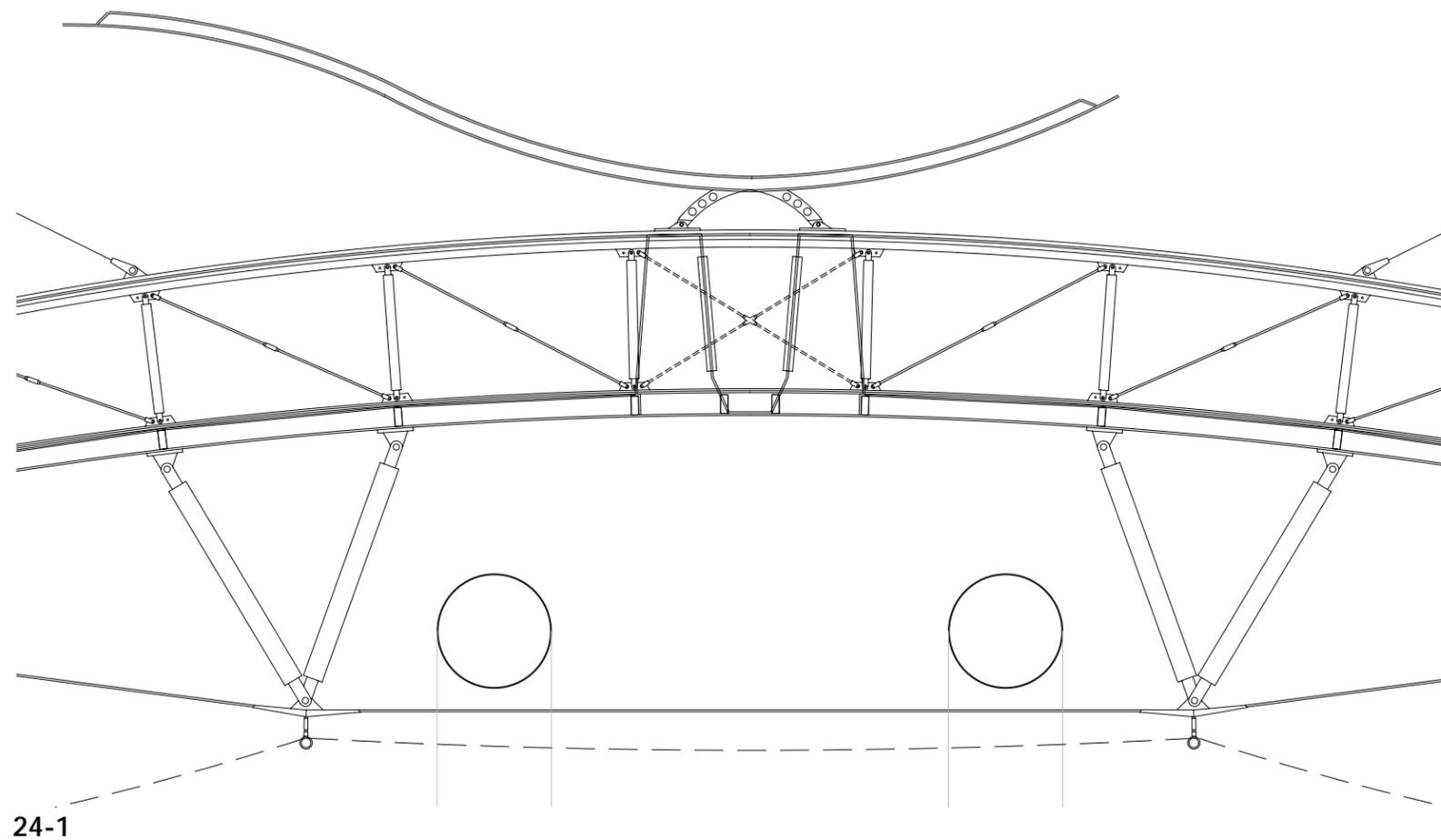
23-1

WARM UP SPACE

PAGE 22 Beneath the main competition floor in the warm-up space

1 Service entrance to the lower area from the northwest side of the building



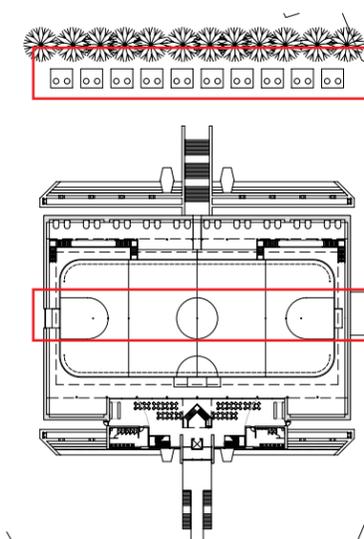


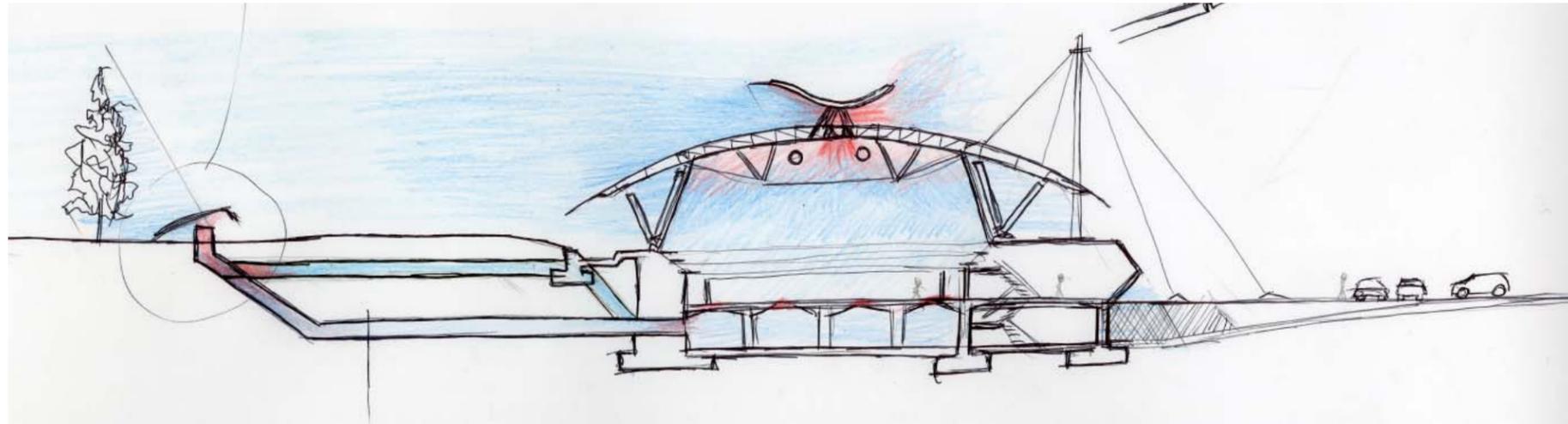
The cool breeze that is felt upon entering the warm-up space is a result of the natural ventilation strategy. As the breeze moves up and over the Teflon coated glass fiber roofing it accelerates. At the peak of the roof the air is compressed by the use of a large wing structure attached to an air vent. This compression and acceleration of the air causes what is called the Bernoulli Effect, where a negative pressure zone is created above the air vent. This will then draw air up and out of the building (figures 24-1 & 25-3). Thermal buoyancy and the stack effect may also contribute to the movement of air throughout the building. This pressure condition also helps draw fresh air into the system through air intakes located in the park just behind the building (figures 25-2 & 25-4). This strategy will provide a more comfortable environment for anyone inside the facility.

Due to ground coupling the air that is introduced through the air intakes will be cooled or heated depending on the outdoor temperature as it

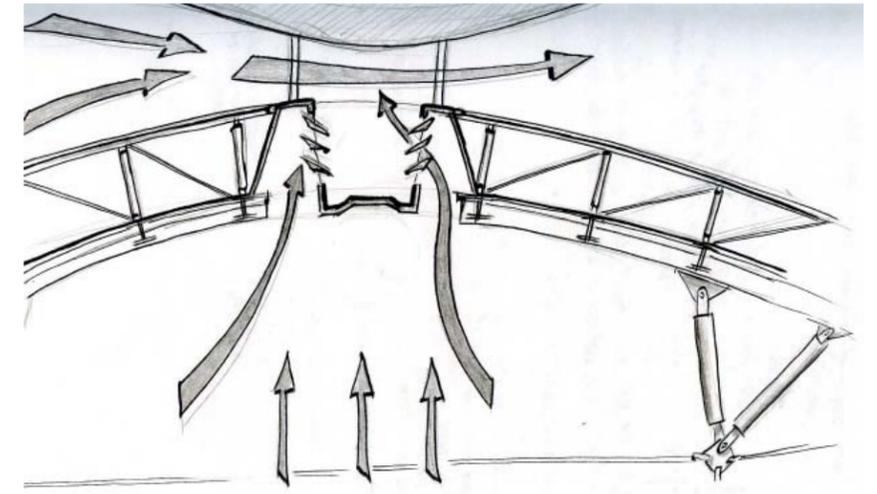
runs through underground ducts for about eighty feet. This temperature change caused by ground coupling will help reduce the costs related to the conditioning of this fresh air. Underground at the end of this run the air will be introduced into the warm-up space. From here the air is drawn to the top of the facility and out the exhaust vents at the peak of the roof structure.

Once the athletes and their teams have warmed up and are ready to take the field, they will climb a set of stairs in either back corner of the facility to emerge into the light and onto the competition pitch. Now the team is greeted by the crowd, sun, and fresh air (Pages 26 & 27).

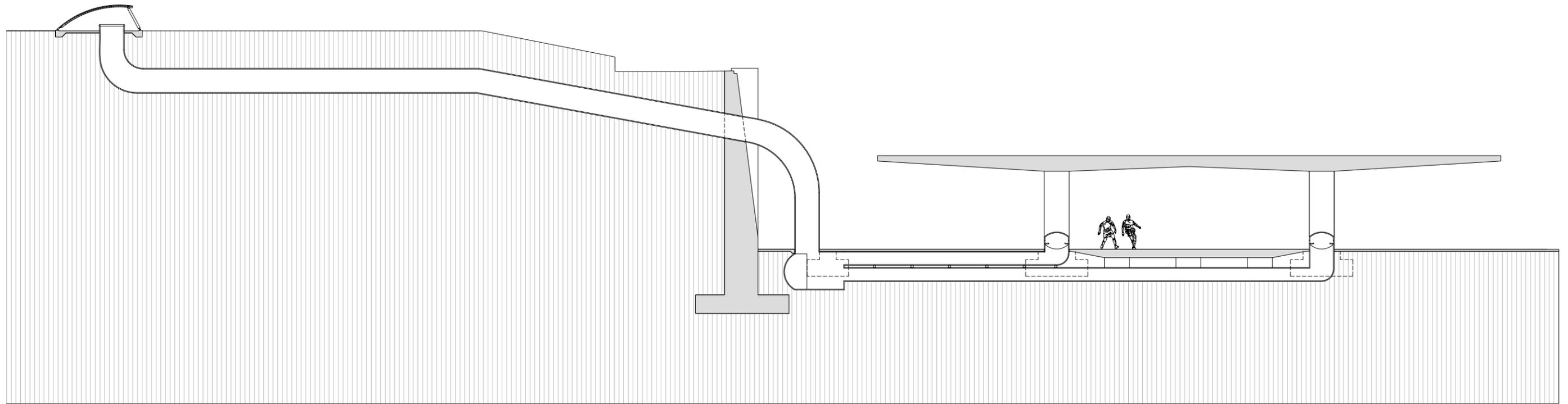




25-2



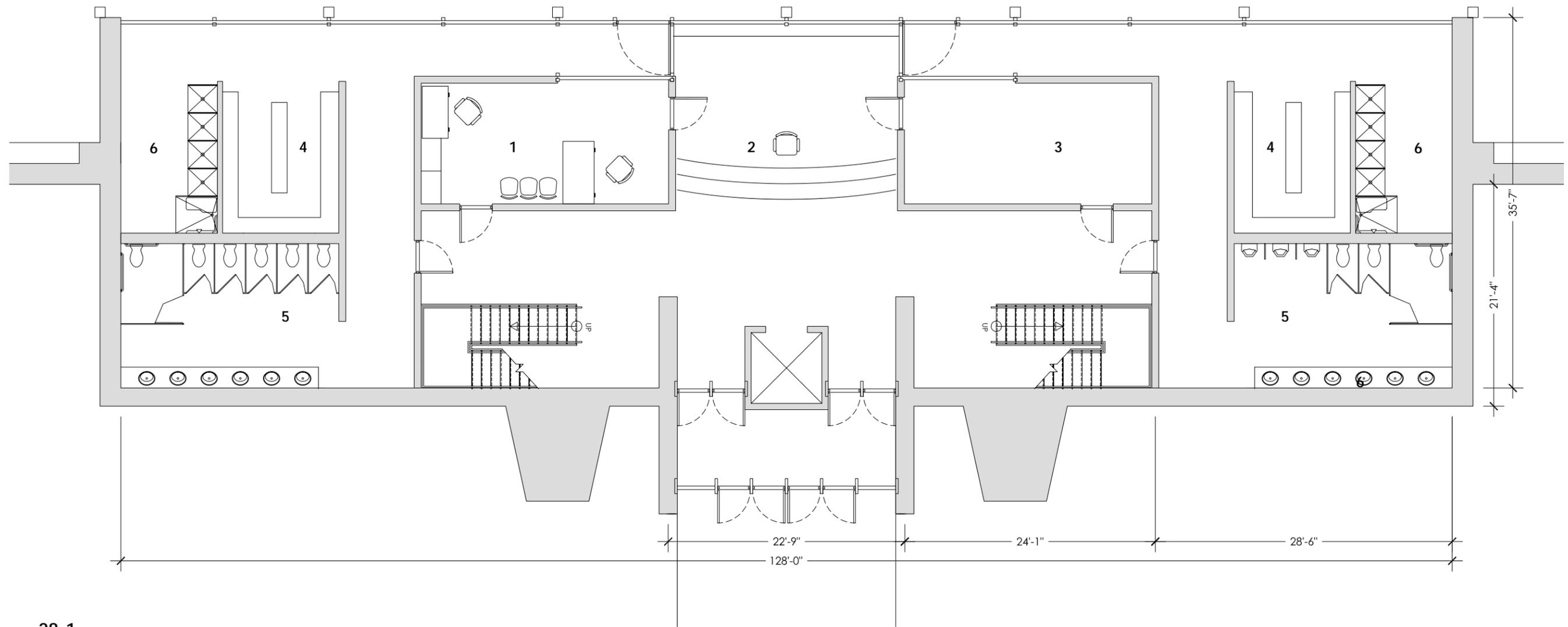
25-3



25-4







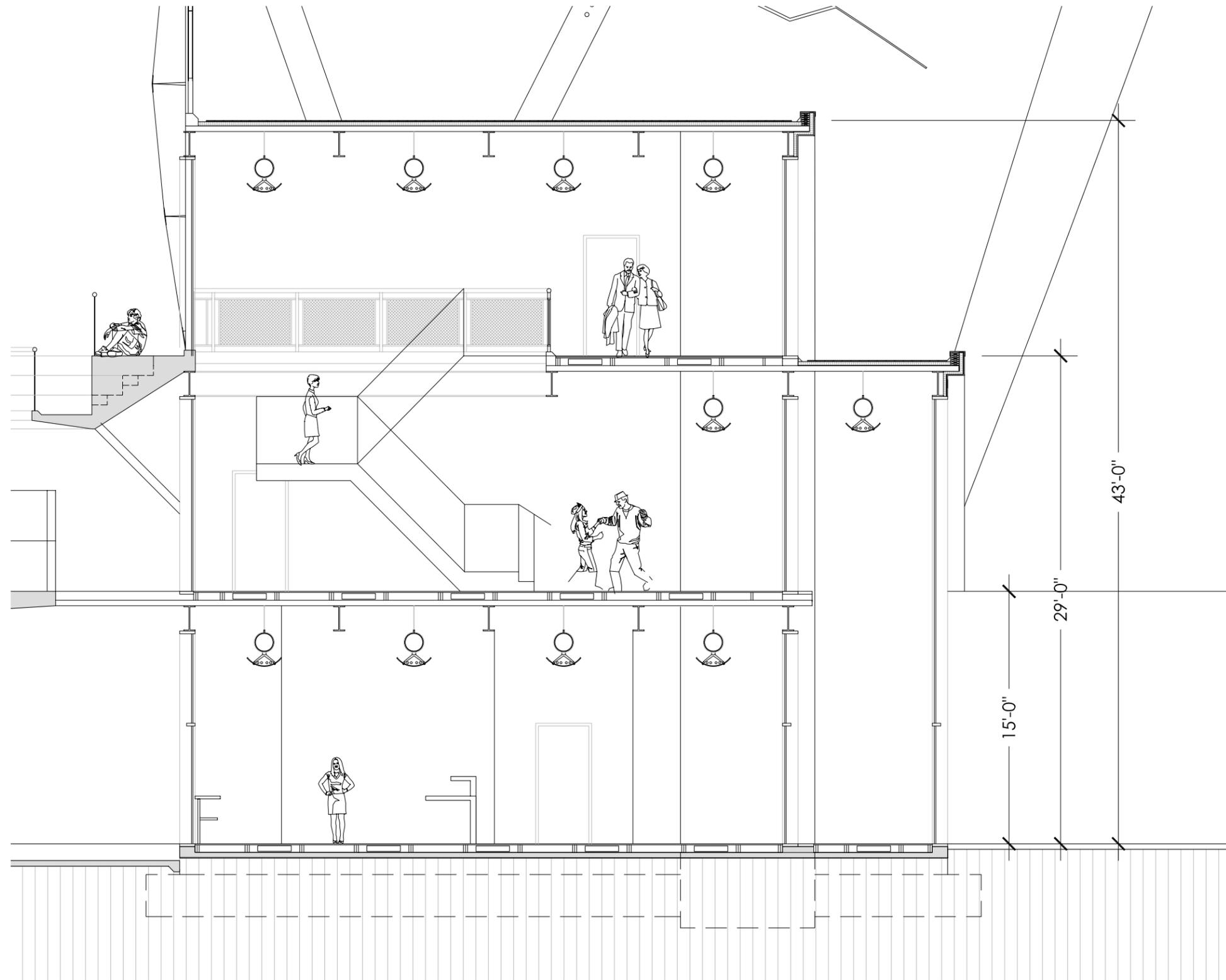
28-1

THE SPECTATOR

A PROLOGUE TO AN EVENT

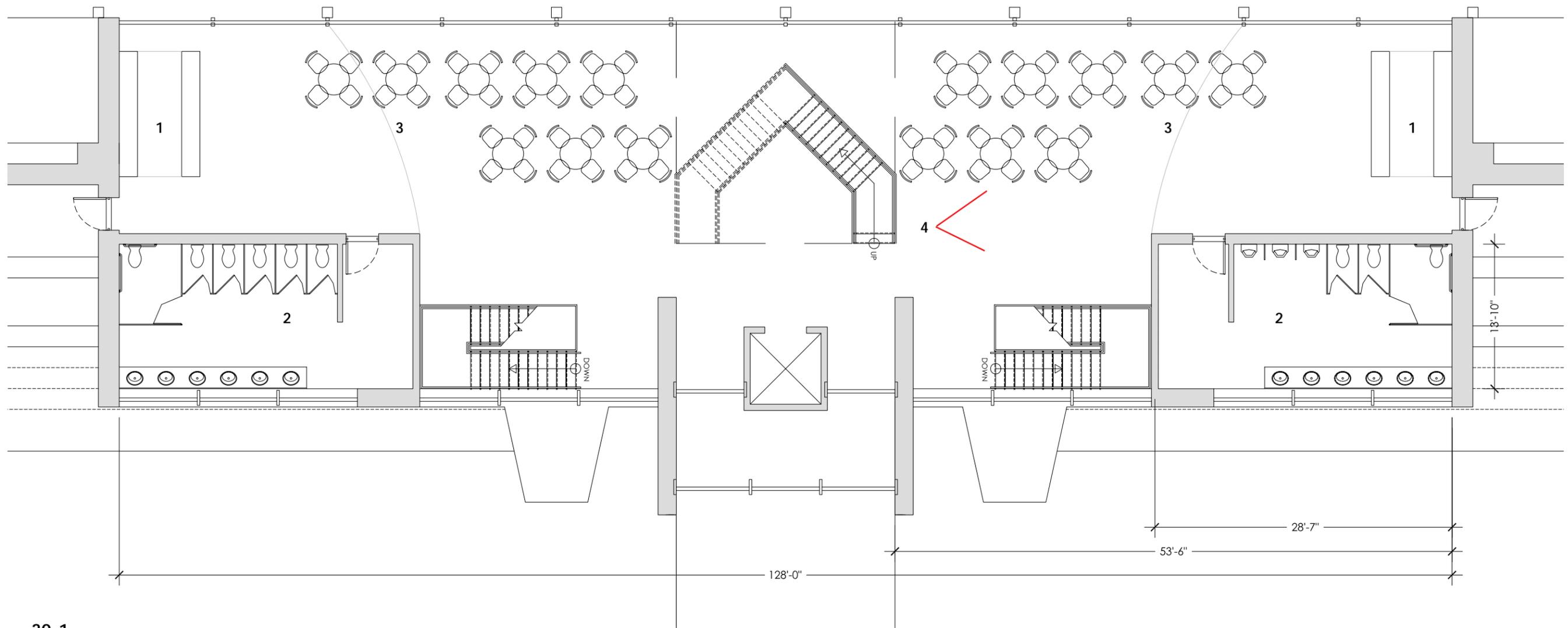
28-1 FIRST FLOOR PLAN

- 1 Office
- 2 Reception
- 3 Storage
- 4 Locker rooms
- 5 Restrooms
- 6 Showers



Meanwhile, the spectators will be greeted by the receptionist at the front desk. To one side of the reception desk is the facilities office and to the other is a small storage space (figure 28-1). This small storage space can be used for smaller objects that are not in use all of the time like chairs, tables, or files that are not needed in the office. Just beyond the receptionist the spectator can see into the warm-up space through a large glass wall. After parting from the athletes the spectators will make their way up to the second level in the support space by way of an elevator or a set of stairs to either side of the elevator.

Visitors will now come to the second level where they find the concessions, restrooms, seating, and a central staircase that will take them up to the spectator seating level (figure 30-1). The elevator will also have access to the third floor.



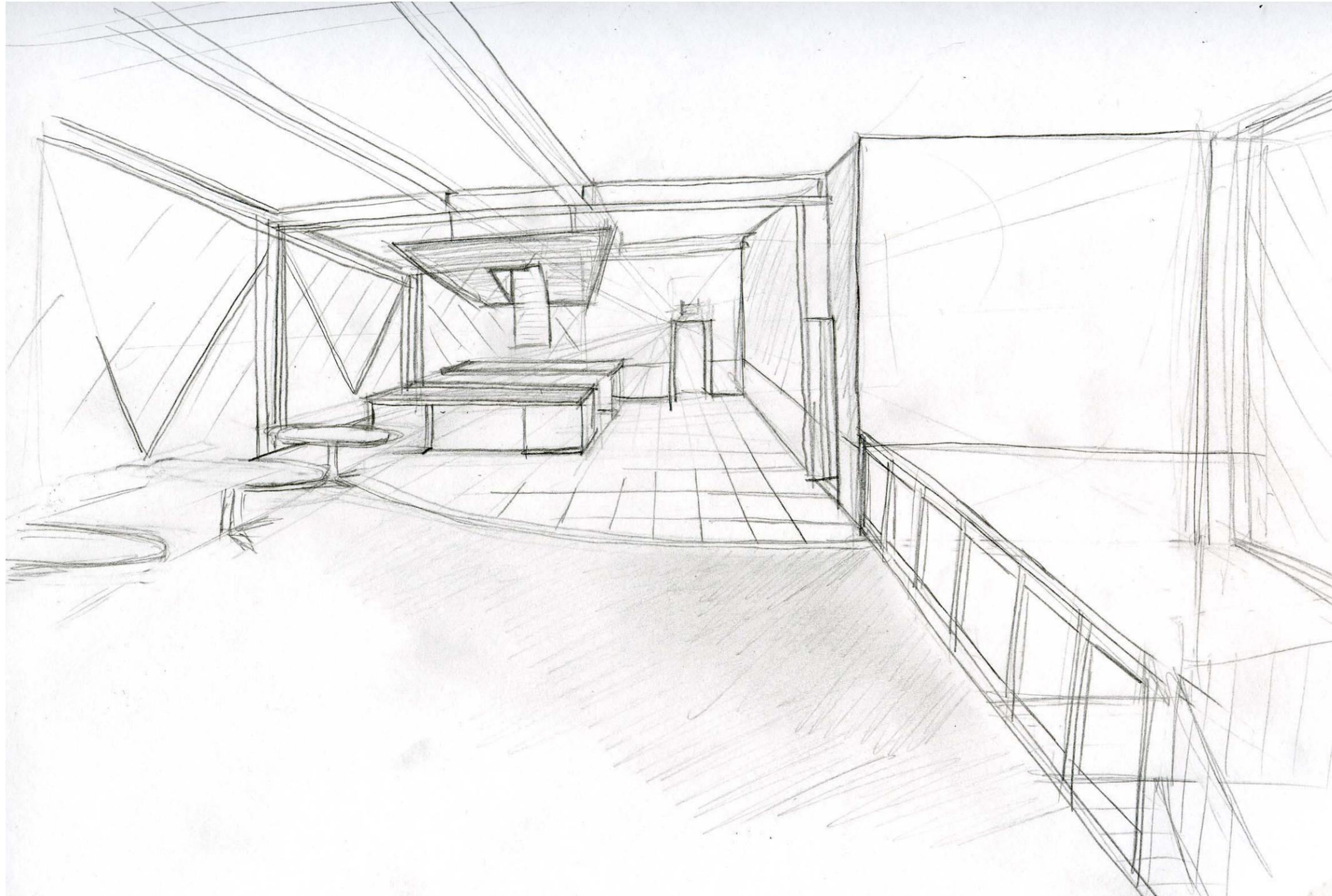
30-1

SECOND FLOOR

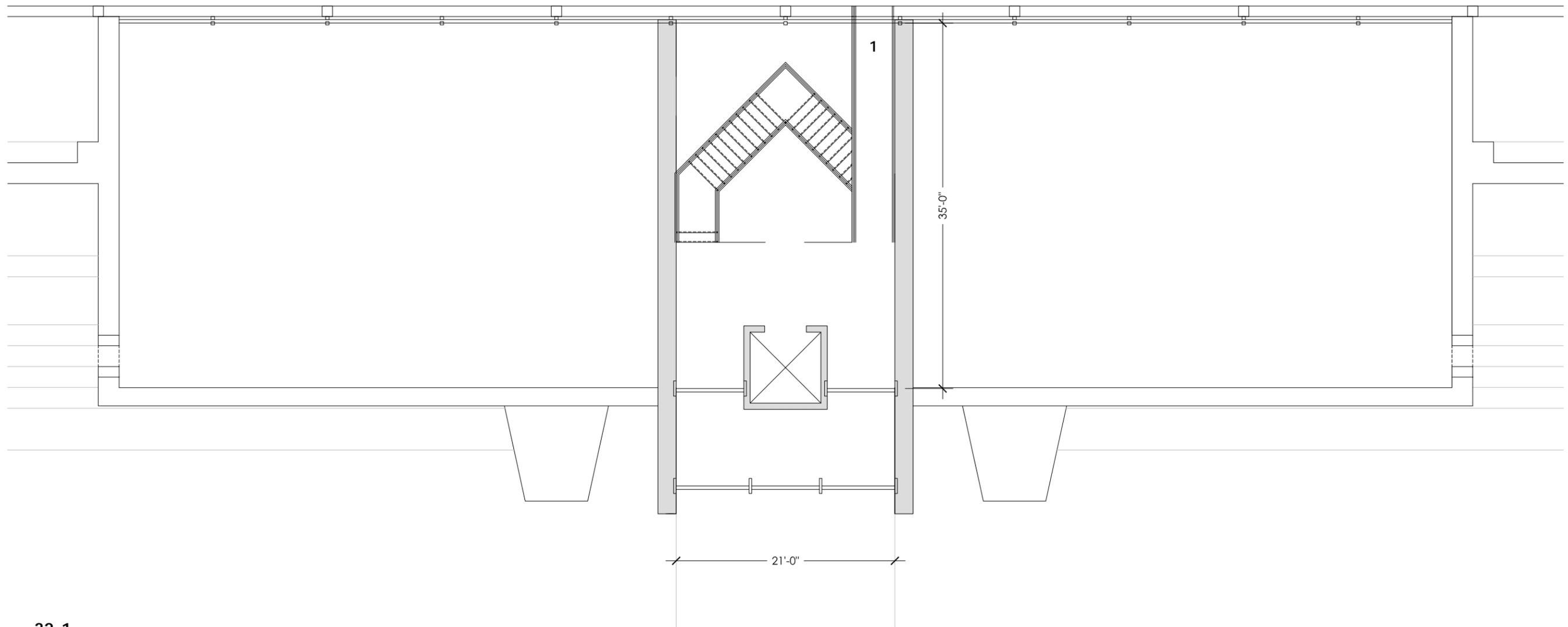
- 1 Second floor plan, concessions, restrooms and seating
- 2 Perspective looking into the concession area

30-1 SECOND FLOOR PLAN

- 1 Concessions
- 2 Restrooms
- 3 Seating
- 4 Perspective view (page 31)



31-2



32-1

THIRD FLOOR

1 Third floor plan, elevator and access to the spectator seating
 PAGE 33 View from the spectator seating at entrance

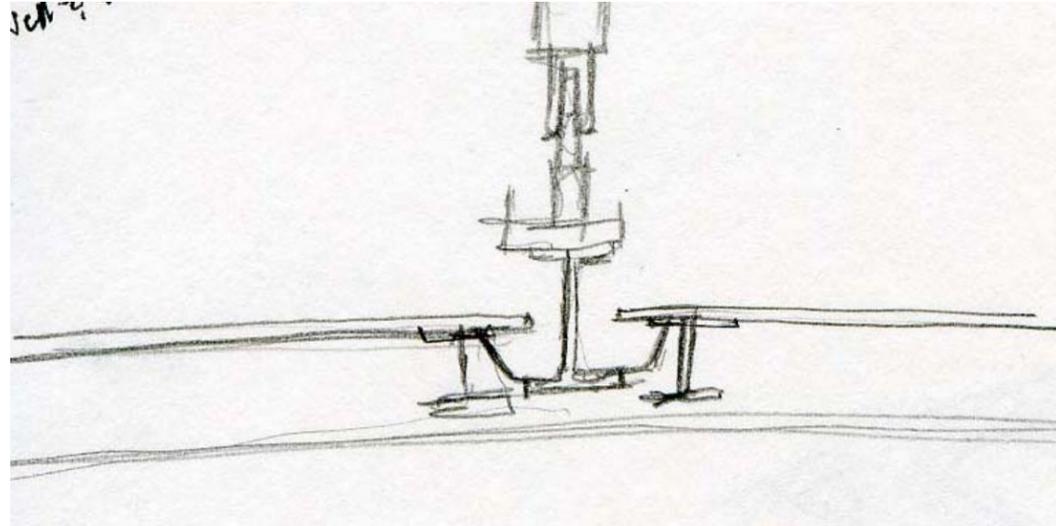
32-1 SECOND FLOOR PLAN

1 Access to spectator seating

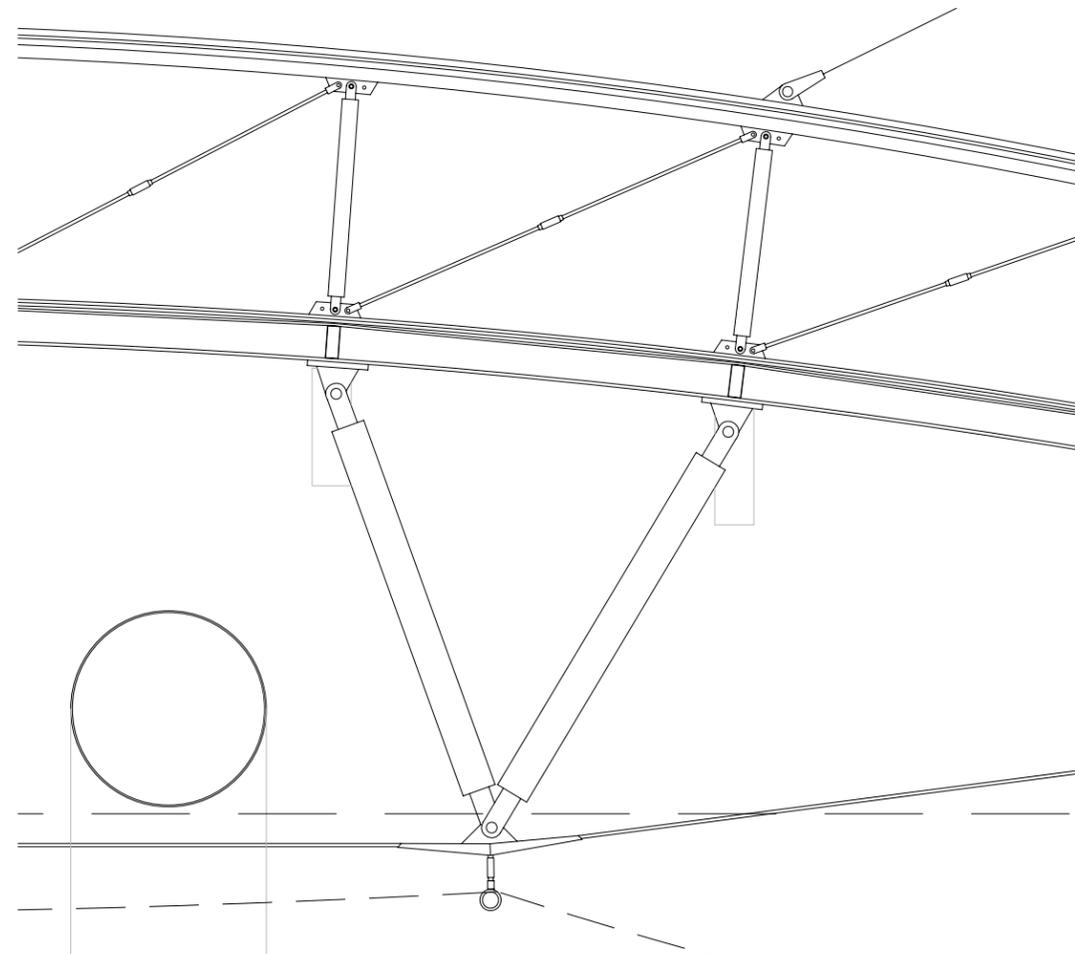


ROOF CONSTRUCTION

- 1 Section through glass layer and drainage if moisture collects below glass fiber membrane
- 2 Top part of truss supports the tensile roof while the lower part supports the glass roof
- 3 Image of connection at base of quad columns
- 4 Column assembly and details



34-1



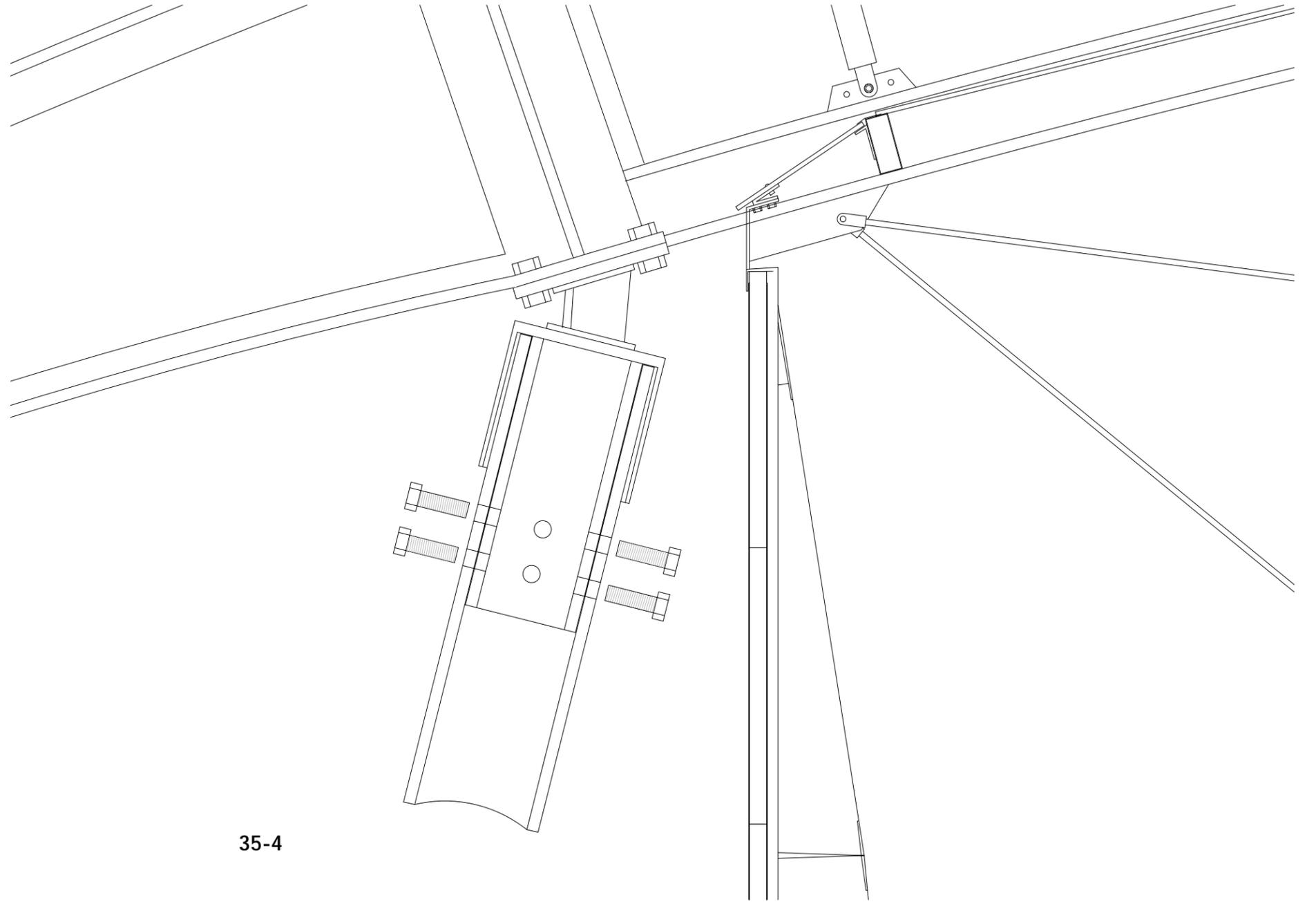
34-2

Now, the spectators can buy a snack from the concessions stand and make their way up to the third floor and out into the spectator seating area (figure 32-1). One of the first things that they notice is the light pouring in through the large roof structure. As the light moves through the first layer of the roof it is dispersed more evenly throughout the space (figure 34-2). Several feet below the fabric membrane rain and sun screen is a layer of glass which acts as the thermal barrier. Looking up into the large structure one notices the light changing as the clouds move past the sun reflecting the conditions outside. The spectators cannot see the sun directly but, filtered through the fabric roof membrane they can follow its path.

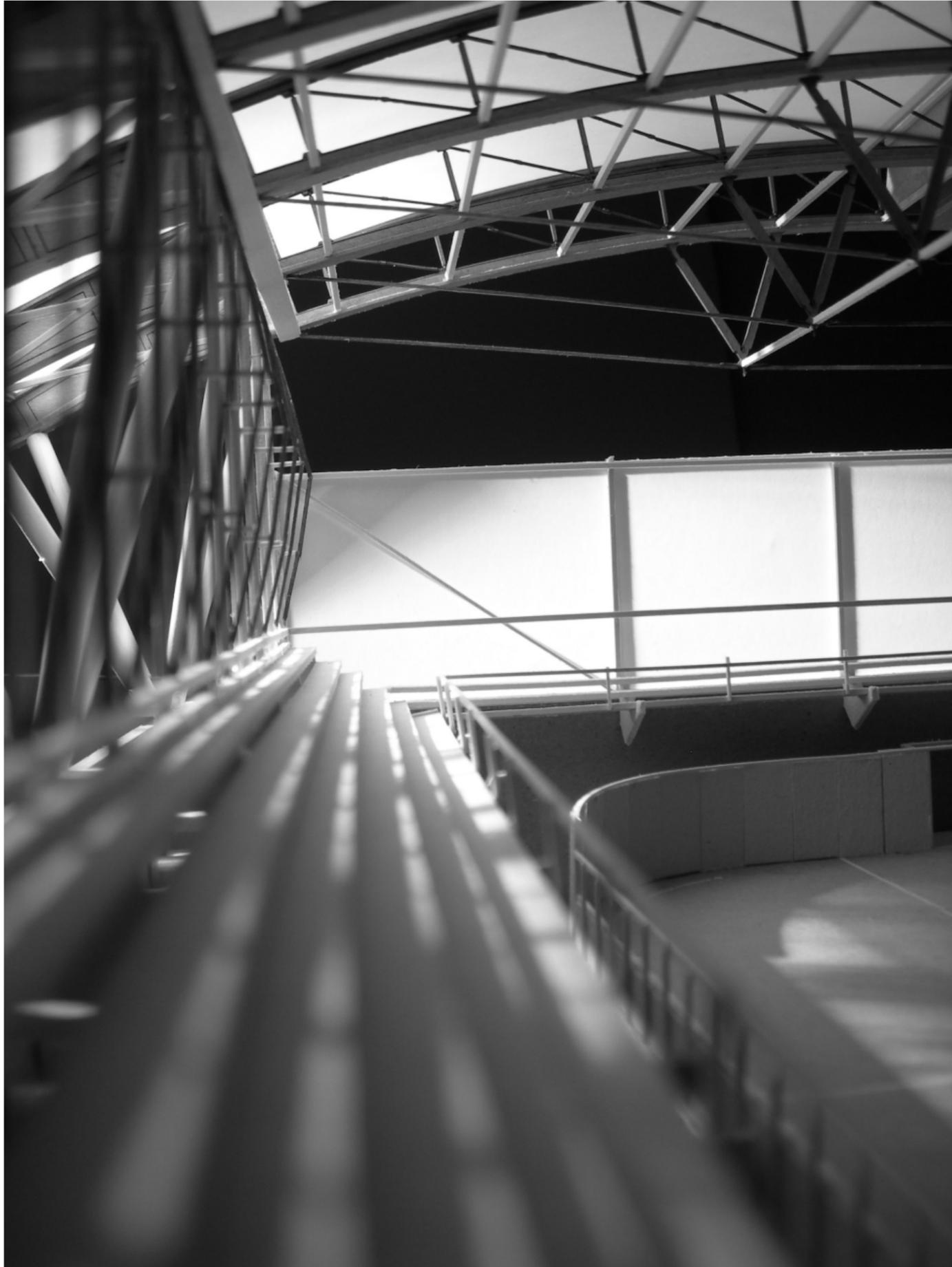
The spectators now follows the structure with their eyes down to the columns holding up this large roof at every other bay (figures 35-3 & 35-4). Through the large glass walls to the north and to the south these column structures are put on display for all to see (figure 41-2).



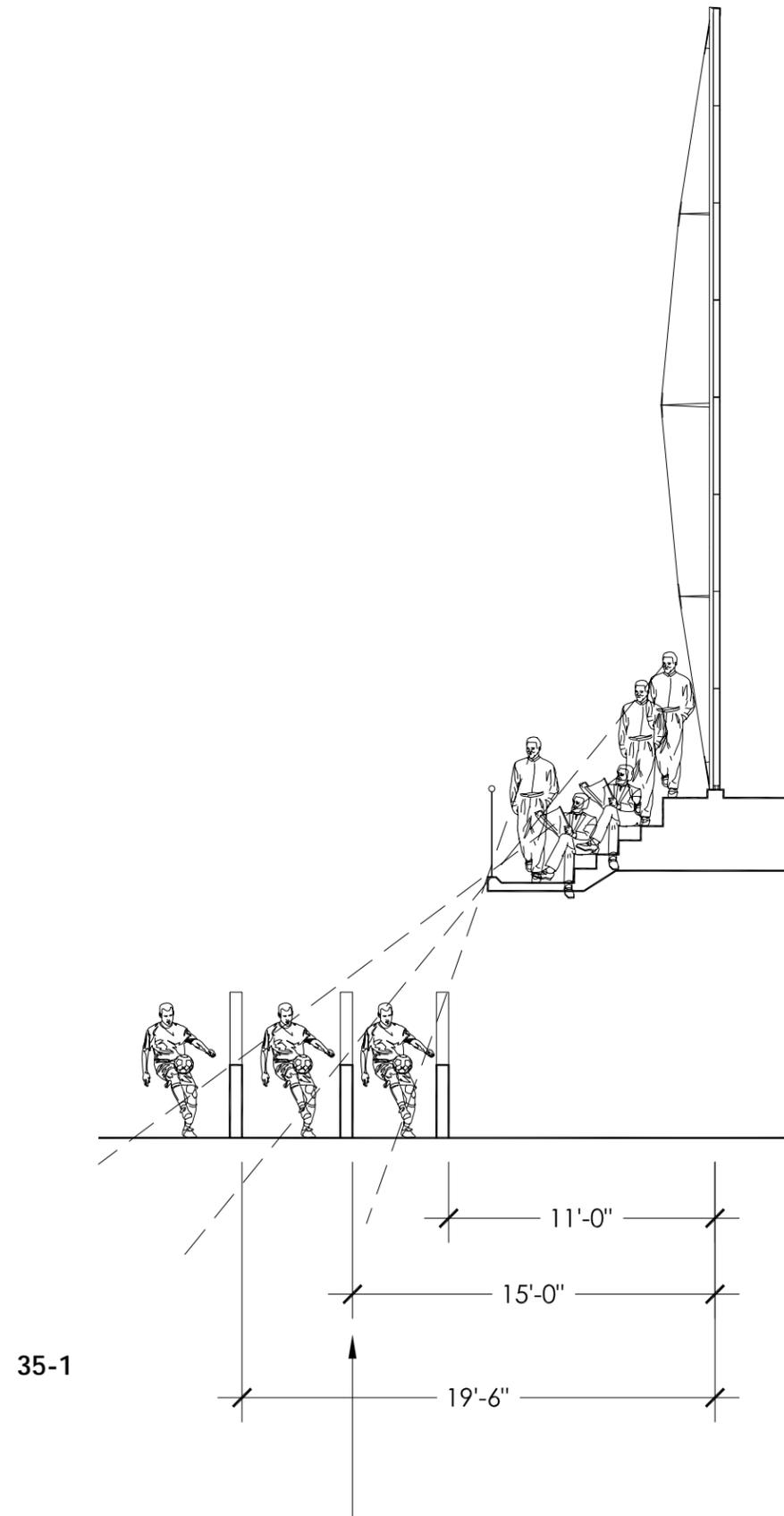
35-3

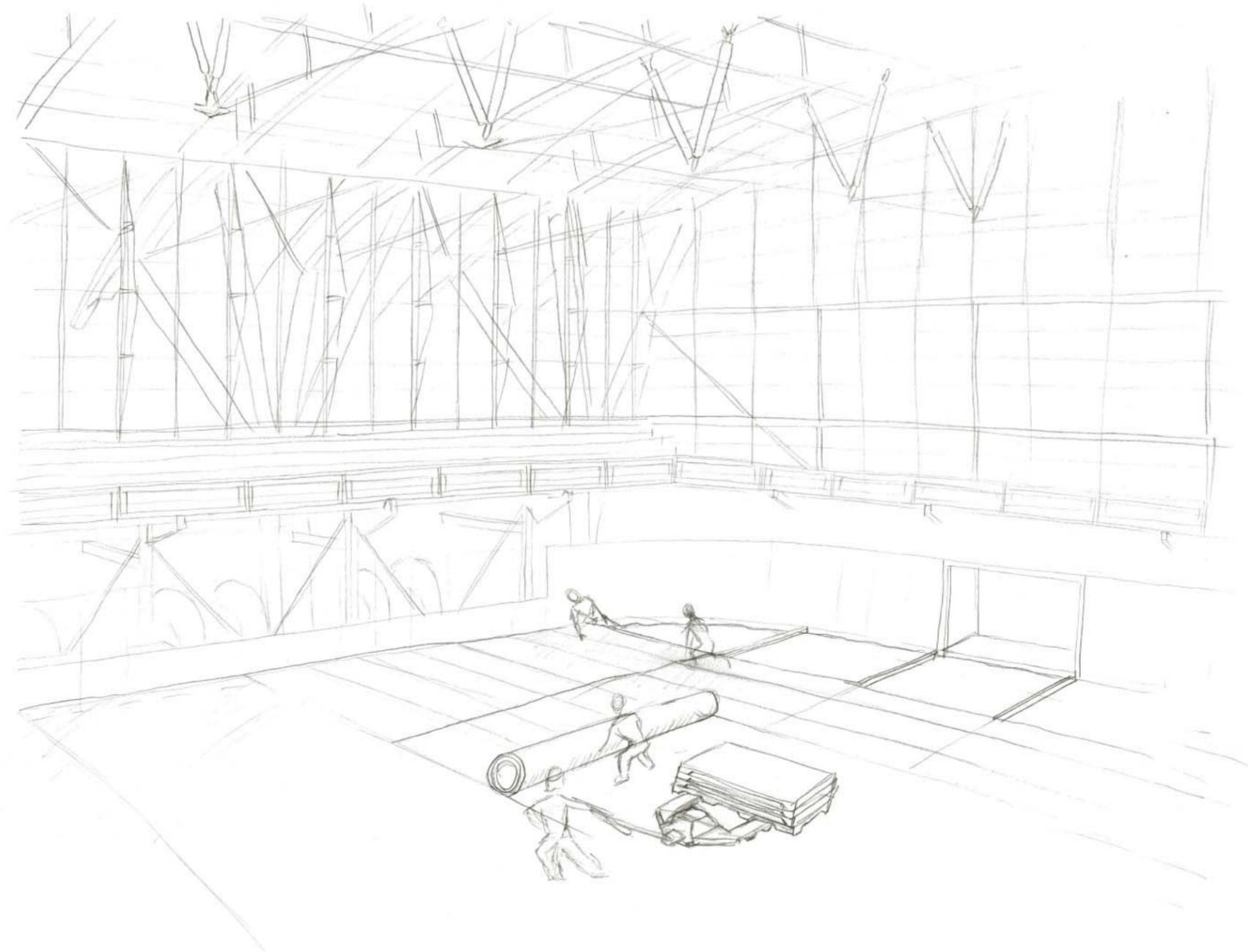


35-4



FLOOR CONSTRUCTION
PAGE 36 Image of spectator
seating on south side of facility
1 Study of spectator position to
field





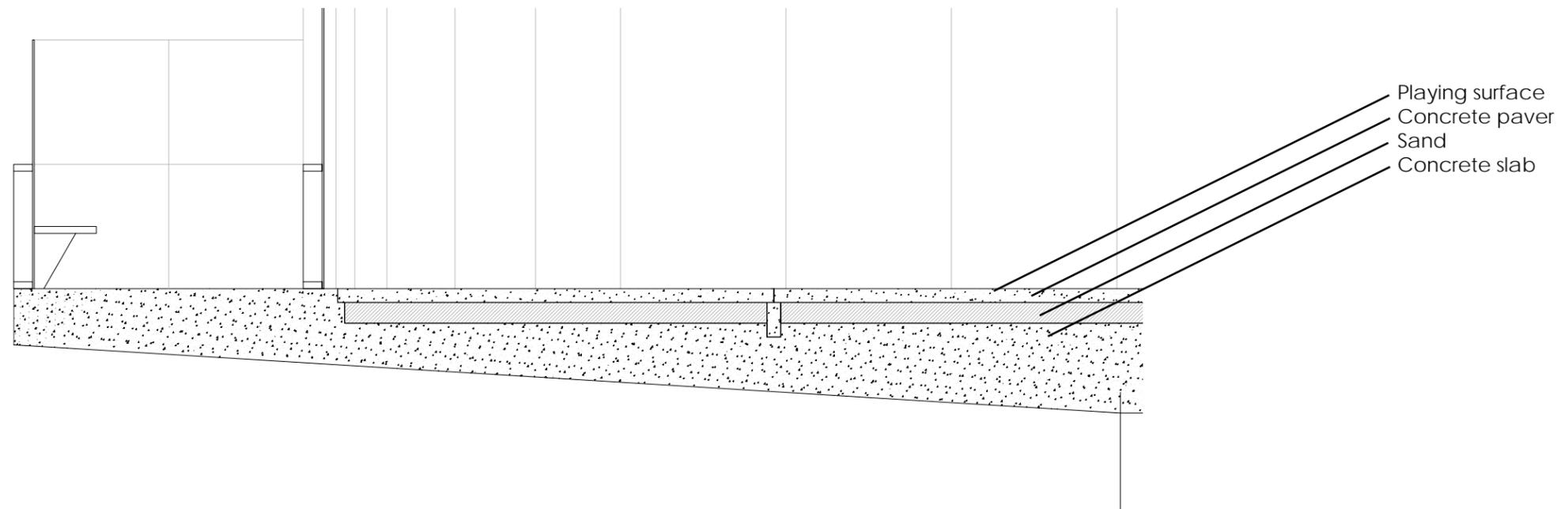
38-1

Now the spectator's eyes have settled down to the field level. The athletes have not taken the pitch, but at one end of the facility there are some employees placing large concrete panels down on the field to cover up what looks to be a layer of sand (figure 38-1 & 39-2). The visitors then recall a sign that they had seen in the lobby about a horse show that had taken place in the facility earlier that day.

The employees have now finished reassembling the floor panels and have rolled out the field carpet. Now the athletes begin to emerge from the darkness below to take the field. It is game time.

FLOOR CONSTRUCTION

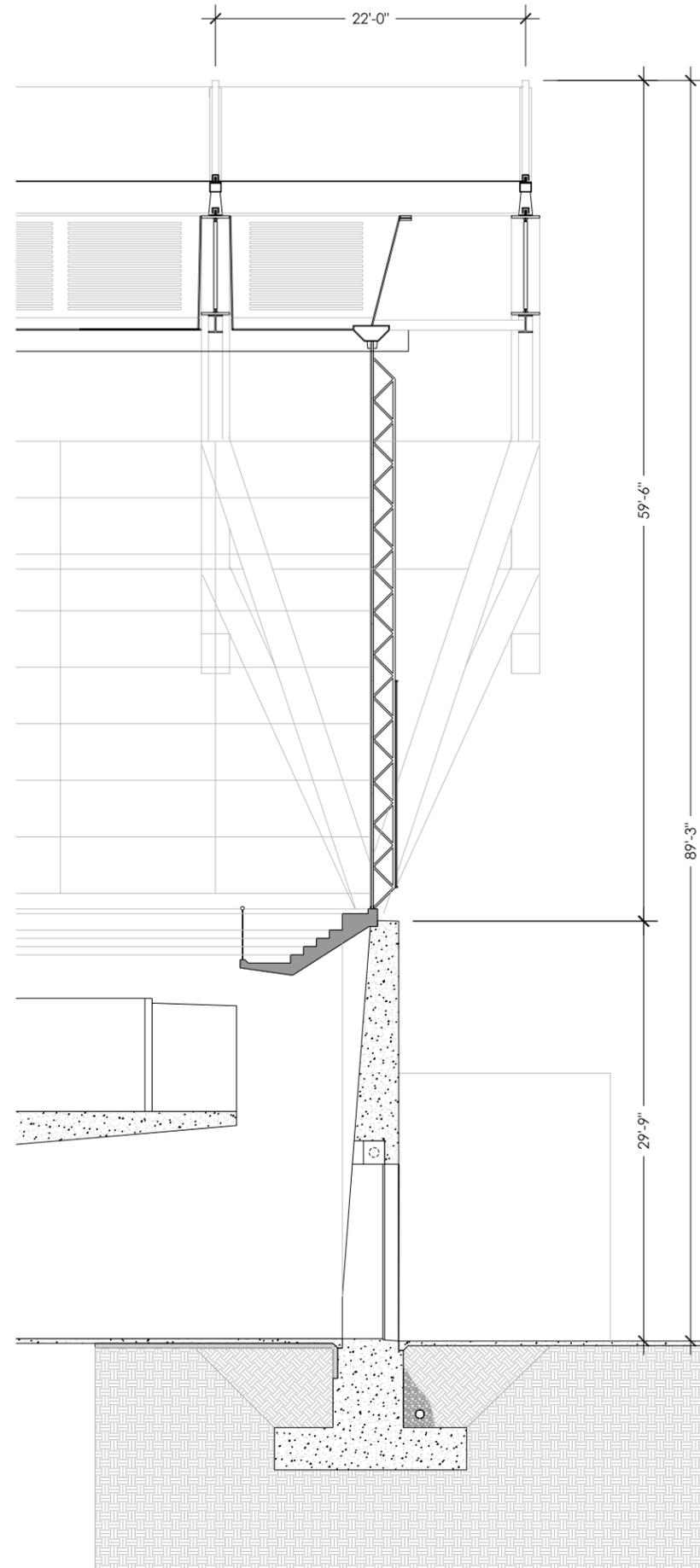
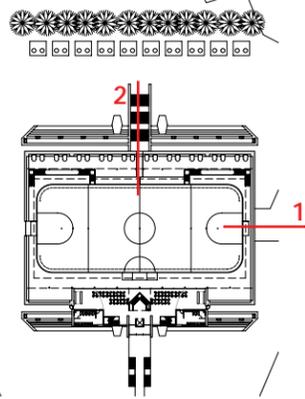
- 1 Floor assembly perspective
- 2 Detail of floor construction with carpet or competition floor applied to large concrete pavers laid over sand



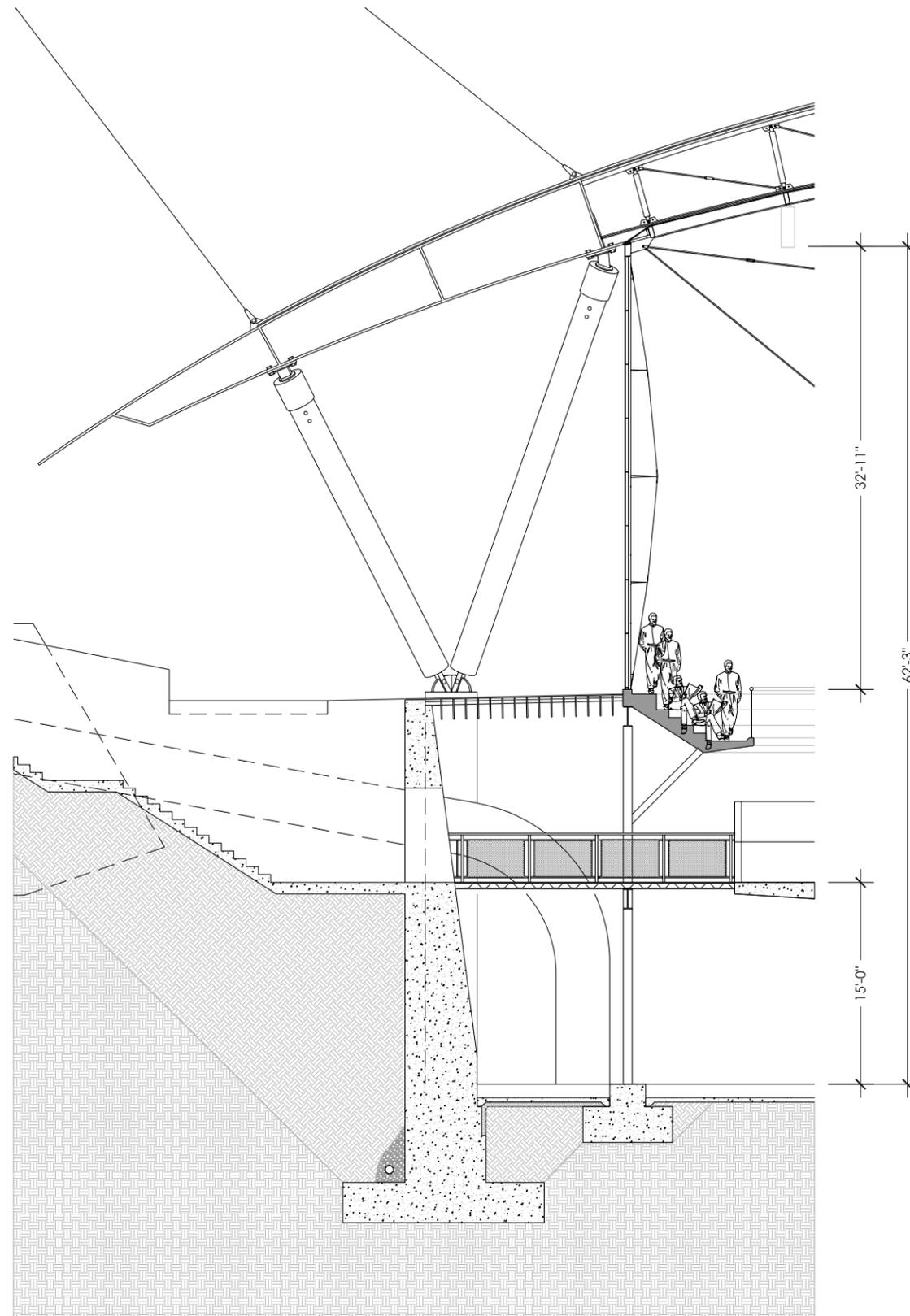
39-2

ROOF CONSTRUCTION

- 1 West wall section at center of wall
- 2 South wall section

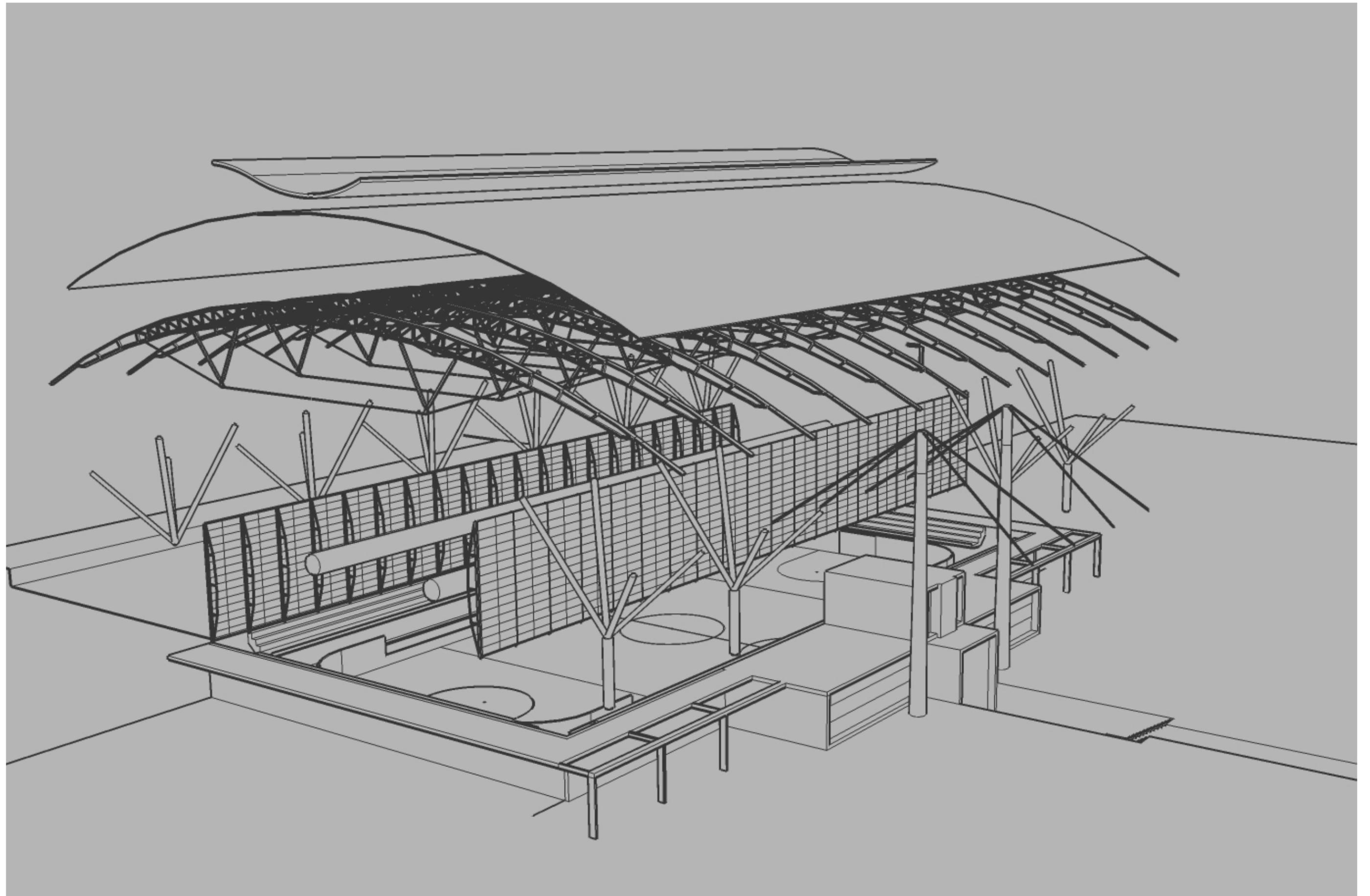


FLOOR CONSTRUCTION
PAGE 42 Image of roof when lit from below
PAGE 43 Exploded assembly drawing of facility
PAGE 44 Image of the cable structure supporting the glass walls on the north and south walls of the building



41-2





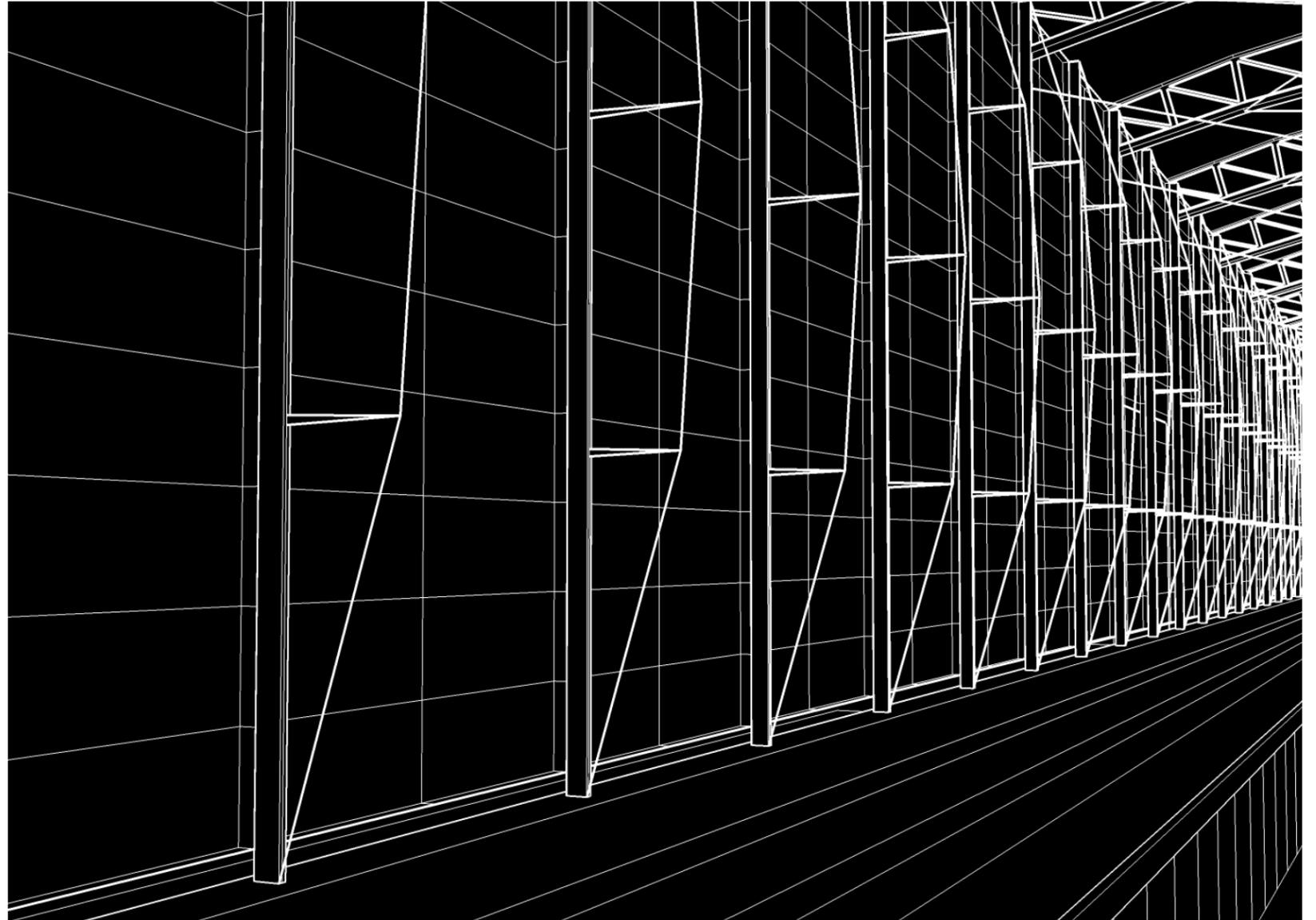
CONCLUSION



This thesis has been an exploration of the expressive opportunities and limitations of steel and a sports facility's connection to the outdoors. The visitors to this facility are to have a clear understanding of the structure and how the roof is held above their head. This was achieved through clearly articulated critical moments in the structure.

The connection to the outdoors was a second important design intent. Natural ventilation and daylighting strategies were employed to achieve the design of an indoor facility that reflected the conditions of the outdoor environment.

The facility was designed with these intentions in mind through the experience of the athlete and spectator. The athlete and the spectator have very different experiences and through this thesis the differences are celebrated and heightened. The result is a facility that expresses its making while allowing both athlete and spectator to be 'connected' to the outdoors.



BIBLIOGRAPHY & IMAGE CREDITS ALL IMAGES BY AUTHOR

Allen, Edward and Iano, Joseph. Fundamentals of Building Construction – Materials and Methods. © 2004 by John Wiley & Sons, Inc., Hoboken, New Jersey p. 427-430 Fabric Structures

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