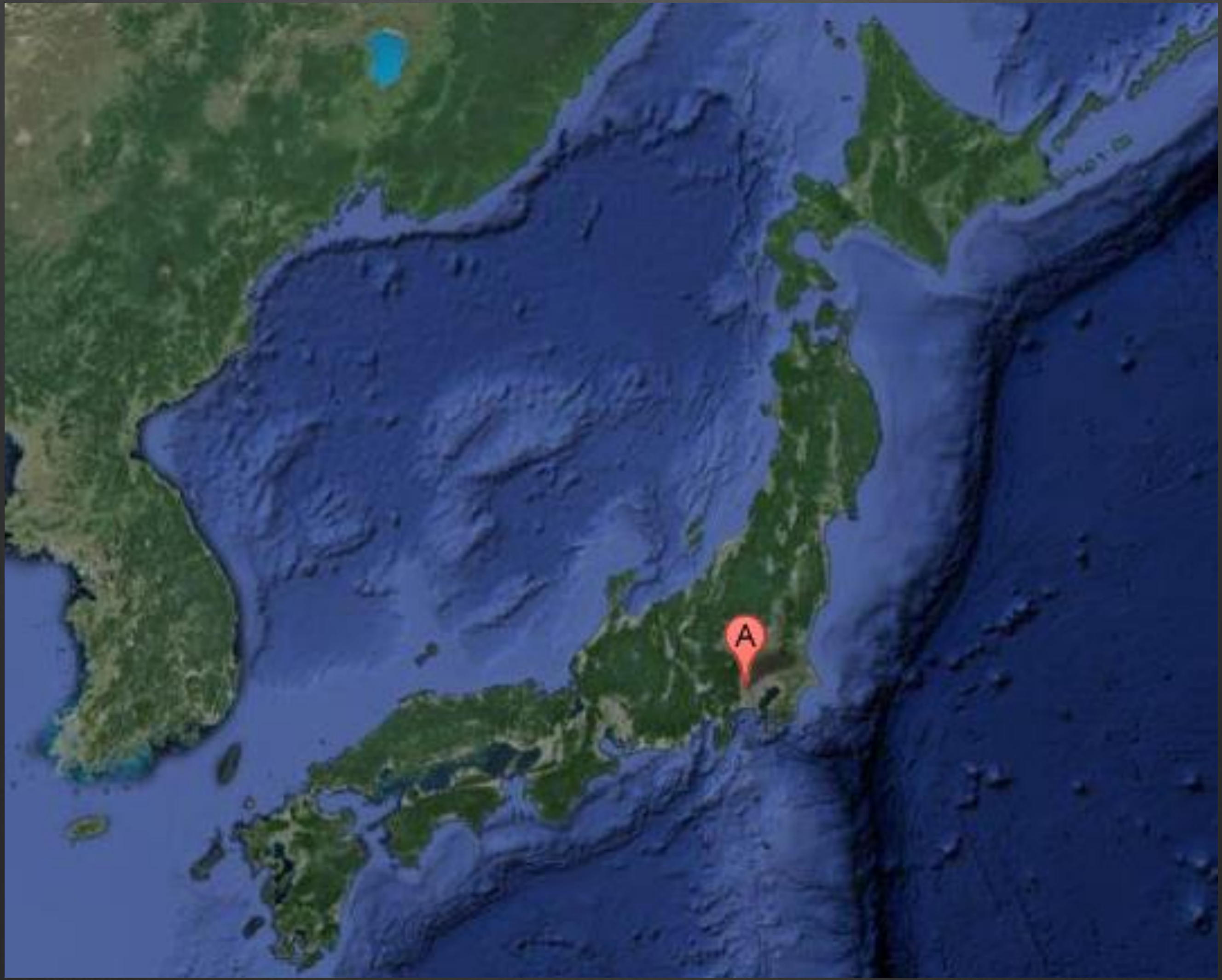
TAMA Art University Library

Tokyo, Japan - By: Toyo Ito, 2007

Architect

- Toyo Ito
- Born in Japan – June 1, 1941
- Recently won the Pritzker Architecture Prize 2013.
- Known for his innovative designs.
- Concrete Designs

Hachioji Tokyo, Japan

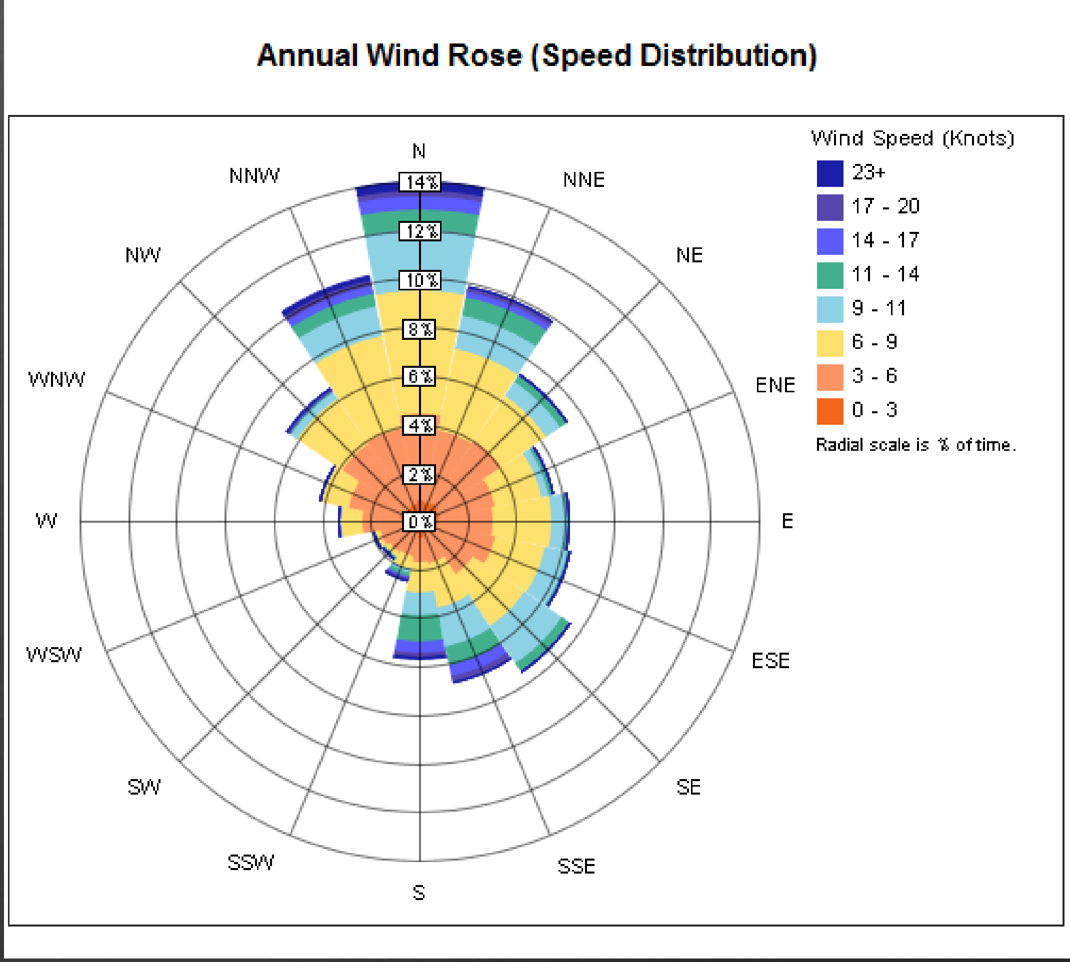


TAMA Art University Campus

Campus North Gate entrance

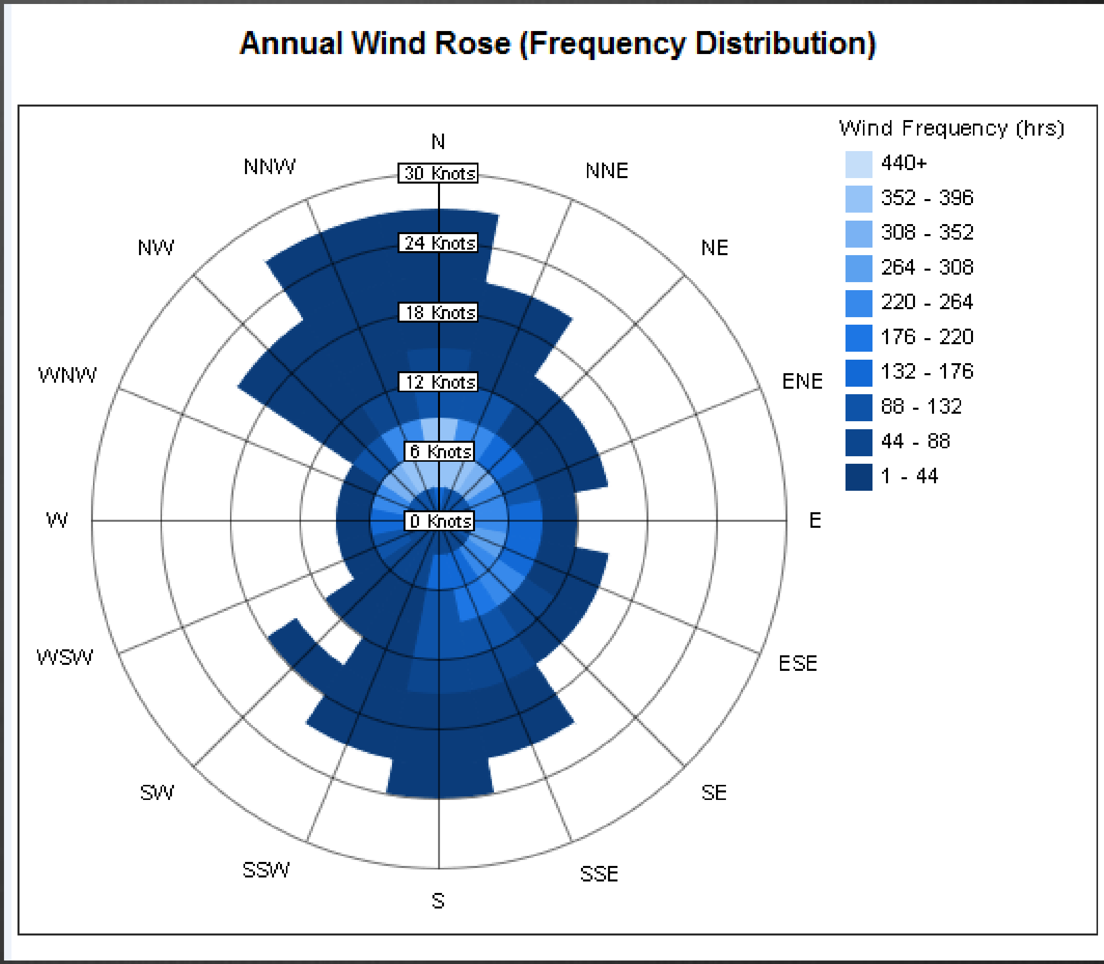
Site's Data

- The fastest wind speed averages from 11 to 23 knots 14% of the year.
- 23 knots ~ 26.5 mph
- 26.5 mph winds are defined as strong breeze and/or high winds, enough to get a red warning flag in costal zones.
- Beaufort number = 6 - 7

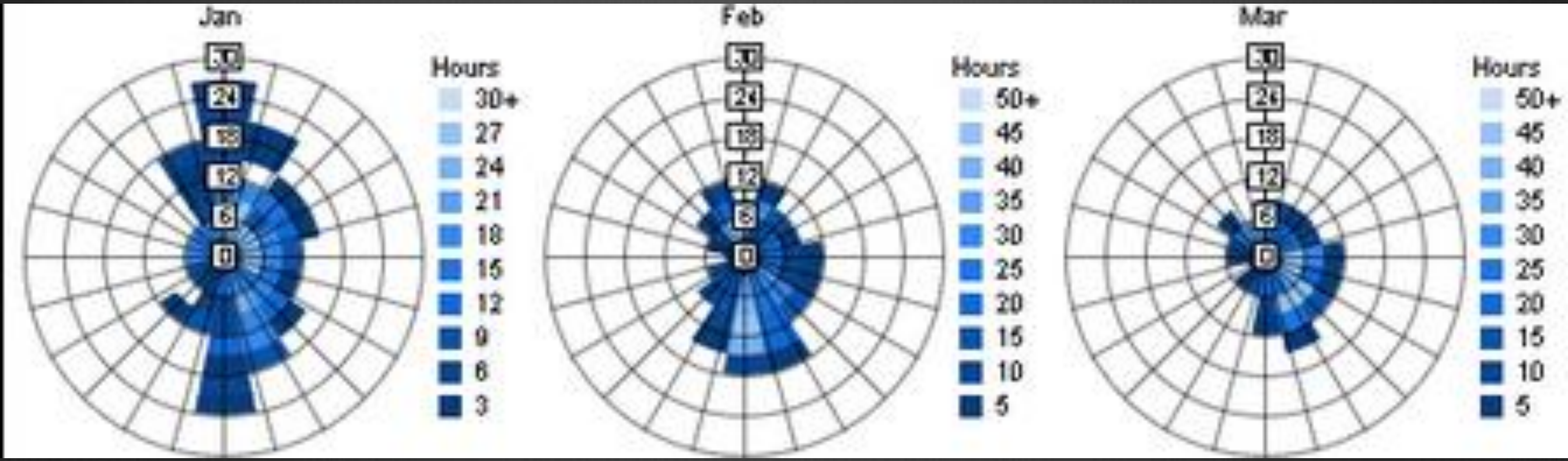


Site's Data

- Most of the wind loads come from the North to South direction.
- Wind frequency is 1-132 hrs and from 12 to 24 knots.
- 1 knot = 1.15 mph
- January and December have the highest wind frequency.

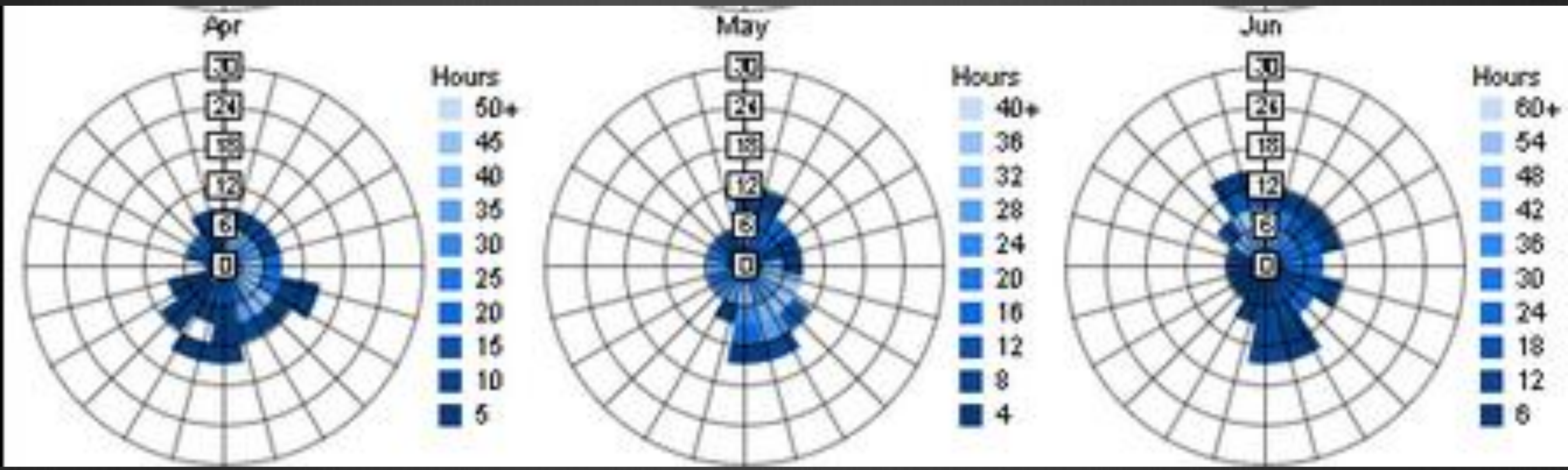


Jan – Feb - Mar

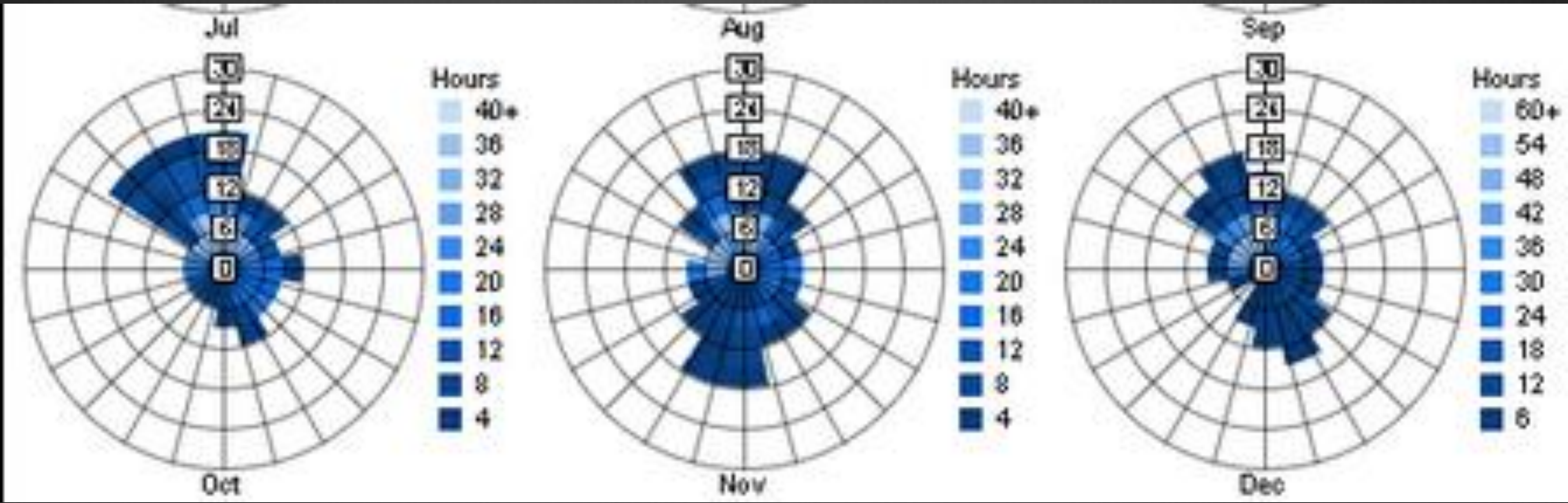


Jan
Hours
30+
27
24
21
18
15
12
9
6
3
Feb
Hours
50+
45
40
35
30
25
20
15
10
5
Mar
Hours
50+
45
40
35
30
25
20
15
10
5

Apr – May - Jun

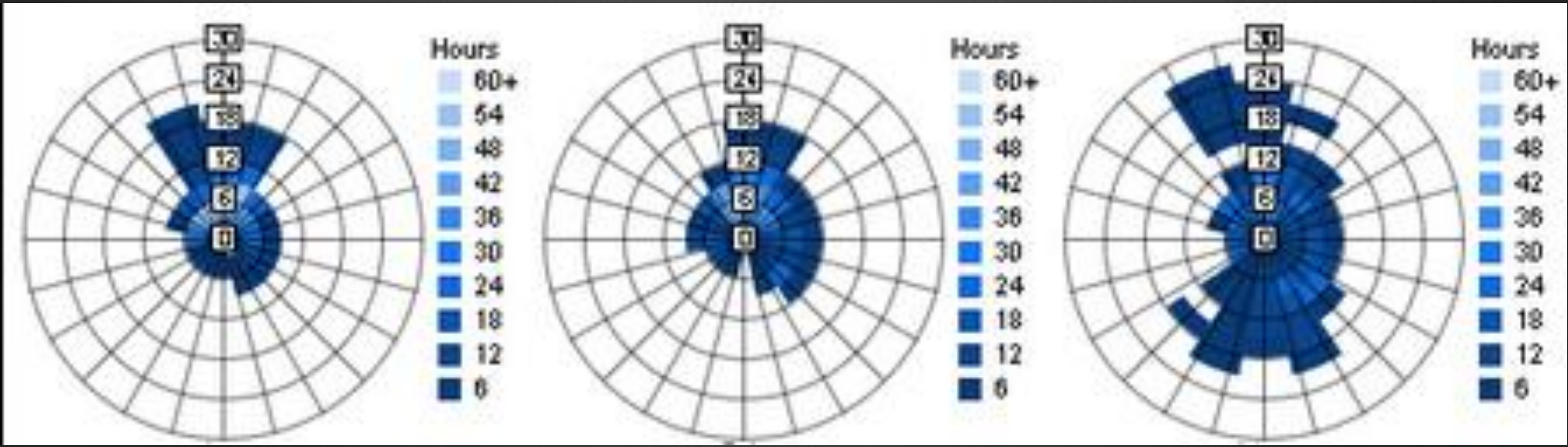

Apr
30
24
18
12
6
0
Hours
50+
45
40
35
30
25
20
15
10
5
May
30
24
18
12
6
0
Hours
40+
36
32
28
24
20
16
12
8
4
Jun
30
24
18
12
6
0
Hours
60+
54
48
42
36
30
24
18
12
6

Jul – Aug - Sep

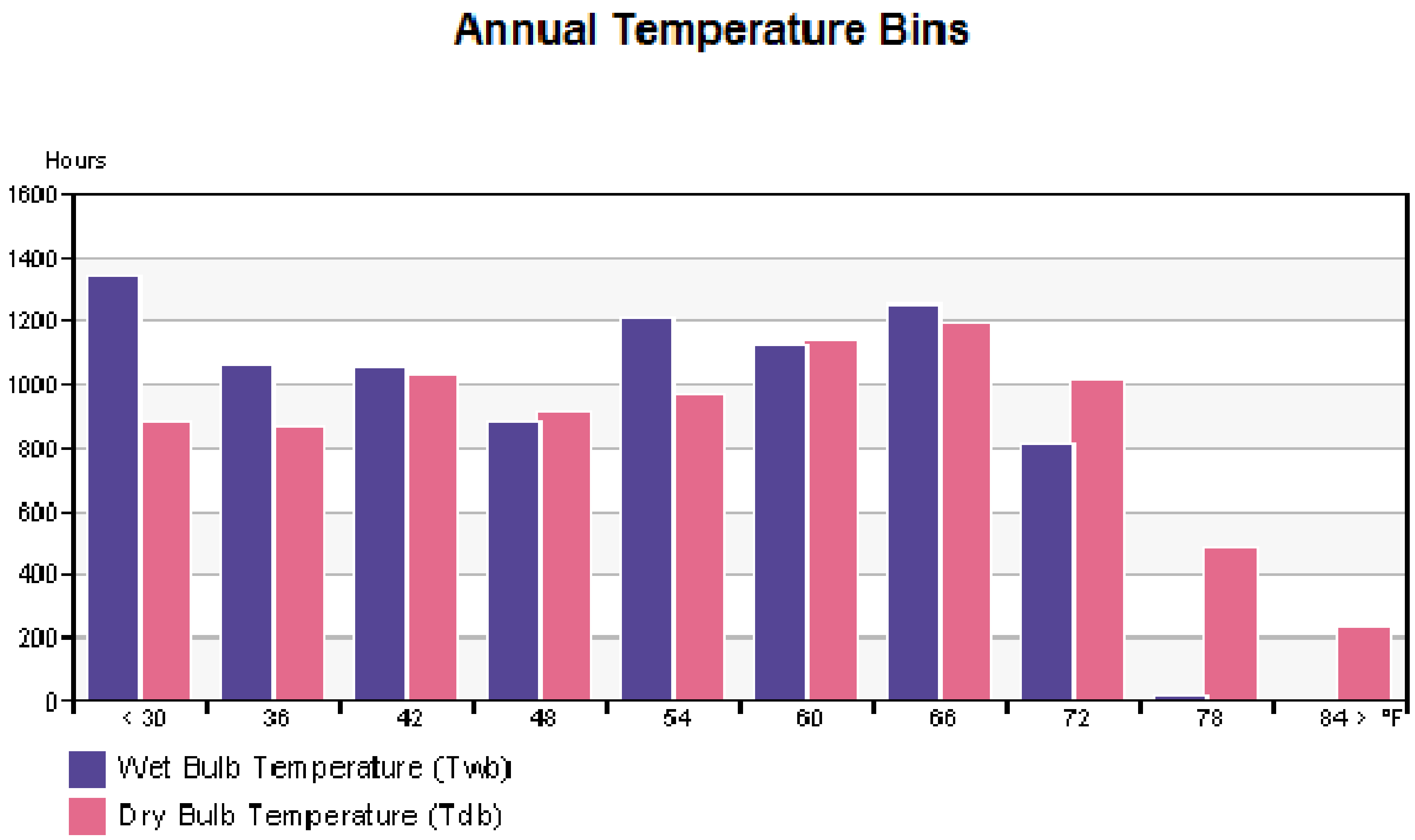


Jul
30
24
18
12
6
0
Oct
Hours
40+
36
32
28
24
20
16
12
8
4
Aug
Nov
Hours
40+
36
32
28
24
20
16
12
8
4
Sep
Dec
Hours
60+
54
48
42
36
30
24
18
12
6

Oct – Nov - Dec

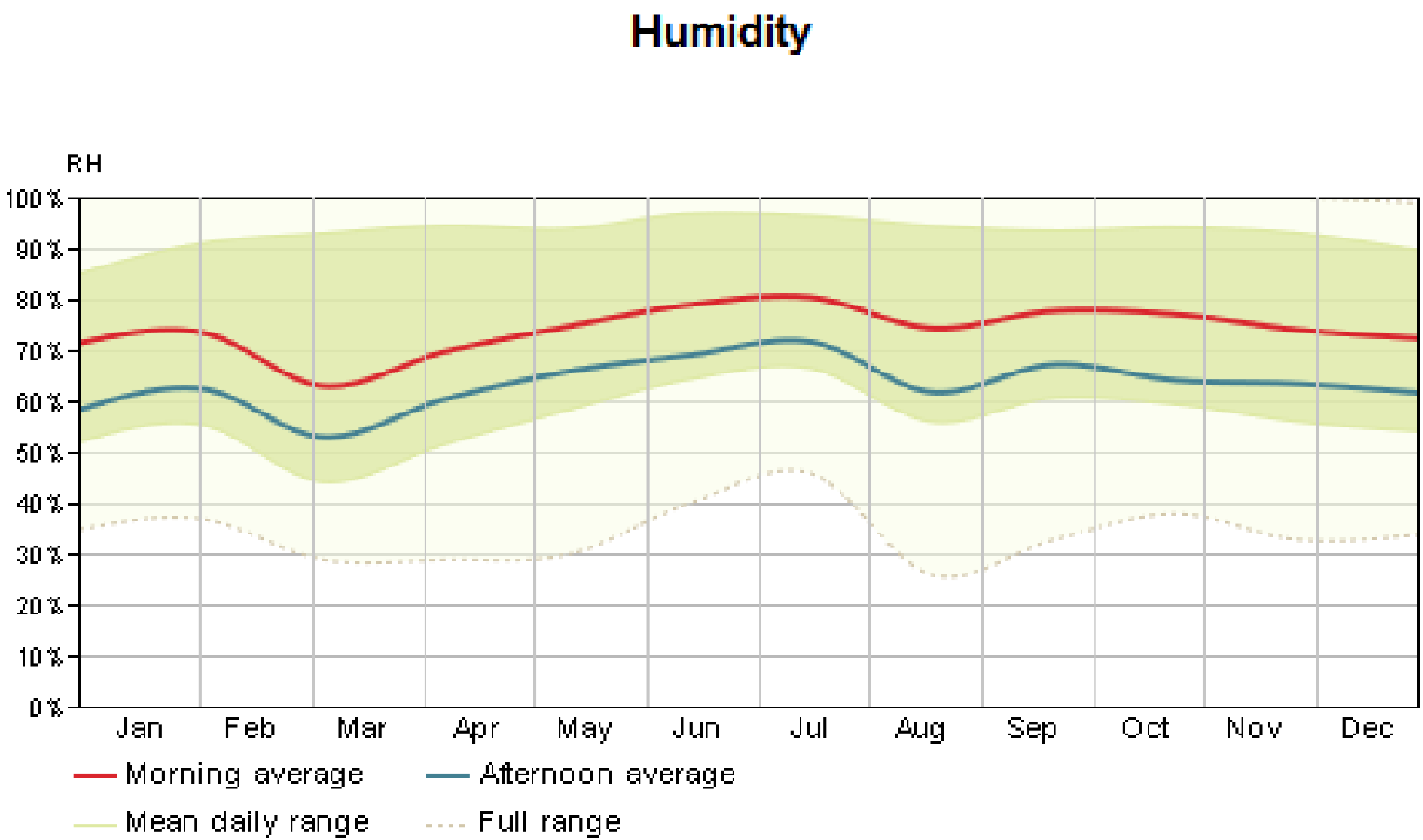


Site's Data

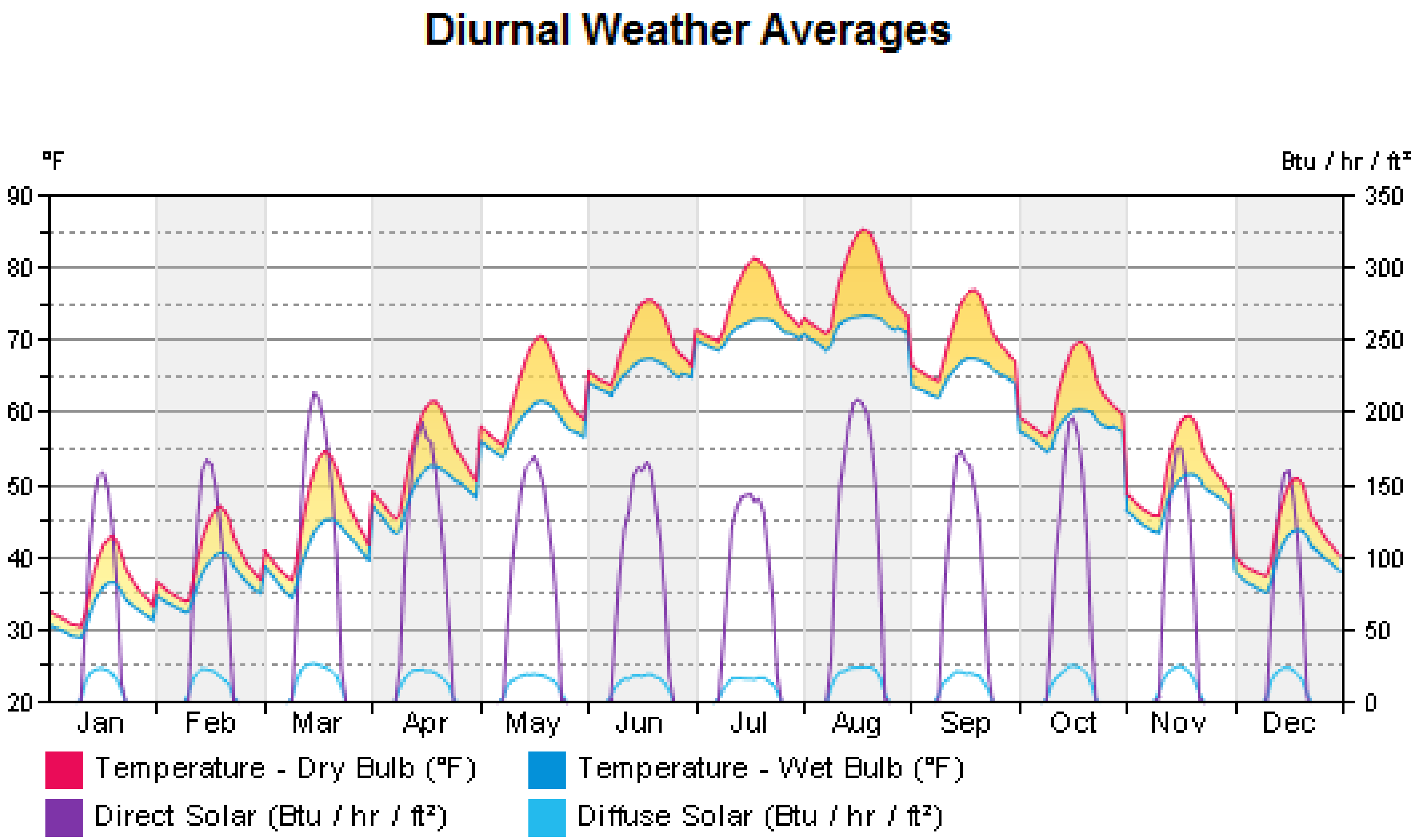


Annual Temperature Bins
Hours
1600
1400
1200
1000
800
600
400
200
0
< 30
36
42
48
54
60
66
72
78
84 >
°F
Wet Bulb Temperature (Twb)
Dry Bulb Temperature (Tdb)

Site's Data


Humidity
RH
100 %
90 %
80 %
70 %
60 %
50 %
40 %
30 %
20 %
10 %
0 %
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Morning average
Afternoon average
Mean daily range
Full range

Site's Data



Diurnal Weather Averages
°F
Btu / hr / ft²
90
80
70
60
50
40
30
20
350
300
250
200
150
100
50
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Temperature - Dry Bulb (°F)
Temperature - Wet Bulb (°F)
Direct Solar (Btu / hr / ft²)
Diffuse Solar (Btu / hr / ft²)

Original Idea

- Toyo Ito's main idea was to have a "Cave" like building.
- This concept can be related to the metaphor for the process of learning and enlightenment, a common concept in Buddhism.
- Due to budget issues the building was moved to the surface, keeping the same arches and structure ideas.
- The arches were meant to resemble stalactites, following the original "cave" idea.

New Concept

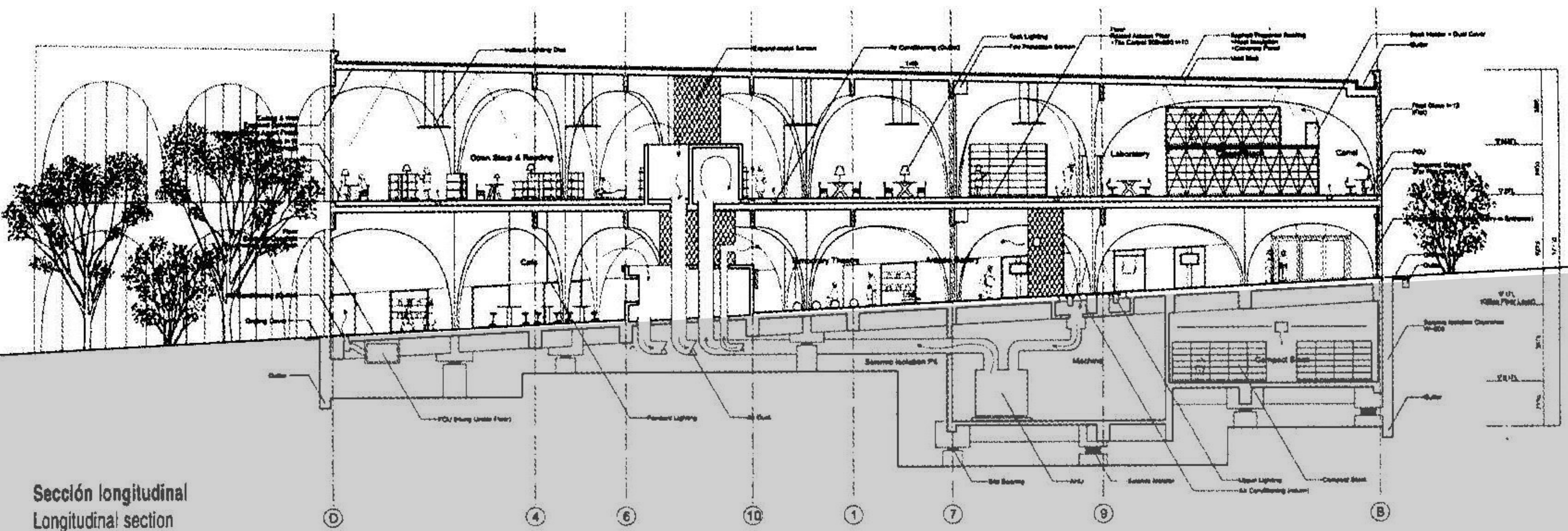
The library was built above ground, which had an opposite outcome from the original idea .

Open Plan

The arches allow for an open plan
which allows continuity through the space.

Seamless Connection

- The architect decided to keep the original slope of the site.
- The slope makes a seamless connection between the interior and exterior spaces.

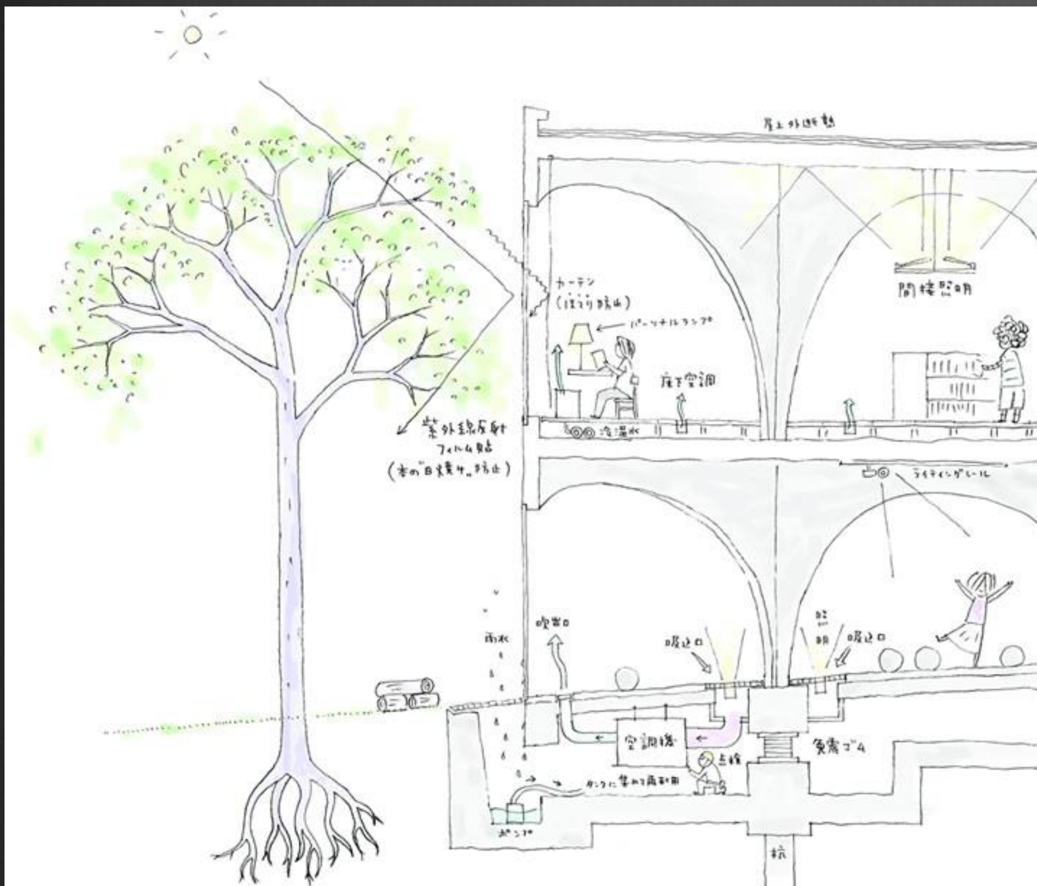


Sección longitudinal
Longitudinal section

Design Feature

- The library is one of the buildings seen at the main entrance, (North).
- The library serves as a communal space for visitors at the first level.
- There is a bus terminal across the street facing the library.
- Many people are attracted to this area after being dropped off.
- The visitors can use the café, and public areas with out necessarily accessing the library.

Design Feature



- Takes advantage of the natural environment
- Introduces natural light through large pieces of glass.
- Branches of large trees offer shade for interior spaces

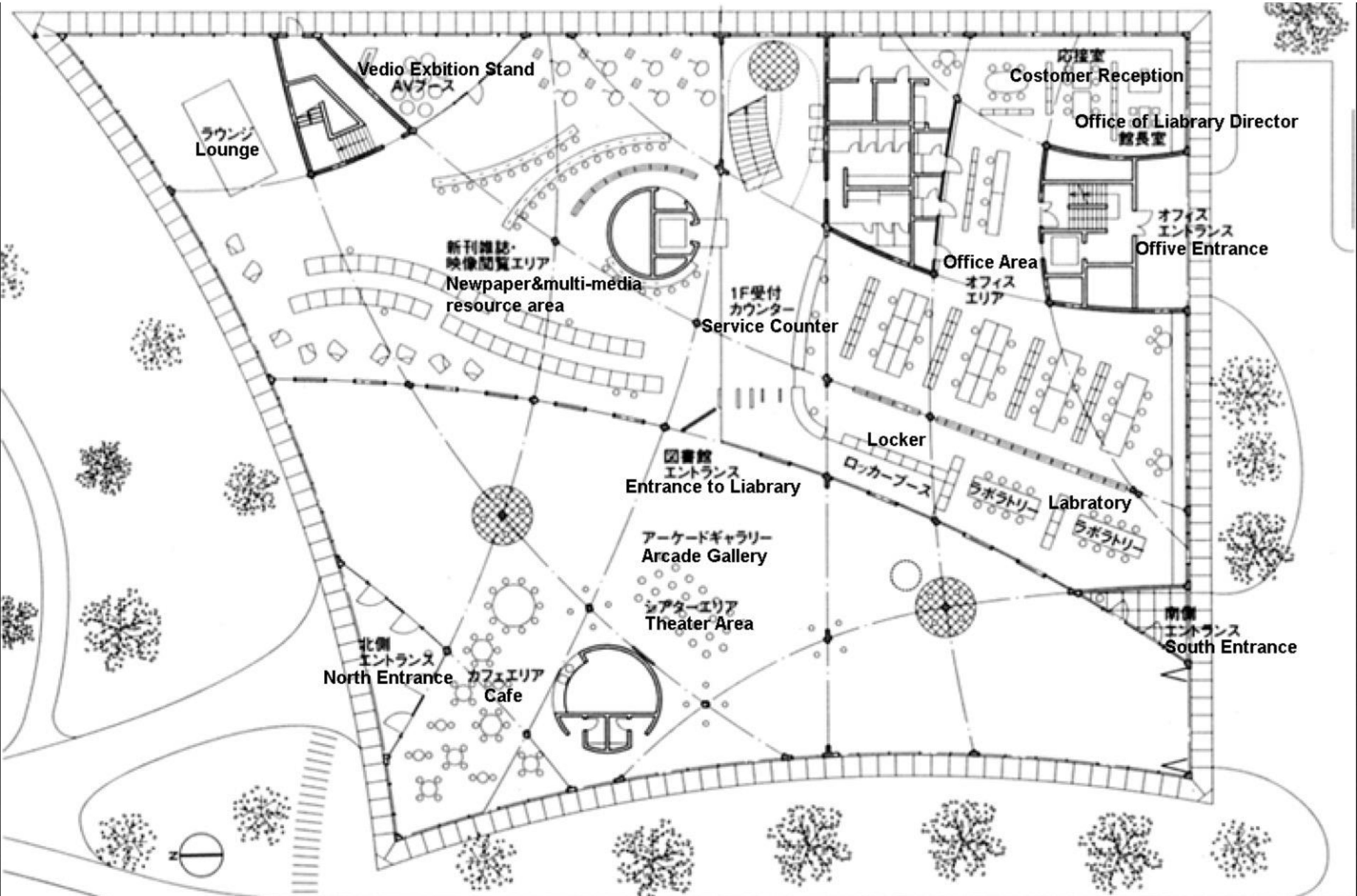
General Information

- Structure systems: Structure steel, concrete mixed structure and reinforced concrete
- Scale: 2 stories, 1 semi-basement
- Site Area: 1,713,451.68 sq. ft. ~ 159,184.87m2
- Building Area: 23,945.28 sq. ft. ~ 2,224.59m2
- Total Floor Area: 60,702.64 sq. ft. ~ 639.46m2

The “Grid”

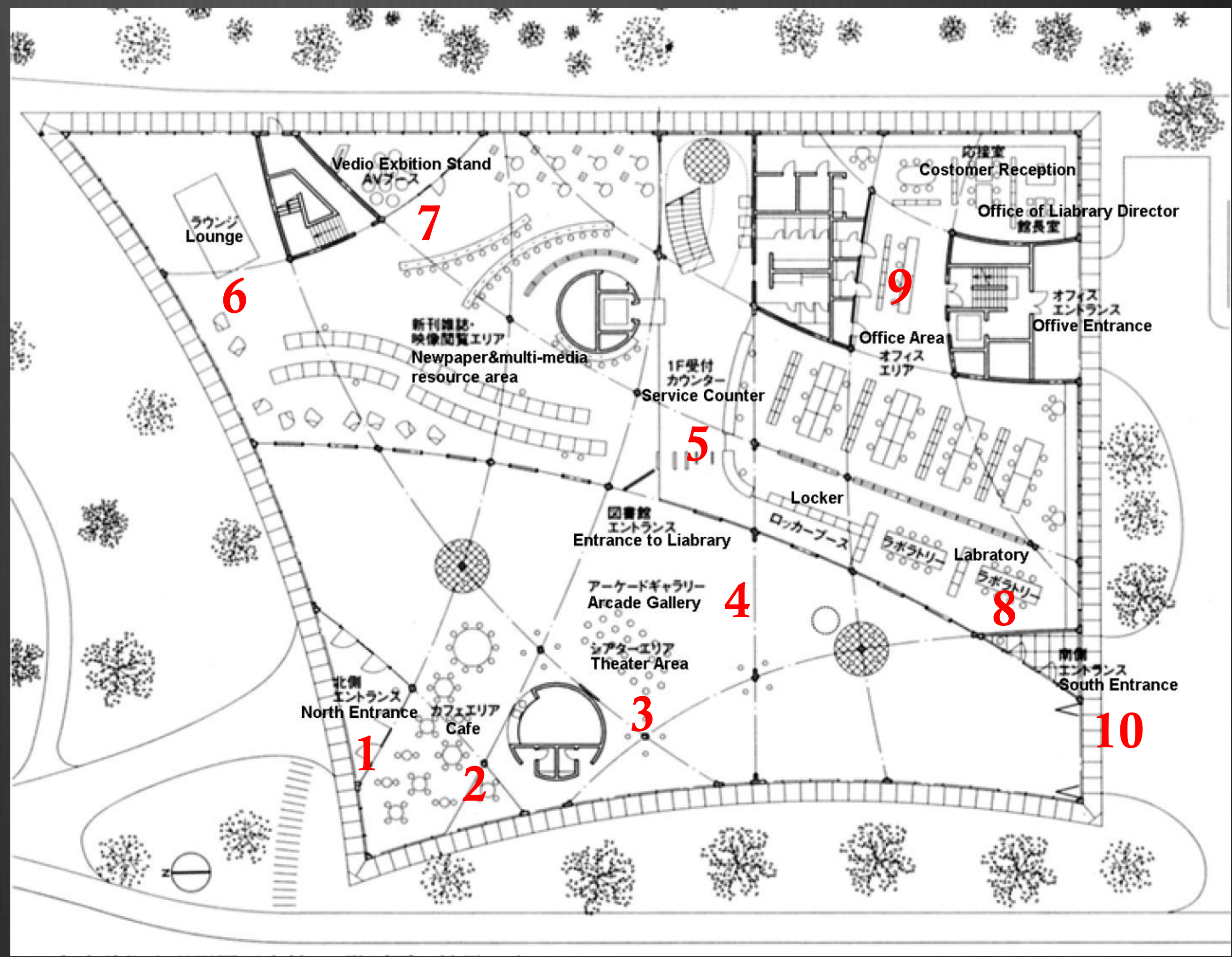
- Emergent grid
- Distorted module
- The curved grid lines distribute the load evenly to the 56 intersecting points, created by the arches.
- There is 166 arches. They vary in width from 1.8 to 16 m. The same grid is followed on both levels. The height ranges from 8.5’ to 19’.
- Unique spaces are created by the combination of three or more arches, which then become part of the program.

1st Floor Plan



1st Floor Plan - Program

- 1-North Entrance
- 2-Café Area
- 3-Theater Area
- 4-Arcade Gallery
- 5-Front Desk
- 6- Lounge
- 7-Video Stand
- 8-Computer Lab
- 9-Offices
- 10-South Entrance



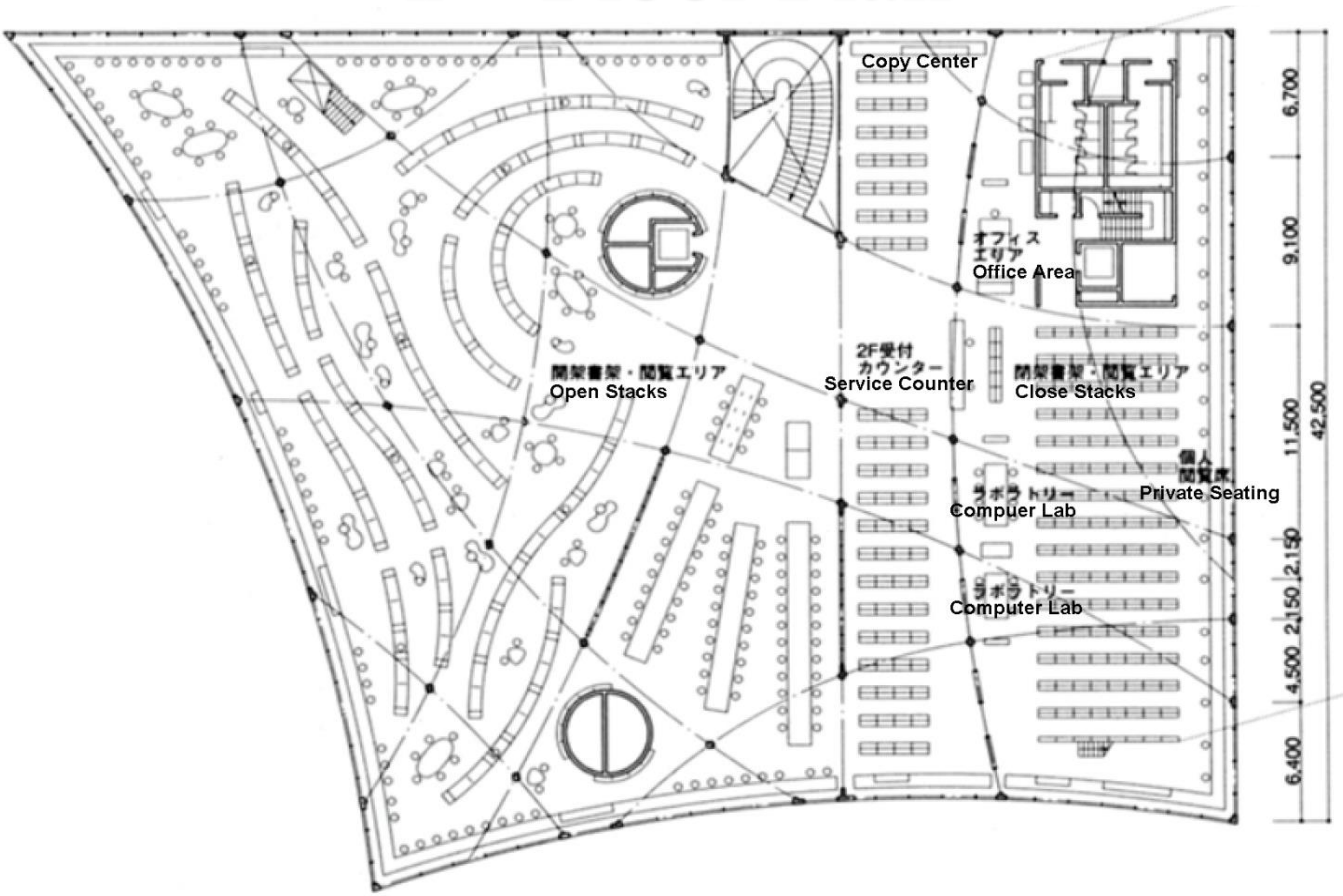
Arcade Gallery

Café

Lounge Area

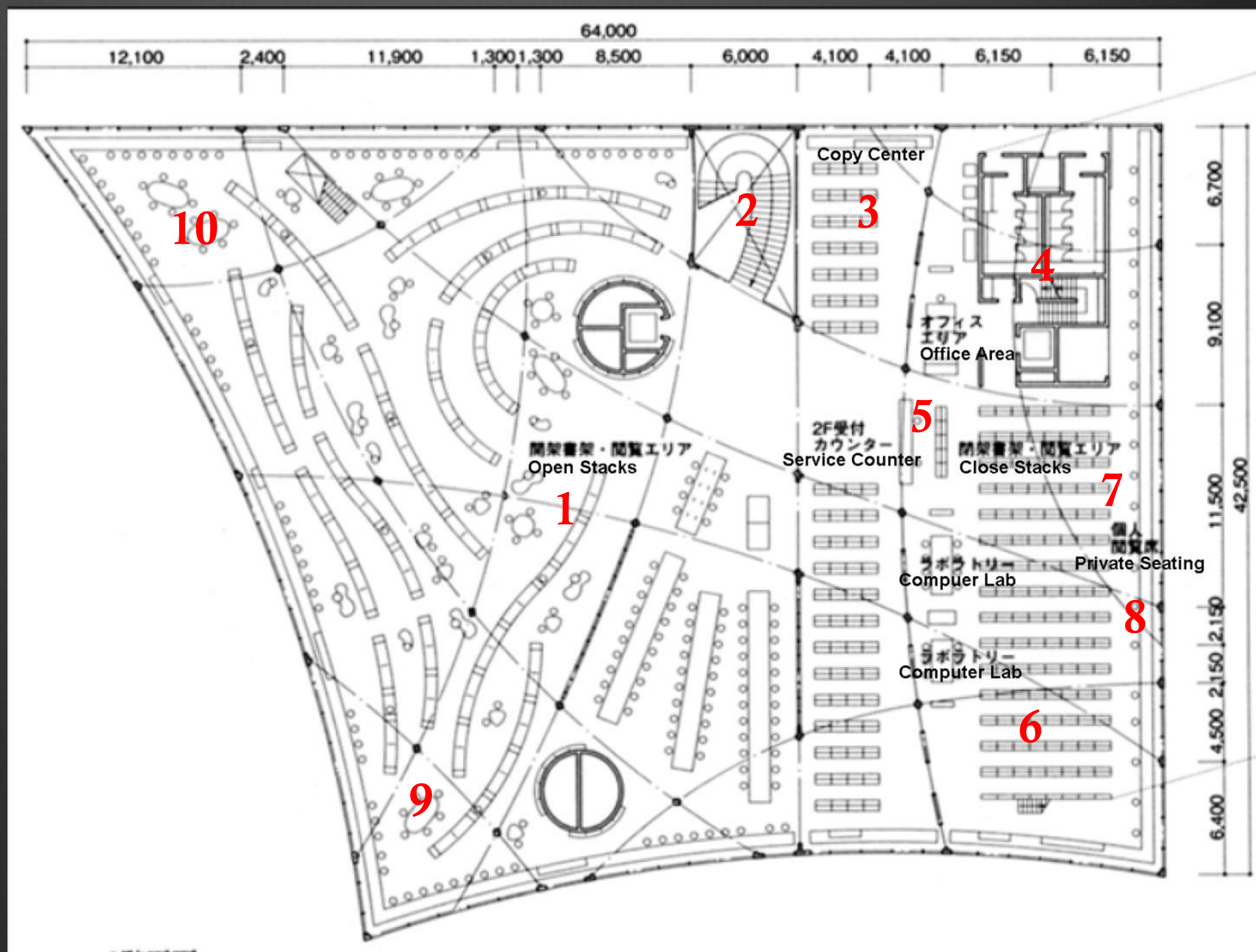
Multi-Media Reading Area

2nd Floor Plan



2nd Floor Plan

- 1-Open Stacks
- 2-Stairs
- 3-Copy Center
- 4-Office Area
- 5-Front Desk
- 6-Computers
- 7-Close Stacks
- 8-Private Seating
- 9-10-Public Table Areas



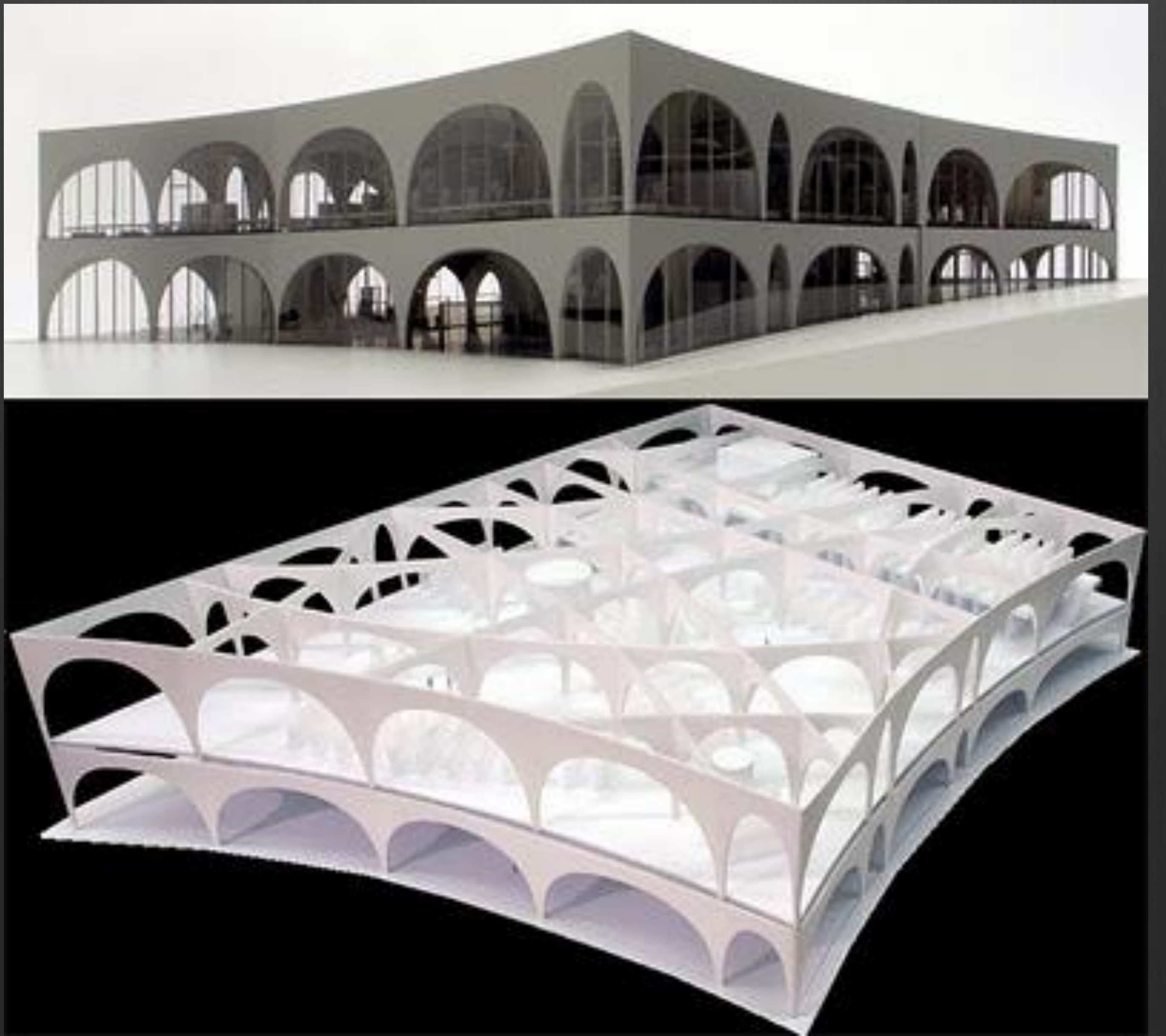
Computer Lab

Open Stacks

Private Seating

Lounge Area

3-D Models



Effects that the arches bring

- The intersection of the rows of arches help articulate softly separated zones within this one space. Shelves and study desks of various shapes, glass partitions that function as bulletin boards, etc., give these zones a sense of both individual character and visual as well as spatial continuity.
- The spatial diversity one experiences when walking through the arches different in span and height changes seamlessly from a cloister-like space filled with natural light, to the impression of a tunnel that cannot be penetrated visually.

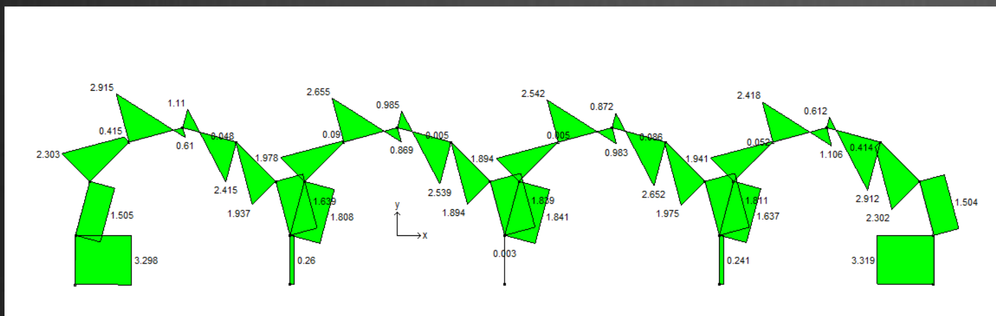
Arches


- 12 mm steel plate reinforced with 75 mm wide flange.
- The steel is then covered with concrete which prevents buckling and and serves as fireproofing.
- All together the wall is about 200 mm reinforced concrete wall. At the intersection points, they form a cross-shape which is 400 mm thick.

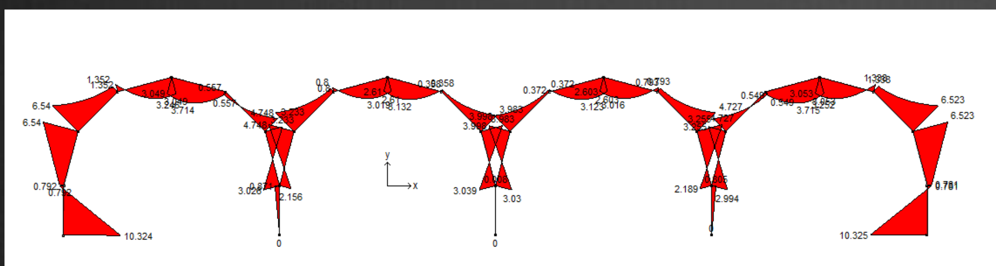
Materials
Reinforced Concrete

- For a strong, ductile and durable construction the reinforcement needs to have the following properties at least:
- High relative strength
- High toleration of tensile strain
- Good bond to the concrete, irrespective of pH, moisture, and similar factors
- Thermal compatibility, not causing unacceptable stresses in response to changing temperatures.
- Durability in the concrete environment, irrespective of corrosion or sustained stress for example.

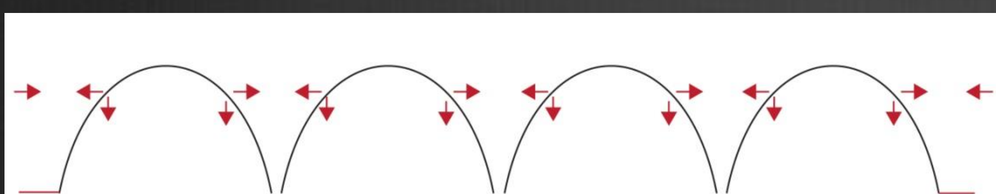
Arches Analysis



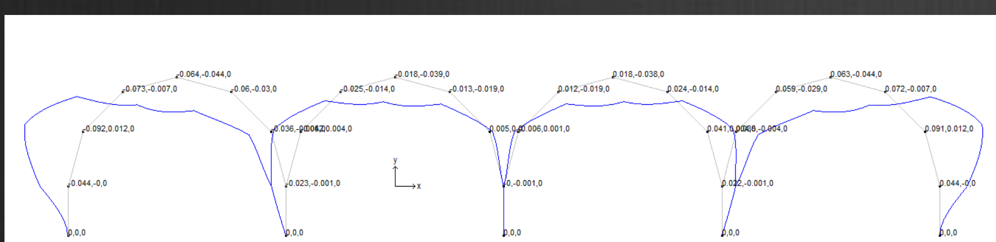
Shear Analysis



Moment Analysis

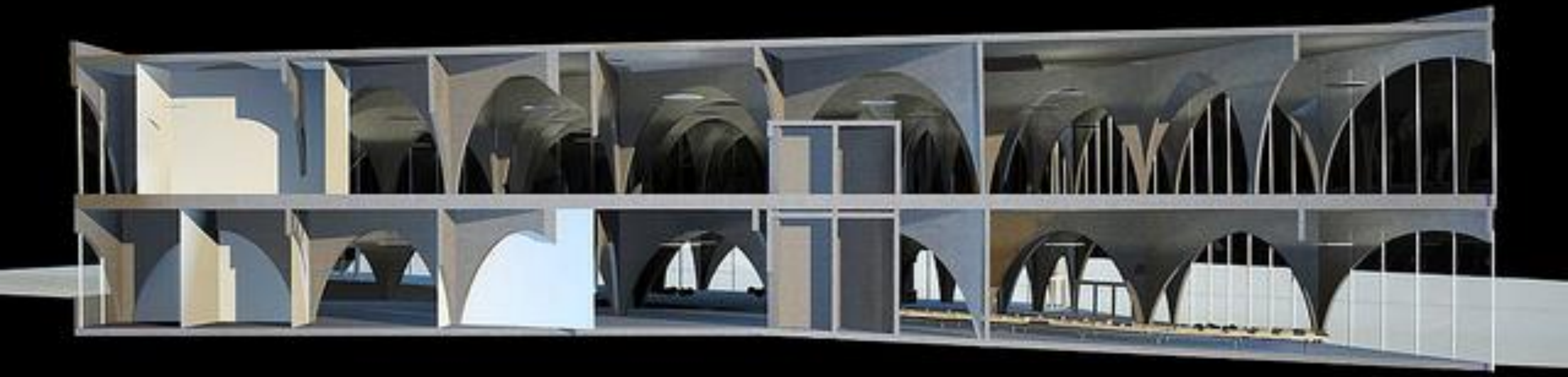


Load Tracing

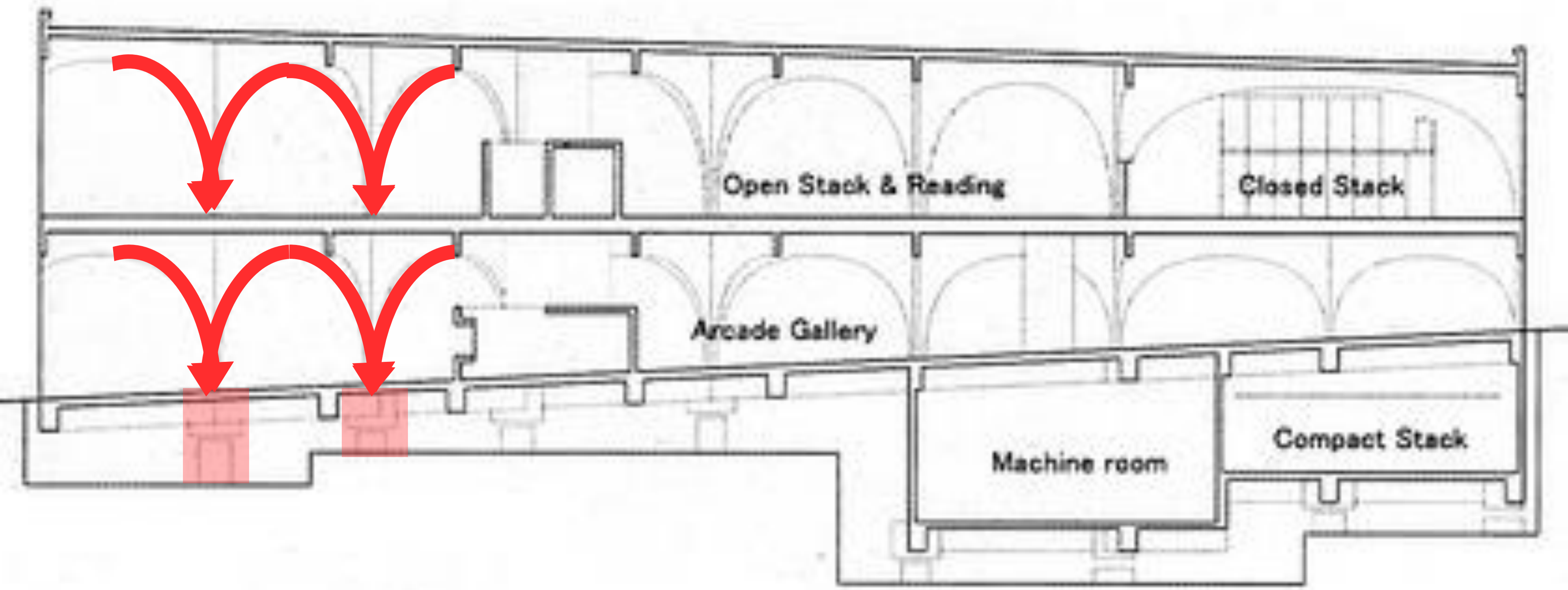


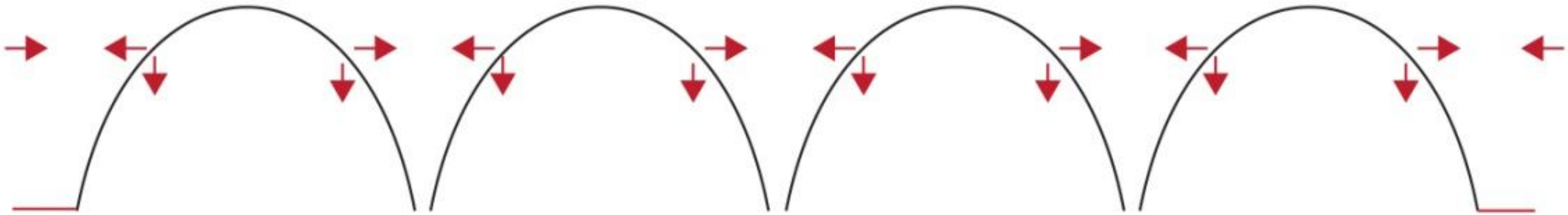
Deflection Analysis

3-D Section

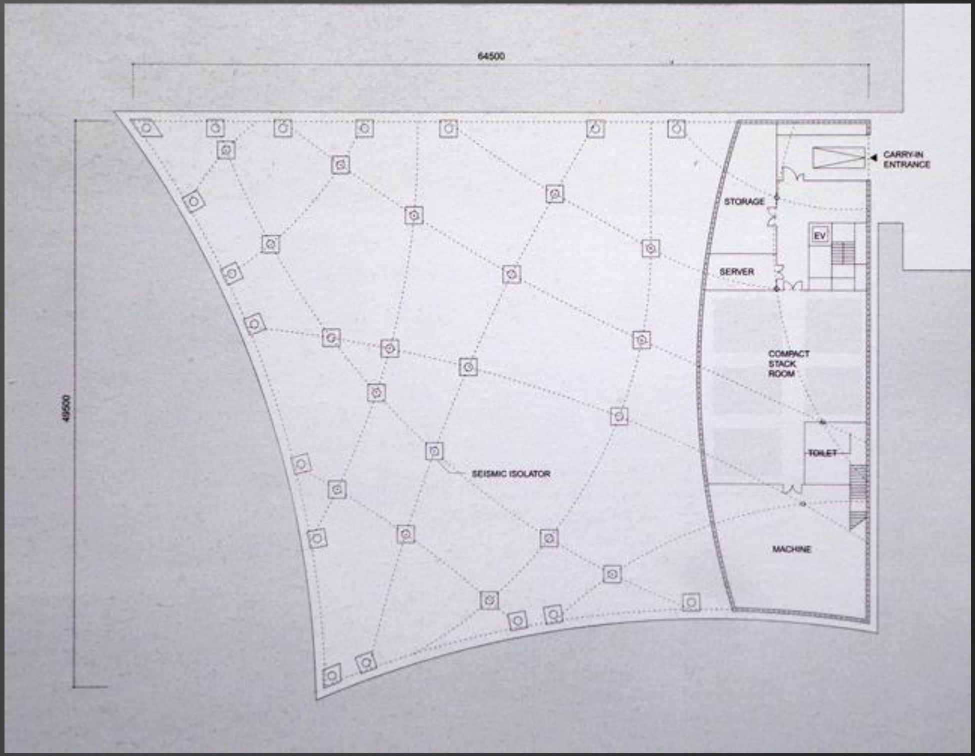


Section


Open Stack & Reading
Closed Stack
Arcade Gallery
Machine room
Compact Stack



Basement Design for Seismic Load



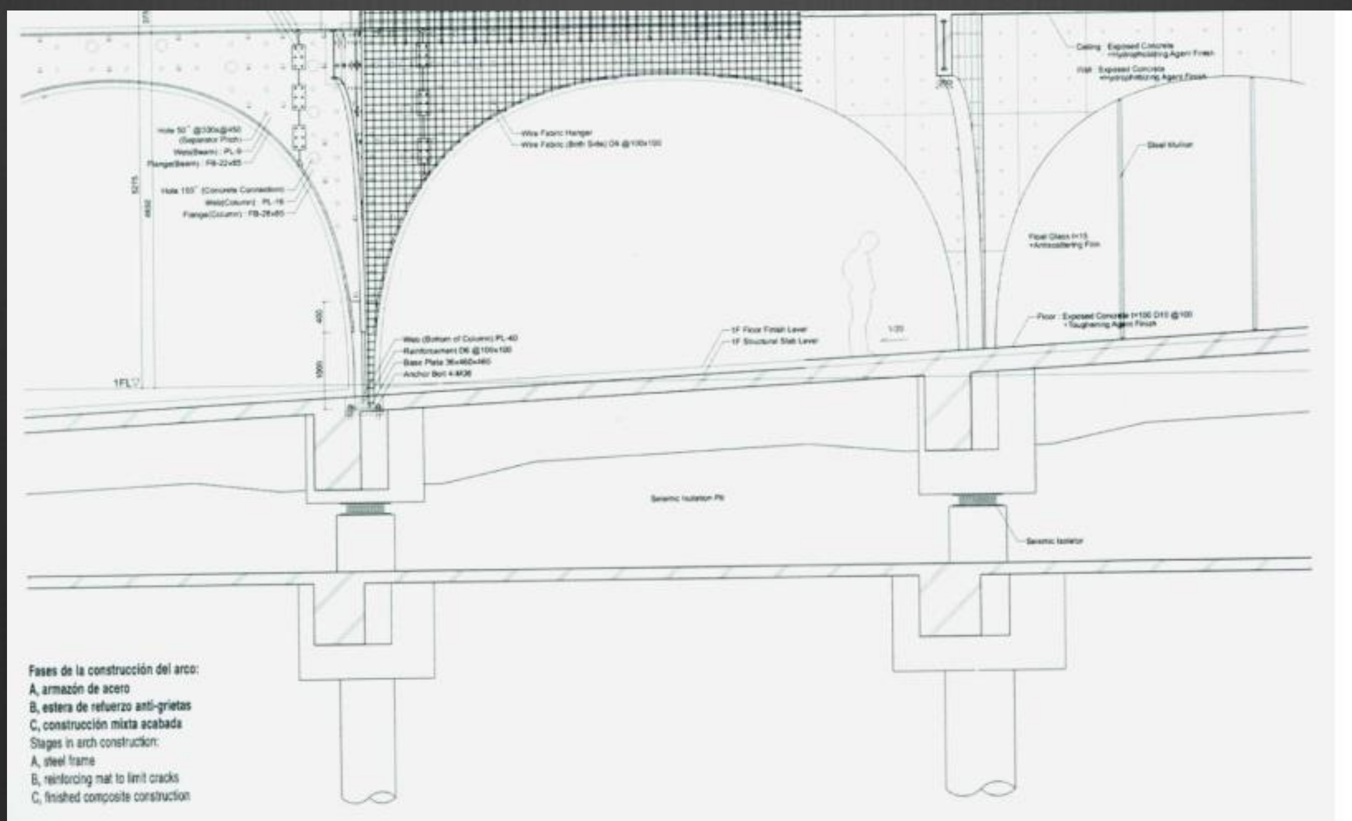
- 24 “Basement Gums” and 27 “sliding supports” are arranged horizontally that keep the whole building “floating” above the ground.
- This basement system keeps the building moving less than 20 inches horizontally in case of a severe earthquake, which may happen once in a hundred years.

Design for Seismic

- Soil Condition on site is andosols which may be subject to liquefaction, and subsidence if subject to seismic vibrations.
- Earthquakes in the region are common because of Tokyo's location next to a fault line off the coast

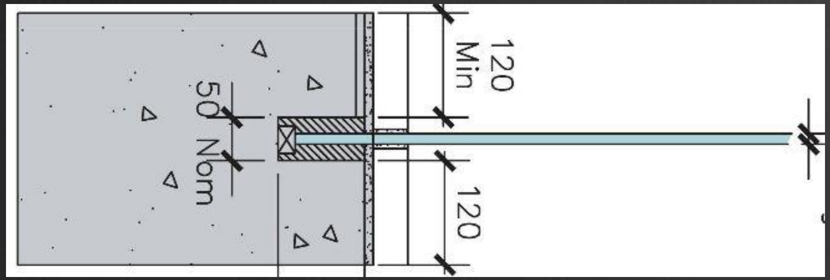
Design for Seismic

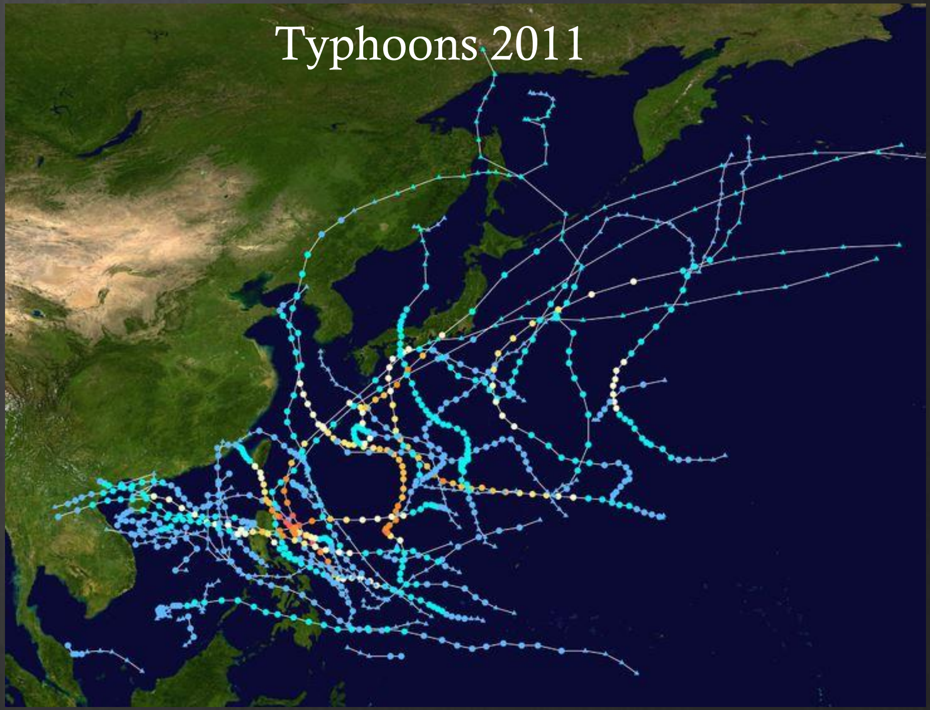
- A seismic isolator and seismic isolation pit was used to account for lateral seismic loads. These strategies decouple the foundation from the building above to prevent vibrations.



Design for Wind

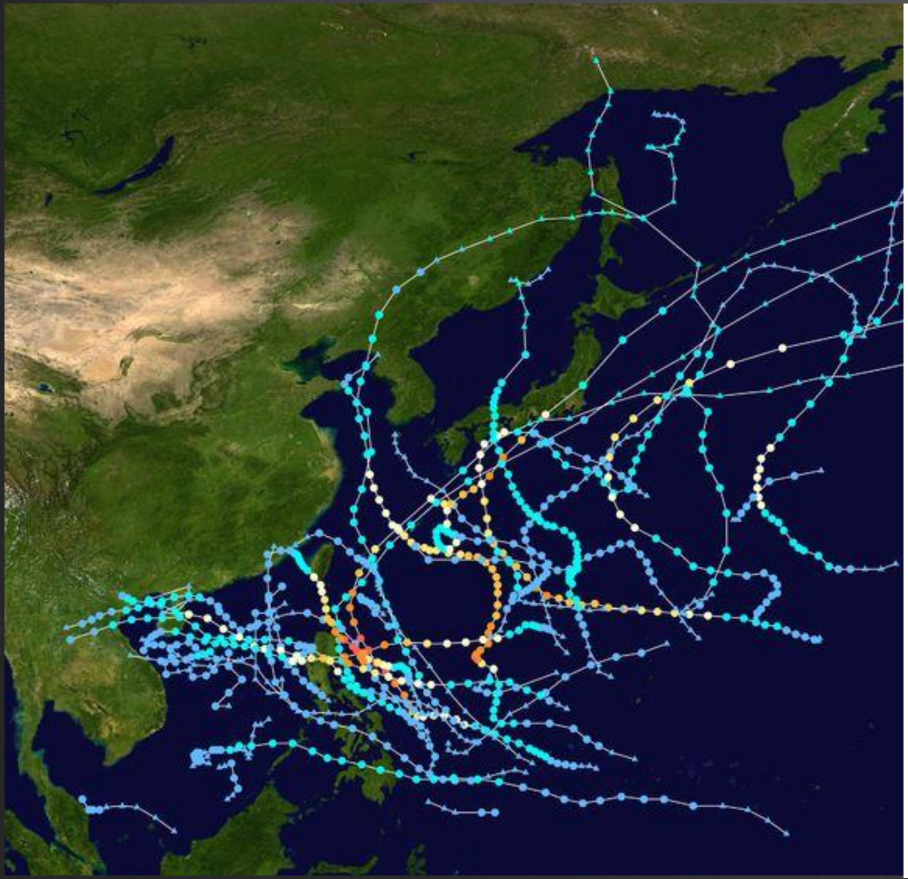
- Roof solid shear diaphragm that carries loads horizontally to columns.
- Two way floor system transfers to a rigid frame concrete system
- The building itself is not uniform in plan so some torsion forces apply
- The perimeter of this medium rise building should have the most bracing.
- In high winds, such as Typhoons, penetration into he interior may cause more damage and the high glass walls do not help.
- Because of vibrations caused by winds and the direct connection to concrete channel rebated fixing would be used leaving extra wiggle room.



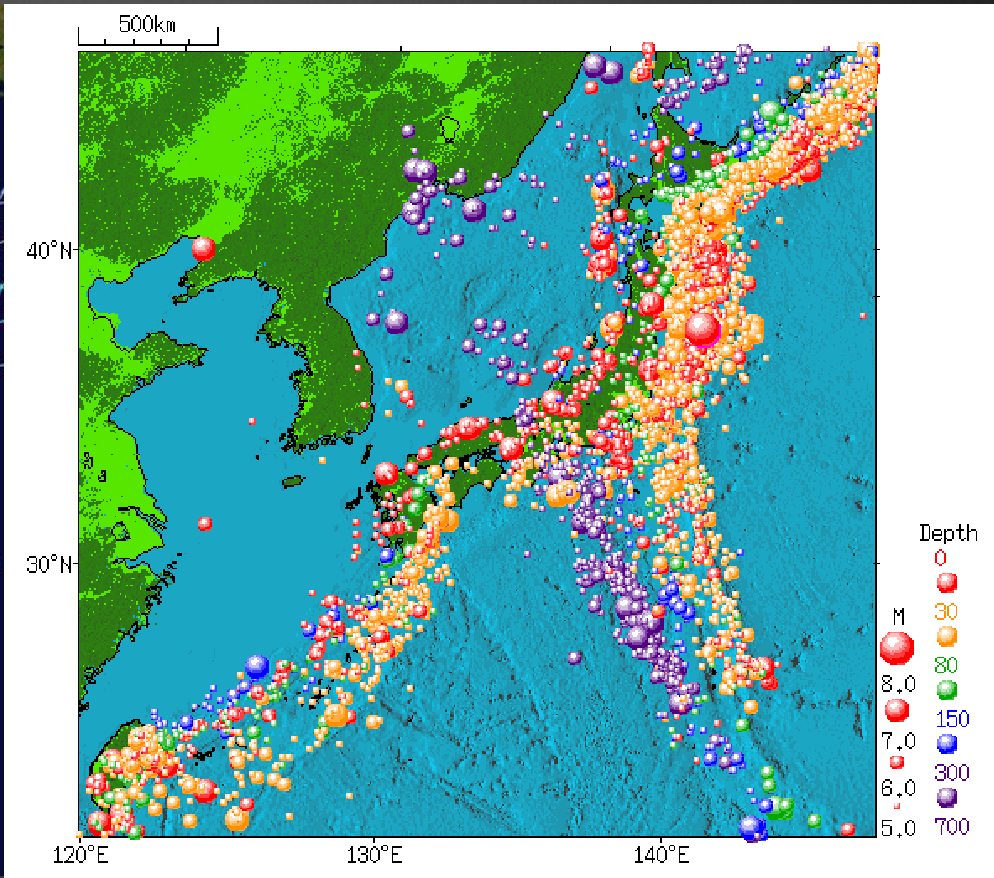


Lateral Consideration

Typhoons 2011



Recorded Earthquakes



Construction Process

References

Floor Plans/ Section/ Design Features:
Tama Art University Library Official Site. http://library.tamabi.ac.jp/hachioji/feature/

Interior Pictures:
Toyo Ito, 2006, Speech in Tozi-as. http://www.tozai-as.or.jp

Sections of Model:
flickr, http://www.flickr.com/photos/emile_work