Prague - Troja

Integrated Daylight Design on Czech Floral Conservatory

by Rafail Afandiyev

Prague - Troja

Integrated Daylight Design on Czech Floral Conservatory

Diploma Thesis Portfolio

Faculty of Architecture, Czech Technical University in Prague
Department of Urban Planning 15121
Atelier Hanson – Landscape Architecture Studio

Summer Term 2017-2018

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Diploma Thesis Supervisor: Henry W. A. Hanson IV., ASLA, ARLA, LEED AP
Diploma Thesis Opponent:
Prague, June 2018

Contents

Thesis Assignment

Czech Technical University in Prague, Faculty of Architecture

2/ ASSIGNMENT of the diploma project

Mgr. program navazující

Name and Surename: Rafail Afandiyev

Date of Birth: 27/11/1988

Academic Year / Semestr: 2018/summer semester
Department Numer / Name: 15121 Department of Spatial Planning
Diploma Project Tutor: Henry W. A. Hanson IV, RA RLA LEED AP

Diploma Project Theme:

Integrated Daylighting Design on Czech Floral Conservatory.

Assignment of the Diploma Project:

Description of the project assignment and the expected solution objective:
Life on earth is possible due to the energy from the sun. One of the key ingredients of the energy received from the sun comes to us in the form of light. Both flora and the human species are dependent on light. In addition to an energy source, humans need light to see the world around us; we experience delight in the qualities light offers as it illuminates our world.

This project explores both the qualitative and quantitative attributes of light to the benefit of humans and plants through the development of a conservatory where people can enjoy light and the plants that depend on it as a source of energy. The project site is located in Prague 7 Troja on the upper land owned by the Botanical gardens.

Although light is a primary focus of this design assignment the project shall also be developed as a public facility available to the residents of Prague and the Czech Republic. The conservatory shall support casual visits by the public as well as educational role in teaching the public, particularly children, about the role of plants in our living environment.

Description of the final result, outputs and elaboration scales

1. A portfolio describing the detailed development of the proposed conservatory, including all interior and exterior areas. At a minimum the portfolio shall include the following:
   - Analysis of the site and relevant context,
   - Theoretical research on conservatories and daylighting,
   - Development of a facility program,
   - Minimum of six case studies of conservatories; at least three in the Czech Republic and at least three worldwide. All case studies should seek exemplary within their context. The case studies shall also include a spectrum of historical periods over the past three hundred years.
   - Graphic description of the proposal development process
   - Photographic documentation of development process in models
   - Complete set of final drawings showing the design proposal.
   - Structural and material drawings that describe the general construction plus typical representative details.
   - All images, quotes, diagrams etc. that are from non-author sources shall be credited at the place of their inclusion in the portfolio.

   All drawings in the portfolio shall be at a scale that enables clear and legible information about the content.

2. Posters shall comply with the Faculty of Architecture dimension requirements and shall provide an outline description of all phases of the project and final design proposal. The following is considered the minimum requirements for the poster drawings:
   - Graphic and textual vision statement
   - Critical context and site analysis in the development of the proposal. Analysis of the site and immediate surrounding context shall be represented as three dimensional drawing such as axonometric, isometric, perspective.
   - Illustrative 'birds eye' representation of the overall design proposal at a scale sufficient for people representing the intended functions to be visible.
   - A minimum of two site and building section / elevation or section perspectives at a minimum scale of 1:200. These sections shall extend through the entire site are and include the immediate surroundings.
   - A minimum of three building section / elevations that describe the interior functions, inside / outside relationships, immediate surroundings and include activities of users of the facility. These sections shall be at a minimum scale of 1:200.
   - Elevation drawings at a minimum scale of 1:200 of primary exterior facades including their immediate context.
   - A minimum of three construction sections from foundation to sky at a minimum scale of 1:50.
   - A minimum of two eyelevel visualizations of the interior of the facility.
   - A minimum of three eyelevel visualizations of the exterior; one of these visualizations must be of the facility from a primary viewing point beyond the limits of the target site.
   - A material and construction diagram of the construction strategy.

3/list of further agreed-upon parts of the project (model)

Model of the building and relevant surrounding site areas at a minimum scale of 1:200. The model(s) shall be constructed exclusively of biodegradable materials.

Date and Signature of the Student: 5.3.2018

Date and Signature of the Diploma Project Tutor: 7.3.2018

Date and Signature of the Dean of FA CTU: 9.3.2018

Statement

I hereby declare that I developed the submitted thesis independently and that I have faithfully and properly cited all sources used in the thesis project in accordance with the "Methodological guideline for ethical training of university theses".

Prague, 24-May-2018

Rafail Afandiyev

CZECH TECHNICAL UNIVERSITY IN PRAGUE
FACULTY OF ARCHITECTURE

AUTOR, DIPLOMANT: Rafail Afandiyev
AUTHOR OF THE DIPLOMA WORK / DIPLOMA PROJECT:
Academic Year 2017/2018, Summer Semester

TITLE OF THE DIPLOMA WORK / DIPLOMA PROJECT:
Integrovaný návrh denního světla na české rostlinné skleník.

TITLE OF THE DIPLOMA WORK / DIPLOMA PROJECT:
Integrated Daylighting Design on Czech Floral Conservatory

LANGUAGE OF THE DIPLOMA WORK / DIPLOMA PROJECT:

Diploma Work / Diploma Project Supervisor **Diploma Work / Diploma Project Opponent**	**Henry W. A. Hanson IV, RA RLA LEED AP**
Key Words (Czech)	Conservatory,Public space, City-Garden relationship,Landscape, Sustainability, Passive climate control techniques, Diagrid system Skleník, veřejný prostor, vztah mezi městem a zahradou, krajina, udržitelnost, pasivní kontrolní techniky klimatu, systém Diagrid
Annotation (Czech)	Víme, že přiměřené denní světlo je rozhodující pro zachování klíčových aspektů celkového zdraví. Život na zemi závisí na světle, které pochází ze slunce. Tento projekt zkoumá jak kvalitativní, tak kvantitativní atributy světla ve prospěch lidi a rostlin skrze rozvoj skleník , kde lidé mohou využívat denního světla a rostlin, jež jsou na něm závislé jako na zdroji energie. Sledování pražských dat o klimatu a prozkoumání vztahů mezi městy a zahradami, návrh integrovaného designu denního světla na konzervatoři pražské Botanické zahrady je hlavním cílem práce. Projekt se zaměřuje také na vztah vnitřku-vnějšku pro nalezení společného bodu konzervatoře pro odpověď na otázku, proč zachováváme rostliny, které patří do různých klimatů vedle vzdělávacích a výzkumných cílů. Křivočaré struktury byly navrženy udržitelně jako výchozí bod se zohledněním různých klimatických podmínek daných pasivním technikám regulace klimatu. Počítačově řízený stínící systém byl integrován do struktury budovy, aby efektivně udržoval klima uvnitř budovy.
Annotation (English)	We know that appropriate light during the day is critical in maintaining key aspects of our overall health. Life on earth is depended on the light which comes from the sun. This project explores both the qualitative and quantitative attributes of light to the benefit of humans and plants through the development of a conservatory where people can enjoy the daylight and the plants that depend on it as a souree of energy. Observing Prague climate data and explore the city-garden relationship, to design integrated daylight design on Prague botanical garden conservatory is the main aim of the thesis project. The project also focuses on the inside-outside relationship to find out the common point on conservatory to answer why we conserve the plants which belong to different climate beside of educational and research purpose. The curvilinear conservatory structures have been designed with sustainable as a starting point, with every consideration such as different climatic conditions given to passive climate control techniques. A computer controlled shading system have been integrated into the fabric of the building to efficiently maintain the climate within.

The Author´s Declaration
I declare that I have elaborated the submitted diploma work / diploma project independently and that I have stated all the used information sources in coherence with the "Methodological Instruction for Ethical Preparation of University Final Works".

In Prague on .....Signature of the Diploma Project Author

Master Thesis Abstract

We know that appropriate light during the day is critical in maintaining key aspects of our overall health. Life on earth is depended on the light which comes from the sun. This project explores both the qualitative and quantitative attributes of light to the benefit of humans and plants through the development of a conservatory where people can enjoy the daylight and the plants that depend on it as a source of energy. Observing Prague climate data and explore the city-garden relationship, to design integrated daylight design on Prague botanical garden conservatory is the main aim of the thesis project. The project also focuses on the inside-outside relationship to find out the common point on conservatory to answer why we conserve the plants which belong to different climate beside of educational and research purpose.
The curvilinear conservatory structures have been designed with sustainable as a starting point, with every consideration such as different climatic conditions given to passive climate control techniques. A computer-controlled shading system have been integrated into the fabric of the building to efficiently maintain the climate within.

Project Introduction

Description of the project

Life on earth is possible due to the energy from the sun. One of the key ingredients of the energy received from the sun comes to us in the form of light. Both flora and the human species are dependent on light. In addition to an energy source, humans need light to see the world around us; we experience delight in the qualities light offers as it illuminates our world.

This project explores both the qualitative and quantitative attributes of light to the benefit of humans and plants through the development of a conservatory where people can enjoy light and the plants that depend on it as a source of energy. The project site is located in Prague 7 Troja on the upper land owned by the Botanical gardens.

Although light is a primary focus of this design assignment the project shall also be developed as a public facility available to the residents of Prague and the Czech Republic. The conservatory shall support casual visits by the public as well as educational role in teaching the public, particularly children, about the role of plants in our living environment.

Theoretical research on conservatories and daylighting

Daylight

Daylight is the natural light of the day, the mix of all direct and indirect sunligt. This includes direct sunlight diffuse sky radiation, and both of these reflected by the Earth and objects on earth. Generally, reflected sunlight by objects in outdoor isn't thought about daylight. However, daylight excludes moonlight, despite it being indirect sunlight. Daytime is the period of time each day when daylight actualize. The reason daylight occurs because Earth rotates, and either side on which the Sun shines is considered daylight. (Christoph Reinhart ,2014). Daylight has been a key factor influencing whole life on earth since universe had beginning. All living organisms have internal rhythms that control cellular functions and physiological processes. These natural rhythmic cycles act as a type of clock that orders when and how our bodies do almost everything — need food, get thirsty, create energy, stay alert, fall asleep, control mood, sustain body temperature and more. Prior to the invention of artificial light, which placed light a "switch" away, humans stayed awake during the period when the sun was up and slept when it set. (Light Rhythms, 2009, in experiencelife.com)

Illuminance

Illuminance is the amount of light that falls on a object around us, measured in footcandles or flux. It is material property of the surface or object. Illuminance is important in architecture as it is what gives form its perceptible qualities to the human eye, and gives sense of space. It allows us to navigate through space, also perform tasks in space. Illuminance plays a large role in our emotional response in architecture. Illuminance was formerly often called brightness, but this leads to confusion with other uses of the word. "Brightness" should never be used for quantitative description, but only for nonquantitative references to physiological sensations and perceptions of light. (http://www.ledke.com/what-is-illuminance-definition/). There is evels of illuminance which can also be used to create hierarchy in space, through changeable lighting levels.

Luminance

Luminance is the amount of light reflected from a surface. It is measured in foot-lambert or candela per square meter, and is dependent upon the material color and surface texture. Luminance plays a important role in material selection in architecture, as the color of surfaces can have a large effect on how light is distributed around the space. (academia.edu.com) Here surfaces become secondary light sources and they can reflect light. It is like how a full moon reflects the sun's light onto the earth.

Color and Temperature

The color and temparature of light is closely linked to our perceptions of time and space. Cool, blue light is associated with sunrise and morning sun, while warm light is associated with evening sun and sunset. "Our circadian rhythms are governed by a daily cycle of light and dark whose nuanced colors evolve with the passing of time." We can estimate the time of day and year based on the color of light, and the position of the sun. Use of artificial light in architecture can be used to alter our perceptions of time, and to create different moods.

Density

Lighting density controls the activity of space. The arrangement of lighting can be used to aid in circulation, direct the eye to a specific place, or create a spatial hierarchy. The placement of light sources can be grouped into three typologies: linear, random and organized pattern. Linear organization creates a single linear light from one or multiple light sources. Up close, individual lights can be seen on an LED strip, but from far away, the light is seen as one continuous strip of light. In random organization, the placement of lights follows no logical pattern, while in an organized pattern, some form of geometric logic is followed. On a larger scale, lighting densityrelates to development and economic prosperity. The largest amounts of light pollution can be found in cities, which are highly developed and wealthy.

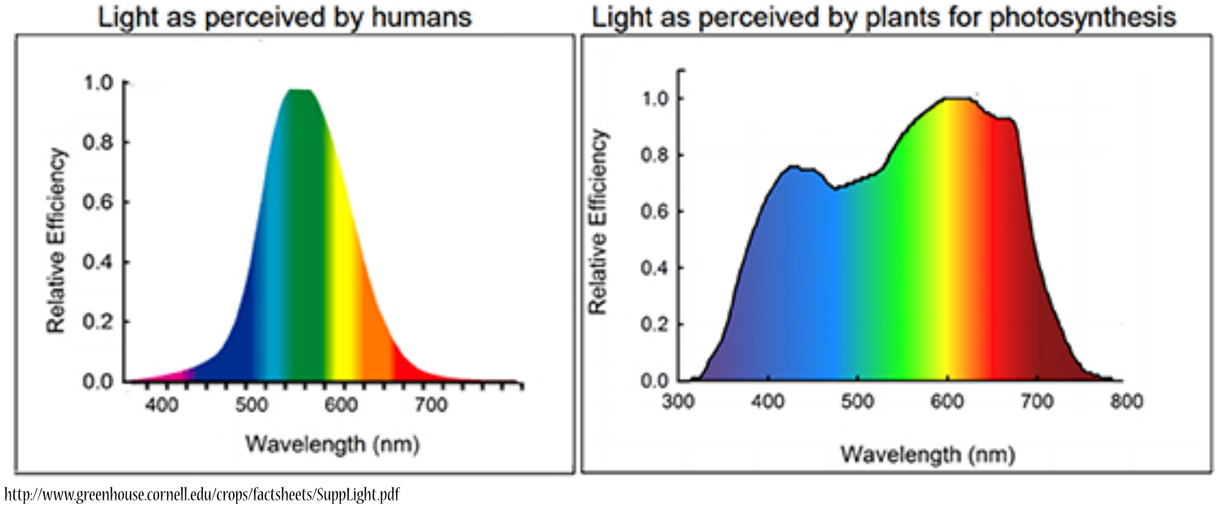
Qualitative and Quantitative Daylight Aspects

Daylight has been an important design factor since the beginning of architectural practice, though qualitative concerns, such as atmosphere and effect, have largely influential quantitative considerations such as functional and thermal optimization. This inequity has only widened as architectural and engineering disciplines become increasingly specialized, such that architects are entirely responsible for qualitative design aspects while engineers are responsible for quantitative matters. However, depending on the context of the project, daylight quality and quantity may have different weights. Therefore, the purpose of this body of work was to initiate the design of a Floral Conservatory, design which account for and encourage overlap between qualitative and quantitative fac-
.tors throughout the design process

Light quantity also depend on light intensity, is the total amount of light supplied to the plant, which is then used
.for photosynthesis; up to a point the high light quantity the more energy a plant can sequester in photosynthesis

Light quality refers to the wavelengths of light supplied (i.e. color of light), for example red light has wavelengths between about 630-700 nanometers, far red light is 705-740 nm, blue light is at 400-450 nm, and ultraviolet A is 315-400 nm. Plants can respond to different colors of light by changing their growth form – a high fraction of far-red light (from incandescent lamps or as shaded by other plants) causes plants to stretch excessively. High frac-
(tion of blue light (such as from fluorescent or metal halide lights) can cause shorter plants (Neil Mattson, 2014

How to measure light quantity, humans and plants see light differently. Humans see green light most easily (peak at 550 nm) and it takes a comparatively small amount of light for us to see well. For photosynthesis, plants use light between 400-700 nm, and the more light and more. Because of this, ways of measuring light for humans (ex-
.ample foot candles) are not appropriate for plants



http://www.greenhouse.cornell.edu/crops/factsheets/SuppLight.pdf

Conservatory

A conservatory is an architectural space having mainly of transparent material or tarpaulin roofing used as a sunroom for plants in which require regulated climatic conditions are grown. A more scientific description is "a covered structure that protects the plants from extensive external climate conditions and diseases, creates optimal growth microenvironment, and offers a flexible solution for sustainable and efficient year-round cultivation." (Shamhiri, Ramina, Kalantari,2018) Mostly conservatories confused with greenhouses. If one wants to look at the definition of a conservatory, probably it will state that it is a greenhouse. Both are transparent rooms in which vegetations can be grown. "But just as a violin and a fiddle are the similar instruments, and they have exactly same shape. But when they are played makes all the difference. With the same way, some con- ".servatories are used that distinguishes it from greenhouses designed exclusively for the growing of plants While some greenhouses suggest design structures that set them apart from the purely useful, they usually are not considered to be living spaces so do not offer the comforts we suppose from the environments in .which we live

A conservatory on the other hand is suitable not only for growing plants, but also have the chance for a count- .less of activities. It can be extra sitting room, study room, even wedding salon

So generally, in Botanical gardens, conservatory have used for exhibition of plants which are belonged different climatic zone. Conservatories originated in the 16th century when rich landlords wanted to cultivate citrus fruits such as lemons and oranges that available their dinner tables brought by sellers from the Mediterranean regions. Public conservatories became popular in the early 19th century which was the golden age of botanic conservatories, mainly in England." English conservatories were the product of English love of gardening and new technology in glass and heating technology". (Antrim & Morrice 2008). Many of the glorious public conservatories, built of iron and glass, are the product of this century. Kew Gardens in London is a perfect case of a .large greenhouse used for growing rare vegetations

Site Analysis

Prague

Prague, capital city of the Czech Republic, is divided by the Vltava River. Nicknamed "the City of a Hundred Spires," it's known for its Old Town Square, the heart of its historic core, with colorful baroque buildings, Gothic churches and the medieval Astronomical Clock, which gives an animated hourly show. Completed in 1402, pedestrian Charles Bridge is lined with statues of Catholic saints. Prague is full of historic monuments, lovely squares and winding lanes of cobblestone. In a city with such rich cultural heritage. Prague also features a variety of parks and gardens, some formal sculpted Baroque gardens, some smaller secret gardens and even some large wild parks

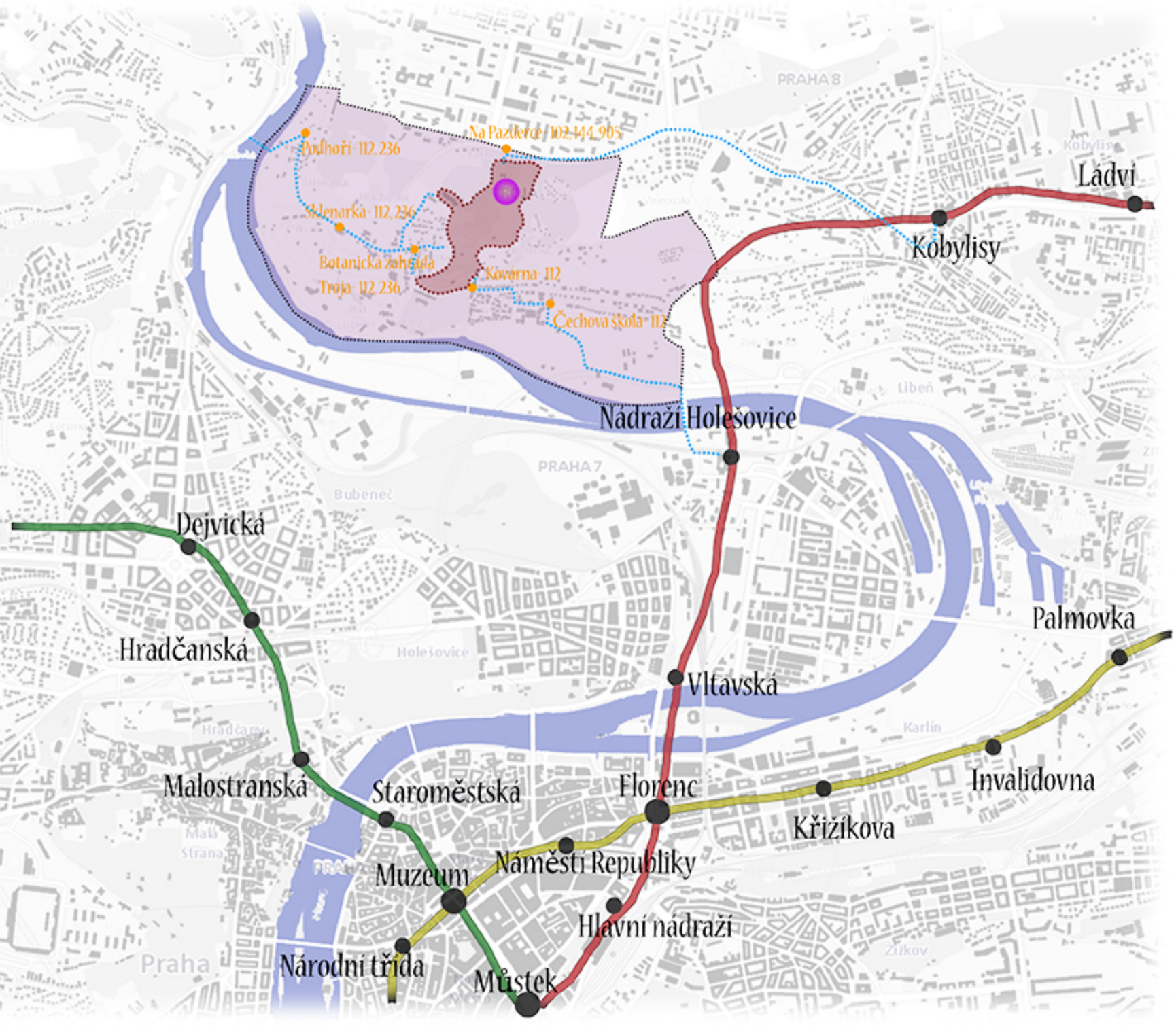
Area :49600 ha
Population :2,594,325
Coordinate: 50°05′N 14°25′E

Site

Praha Troja

Area :53 ha
Population :1272
Density :24/ha

On the banks of the Vltava, leafy Troja is a peaceful residential suburb with several high-profile attractions. The baroque Troja Castle houses 19th-century Czech paintings, and hosts wine festivals and concerts in its manicured gardens, while Prague Zoo is home to elephants and Komodo dragons. The hillside Botanical Garden offers sweeping views, ,and a tropical greenhouse and a wine shop at St. Clare's Vineyard



Accessibility

Line A Nemocnice Motol-Depo Hostivař

Line B Zličin-Černý Most

Line C Letňany-Háje

Muzeum is a Prague Metro station providing the interchange between Lines A and C, and serving the National Museum. It is located at the top end of Wenceslas Square

Můstek is another interchange point between lines A and B. Each line has a separate set of platforms which are connected by a series of corridors

Florenc providing the interchange between Lines B and C. It serves the .city's central bus station

Bus Stations

It takes 27 min from city center to the upper part of the Botanical Garden by using 905. It is possible to take 112 from subway station Nádraží Holešovice to the stop "Zoologická zahrada" or "Botanická zahrada Troja" and using buses 144 or 102 .from Kobylisy subway station to the stop Na Pazderce

One of the biggest challangesof accessibility of project area is the abcent of tram lines that with 500 km of tracks, trams cover a large area of Prague and are used by some 300 million people a year

Nádraží Holešovice is a Prague Metro station on Line C, serving the Holešovice mainline railway station. By walk, it takes 30 min to the lowest part of the Botanical Garden. Kobylisy is another statoin on Line C that takes 34 min walk to the upper part of the site

Praha Troja border

Botanical Garden Border

Walking Tracks

Prague Botanical Garden

The botanical garden spreads over the Troja basin, its surface area being approx. 70 ha in a very rugged terrain, elevated 179 to 276 metres above sea level. The plan for building a botanical garden in this area was approved in 1968. The garden was then realized according to the winning project of academic architects Josef Hrůza and Jiří Navrátil, and ing. J. Jager. Building the garden is a long-term project, due to its extensiveness. Until 1992, the garden was not generally accessible, and the initial exposition was opened on a surface area of 3 ha. It is arranged as a park with collections of small bulbous plants, perennials, annual flowers and healing plants, moor plants, xerophilic and hydrophilic plants, with a greenhouse with alpine plants, and a department of dendrology with domestic and foreign coniferous scrubs. Today's area, which is open for public in the season, spreads on an area of 4 ha, and apart from the initial exposition, we can also see a Japanese garden here with original kinds of Japanese plants, a geographical exposition of plants from Turkey and the Mediterranean, with a collection of iris below. There is a unique floral sundial in the garden /http://www.botanicka.cz

St Claire's Vineyard

Spanning 3.5 hectares, our vineyard is the second largest in Prague and is classified a "national heritage". It was likely established during the 13th century in the time of reign of Přemysl Otakar I., with certainty it was there in times of Charles IV, who supported the winemaking by establishing a vineyard on every suitable slope 3 miles from Prague Castle. The vineyards landscape is dominated by St. Claire's chapel, which was build around the same time as the Troja Chateau – at the end of 17th century. The collection part includes about 50 table and 60 grape varieties, in the production part of the vineyard 9 grape varieties are grown. After harvesting they are processed in our wine cellar. Local wines can be bought only in the Wine Shop There you can enjoy a glass of wine along with a non-traditional view of Prague, in winter you can warm yourself by a crackling fireplace /http://www.botanicka.cz

Greenhouse Exhibition

Pivoňková Meadow

North American

Wetland

St Claire's Vineyard

Mediterranean

Ornamental Gardens

Japanese Gardens

Greenhouse for shade plant conservation

Greenhouse for important collections of cacti and other succulent plants

Cacti and other succulent plant Conservatory

Wetland with moisture loving shrubs and perennials

Small Greenhouses for perennials and shrubs

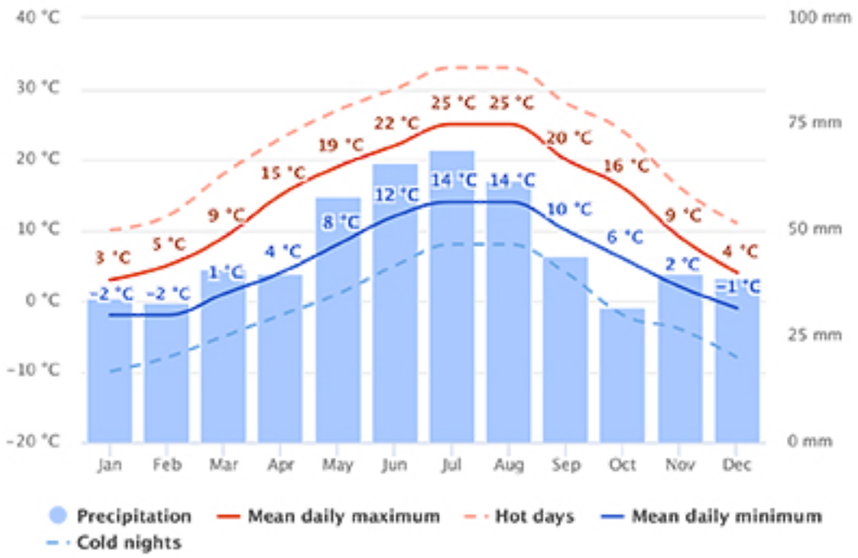
Aligned raised beds for plants.

Pivoňková Meadow

Wetland with Carex Rostrata and acorus calamus

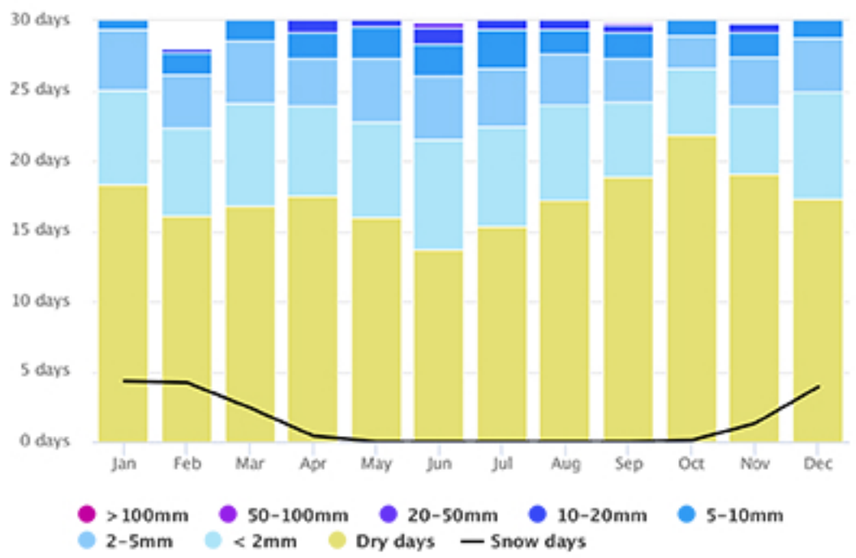
Average temperatures

The red lines indicate the maximum temperature of an average day for every month for Prague. Likewise, blue line indicate the average minimum temperature. For hot days and cold nights, dashed red and blue lines show the average of the hottest day and coldest night of each month of the last 30 year



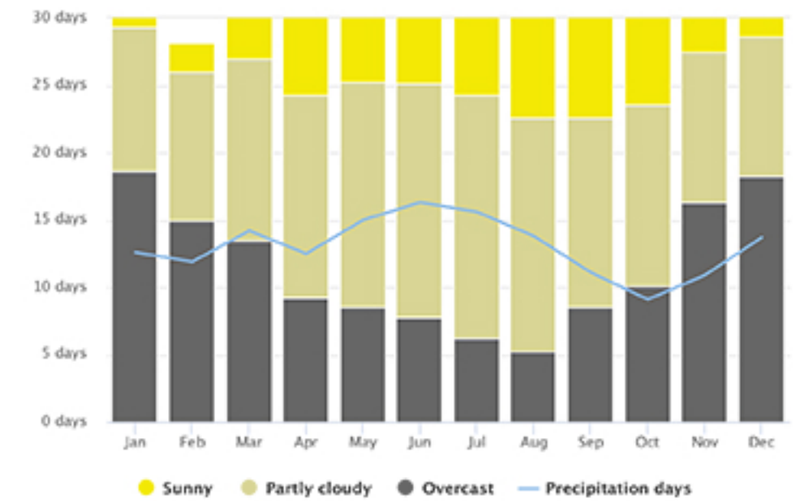
Precipitation amounts

The precipitation diagram for Prague shows on how many days per month, certain precipitation amounts are reached



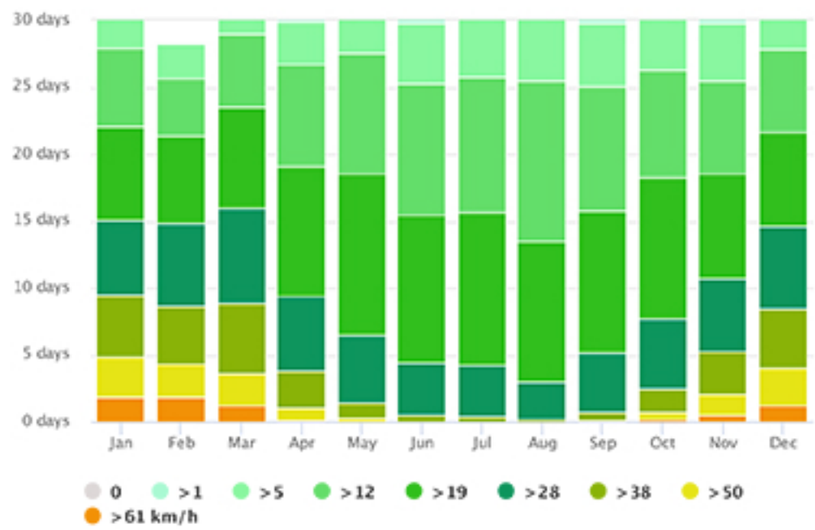
Cloudy, sunny, and precipitation days

The graph indicate the monthly number of sunny, partly cloudy, overcast and precipitation days. Days with less than 20% cloud cover are considered as sunny, with 20-80% cloud cover as partly cloudy and with more than 80% as overcast

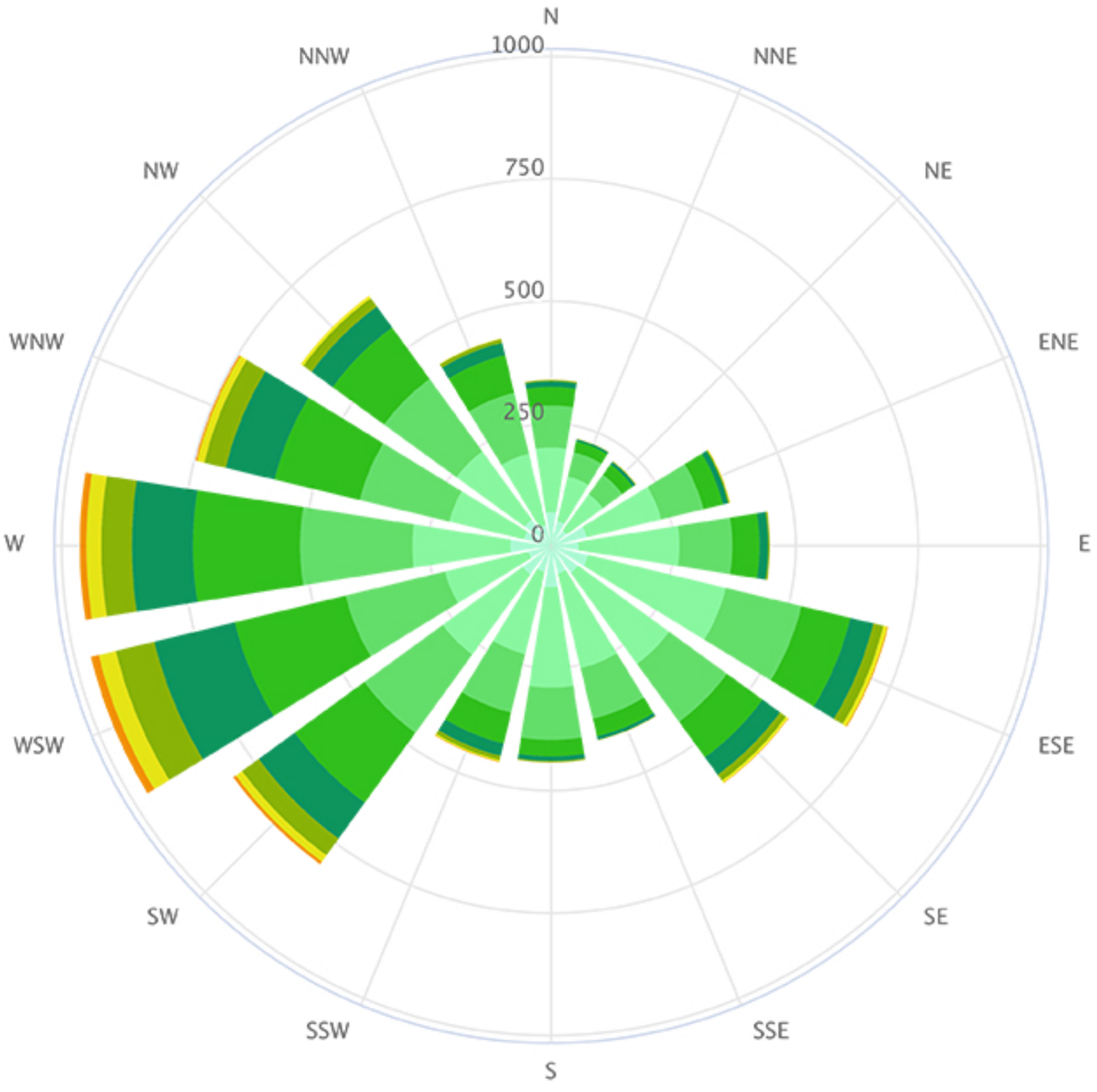


Wind speed

The diagram for Prague shows the days per month, during which the wind reaches a certain speed



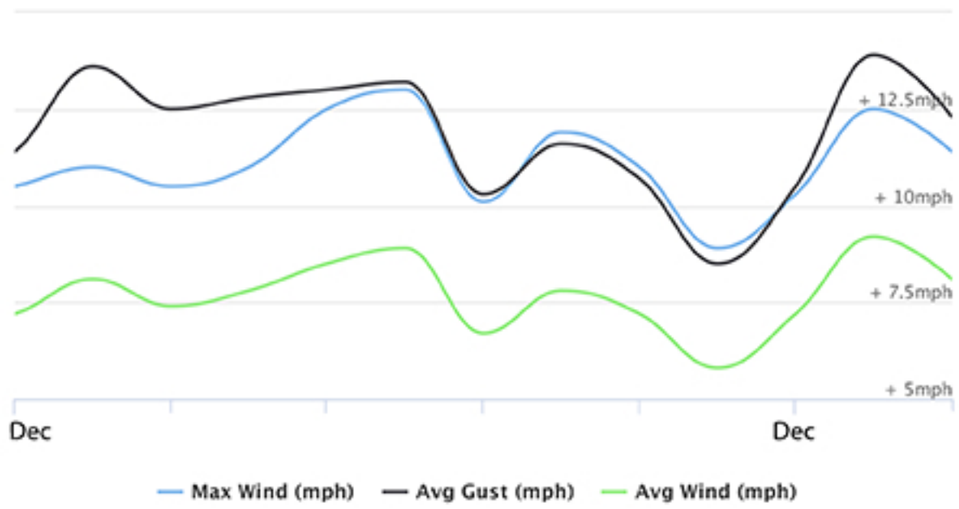
Prague Wind Rose



The wind rose for Prague indicates how many hours per year the wind blows from the indicated direction. Example (SW: Wind is blowing from South-West (SW) to North-East (NE

0 >1 >5 >12 >19 >28 >38 >50 >61 km/h

Average and Max Wind

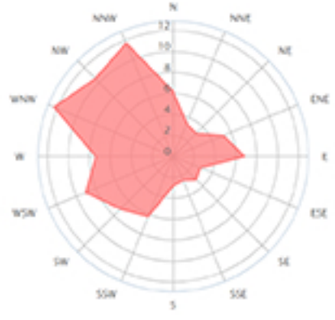


Seasonal Wind Rose

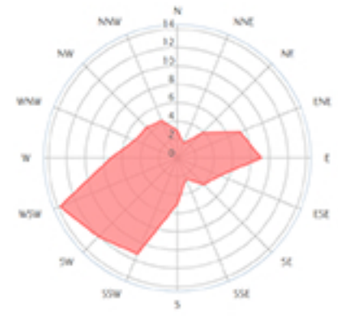
Winter

Summer

Spring

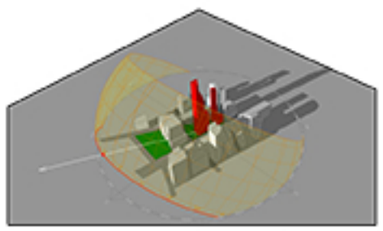


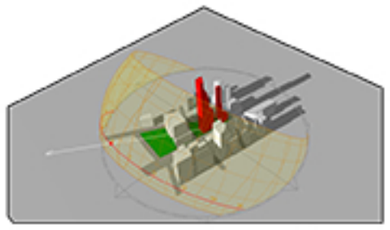
Fall



Sun Direction Monthly in Prague

Latitude: +50.08 (50°04'48"N)
Longitude: +14.43 (14°25'48"E)


January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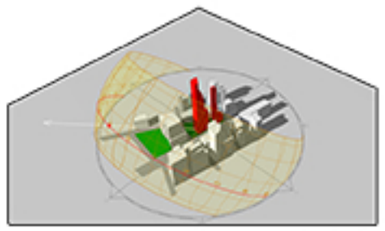
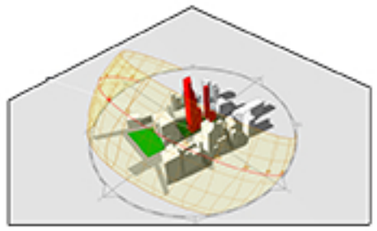
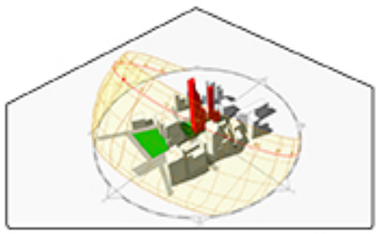
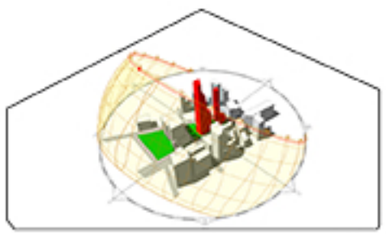

March


April


May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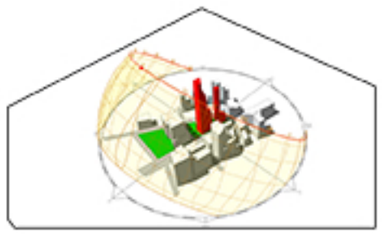
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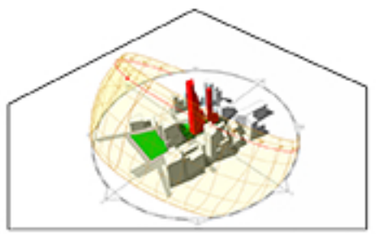
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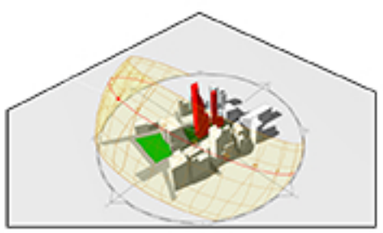
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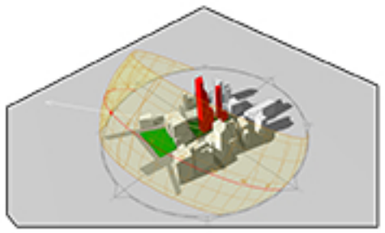
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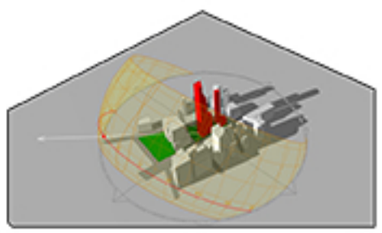
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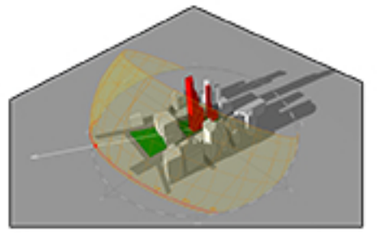

December

Climate Variable	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max Temperature °C (°F)	0	3	8	13	18	21	23	23	19	13	6	2	13
Average Temperature °C (°F)	-2	-1	3	8	13	16	17	17	13	8	3	0	8
Average Min Temperature °C (°F)	-5	-4	-1	2	7	10	12	12	9	4	0	-3	3
Average Precipitation mm (in)	24	23	28	38	77	73	66	70	40	31	32	25	526
Number of Wet Days (probability of rain on a day %)	13%	12%	12 %	13 %	13 %	13 %	13 %	13 %	10 %	13 %	12 %	13%	150%
Average Sunlight Hours/ Day	1h 46'	3h 02'	4h 56'	6h 18'	7h 48'	8h 48'	8h 32'	7h 54'	6h 22'	3h 46'	1h 46'	1h 21'	5h 12'
Average Daylight Hours/ Day	8h 35'	10h 00'	11h 49'	13h 45'	15h 25'	16h 18'	15h 54'	14h 26'	12h 34'	10h 38'	8h 59'	8h 08'	12h 00'
Percentage of Sunny (Cloudy) Daylight Hours	21 (79)	31 (69)	43 (57)	47 (53)	51 (49)	55 (45)	55 (45)	56 (44)	52 (48)	36 (64)	20 (80)	17 (83)	43 (57)
Sun altitude at solar noon on the 21st day (°).	20	29.4	40.2	51.8	60.1	63.3	60.3	52	40.5	29.1	19.9	16.5	40.2

Prague located at 50°6'N, 14°15'E, and attitude is 365 m. Prague has a marine west coast climate that is mild with no dry season or warm summers. Heavy precipitation happen during mild winters which are dominated by mid-latitude cyclones. According to the Holdridge life zones system of bio-climatic classification Prague is situated in or .near the cool temperate steppe biome

Case Studies

Fata Montana Conservatory

Fata Morgana Tropical Greenhouse is one of the selected case study of my diploma project.Main reason of selection is its location that located outside the outdoor exhibition area of the Botanical Gardens on the sunny southern slope of the Trojan hillside which is almost same location with my project site.Another argumentation is division into three separate parts with different temperature and humidity in which the visitor gradually acquaints with tropical and partly subtropical climatic zones.

Chateau Lednice Conservatory

Chateau Lednice Conservatory is another case study conservatory that located in Czech land with its historic glory which it can be consider masterpiece of ts time in regards to iron architecture.Also it is one of the first fully functional hothouse on the European continent.What is even more unique and remarkable about the Lednice conservatory is that it was built without diagonal supports to buttress it against the wind. The curvilinear glass and iron structure can withstand the wind without being supported by any other structures.

Phipps Conservatory

During the case study about worldwide conservatories, Phipss conservatory in Pittsburgh took my attention in terms of their educative purpose and the facilities house elaborate gardens within the fourteen room conservatory itself and on the adjoining ground. Phipps Conservatory and Botanical Gardens offers a variety of on- and offsite programs for formal and informal education groups, providing students with multi-disciplinary learning opportunities that align with state standards, reach across the curriculum, and use botany and ecology to inspire young minds.At Phipps, research and discovery are essential tools to evolve the interconnections between people, plants, health, planet and beauty.

Oman Botanic Garden

From the case studying perspective , program facilities of Oman Botanic Garden has many alternatives such as interpretive installation for exterior and interior exhibitions, research facilities including laboratories, library, herbarium, auditorium, education facilities with classroom seminar rooms and accommodation. Overall the garden consist of the following key components: nursery, visitor center, research center, field study center, outdoor habitat gardens, northern mountain biome, southern mountain biome, and nature reserve area. Environmental education is at the heart of the garden and one of its key functions .

Gardens by the Bay

Garden by the Bay is one of the largest contemporary conservatory in terms of its structure and facade optimization. Supertrees are tree-like structures that dominate the Gardens' landscape with heights that range between 25 metres and 50 metres . They are vertical gardens that perform a multitude of functions, which include planting, shading and working as environmental engines for the gardens.Gardens by the Bay is part of a strategy by the Singapore government to transform Singapore from a 'Garden City' to a 'City in a Garden'. The stated aim is to raise the quality of life by enhancing greenery and flora in the city.

Castle Prague Orangery

One of the examples of high tech architecture in the Czech Republic is located in one of the most exposed locations. The project consisted of the reconstruction of the Orangery in the Prague Castle's Royal Gardens, the history of which can be traced to the 15th century.The structure consists of four lattice arches 4.3 m in diameter supporting a system of diagonal pipes made of sandblasted stainless steel. The pipes create welded crosses attached to each other mechanically by one single screw. Brackets, consisting of flat metal strips, support laminated glass panels sealed by clear silicon. The brackets are connected to the lower part of the joint.

Phipps Conservatory

The gardens were founded in 1893 by steel and real-estate magnate Henry Phipps as a gift to the City of Pittsburgh. Its purpose is to educate and entertain the people of Pittsburgh with formal gardens (Roman, English, etc.) and various species of exotic plants. Currently, the facilities house elaborates gardens within the fourteen-room conservatory itself and on the adjoining grounds. In addition to its primary flora exhibits, the sophisticated glass and metalwork of the Lord & Burnham conservatory offers an interesting example of Victorian greenhouse architecture
Phipps is one of the 'greenest' facilities in the world. The entrance pavilion of the Phipps Conservatory has silver-level LEED certification. Its greenhouse production facility has received Platinum certification, the first and only greenhouse to be so certified. Moreover, the Center for Sustainable Landscapes, designed to be as environmentally sustainable as possible, is also LEED Platinum certified, and produces all of its own energy

Location: Pittsburgh, Pennsylvania
Built: 1893
Architect: Lord & Burnham

https://www.phipps.conservatory.org
https://www.pittsburghparktrail.com/phipps-conservatory-botanical-gardens
https://statesymbolsusa.org/place/pennsylvania/phipps-conservatory

Oman Botanic Garden

Oman Botanic Garden is located in Muscat in the Sultanate of Oman. The Garden, currently under development, is an exciting, dynamic and ground breaking project. The Garden will combine the cultivation, study and conservation of Omanis rich native flora with creative large scale native habitat displays and amenity planting under the over-arching themes of plant conservation, envi-ronmental education and horticultural excellence
The Garden will bring the plants and habitats and plant-related traditions of Oman to life through displays, exhibitions, events and activities to engage a wide range of visitors. Omanis climate is hot and dry with an average annual rainfall of less than 100 mm. This aridity means that maintaining an adequate supply of water for agricultural and domestic use is Omanis most pressing environmental problem. Occasional droughts contribute to shortages in the nations water supply and this will impact strongly on the future management of the Oman Botanic Garden

Location: Muscat, Oman
Built: under construction
Architect: Grimshaw Architects

https://www.designboom.com/tag/grimshaw-architects
https://en.wikipedia.org/wiki/Oman_Botanic_Garden
https://www.bgci.org/garden.php?id=6611

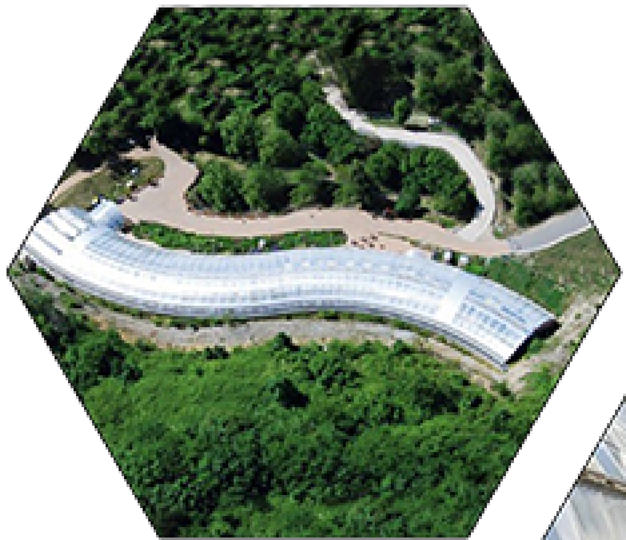
Fata Montana Conservatory

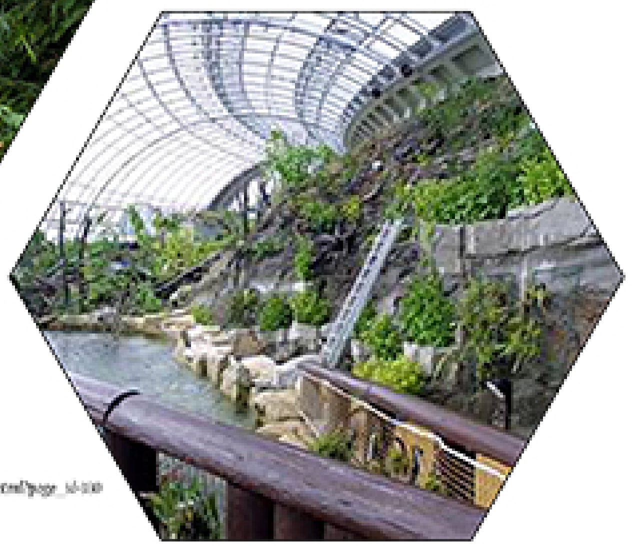
The tropical greenhouse of Fata Morgana, which is under the administration of the Botanical Garden of Prague, is located on the southern slope of the .Trojan slope. The largy structure has a sinuous ground plan and is embedded in a rocky terrain

Access to the garden is relatively difficult for pedestrians, given the location of the greenhouse on the slope. From the bus stops, the asphalt pavements with an oblique narrowing (width of at least 83 cm) rise up to 10%, with a considerable transverse slope of up to 8%. Upon prior arrangement, it is possible to park on a flat area directly at the entrance to the building. The area has a quality surface from the pavement and besides the unmarked parking space it offers a pleasant sitting on wooden benches next to herb beds

First Section contains Australian bush, unique flora of Madagascar, xerophilous vegetation from South Mexico and some regions of Africa can be seen there. The central section is the largest and shows a lowland tropical rainforest. Major part of the rainforest section hosts plant associations of South America and selected regions of Central America, other parts present the flora of Australia and Oceania, Africa and Madagascar, Vietnam and the Philippines. The last, cooled section presents the harsh environment of high mountains. Examples of the flora of South American Andes and alpine regions of .both mainland and island Asia and subtropical South Africa are displayed here

Location: Prague, Czech Republic
Built: 2012
Architect: Zdeněk Dey





http://www.botanicka.cz/[illegible]/sklenik-fata-morgana.html?page_id=100
http://www.[illegible]/Sklenik-Fa-
ta-Morgana-[illegible]

Chateau Lednice Conservatory

The conservatory at the Chateau Lednice (Liechtenstein Castle) in the southern area of Moravia in the Czech Republic is one such British designed project. Duke Alois II the Prince of Liechtenstein in 1840 wanted to renovate the palace and sent his architect Georg Wingelmüller to Great Britain to study Tudor architecture. Soon after, the Duke hired English architect, P.H. Desvignes, to design and build the iron conservatory adjoining the drawing rooms. Klein Brothers Iron Works in northern Moravia supplied the cast-iron needed for the project. The greenhouse construction was started in 1843 and finished in 1845.

The conservatory at Lednice is unique in many ways; the first being that the building is the only existing fully functional hothouse on the European continent. The second unique feature is that it was built using John Claudias Loudon's avant-garde architectural style. Loudon created a system of wavy semicircular arches that end at quarter spheres. The resulting grids make it possible for the insertion of panes of glass thus giving the structure rigidity and a way to block wind and rain.

Location: Lednice, Czech Republic
Built: 1845
Architect: P.H. Desvignes

https://www.gardenvisit.com/gardens/lednice_valtice_park
http://tanglewoodconservatories.com/heritage/lednice
/

Castle Prague Orangery

The orangery of Prague Castle situated in the Royal Garden. The orangery is used for growing exotic plants, especially citruses. On the south side of the royal gardens, on the edge of the moat, there is an old stone wall behind which the first orangery was built in the middle of the 17th century. Under the protection of this wall, the orange trees thrived until the beginning of the First World War. After that, they were no longer cared for and went in. It was not until 1945 that the place for the cultivation of plants was discovered again. A simple glass house was built, which housed various plants and tree species. But even this house was soon the expiry price and finally tore it from the late 90s. Vaclav Havel, the Czech president, who had already valued the old glass house as a retreat, was the initiator of the revival of the place in its historical function. He commissioned Eva Jiricna to design it. The heating and irrigation are controlled by a computer. The venetian blind control, lighting and ventilation is automatic

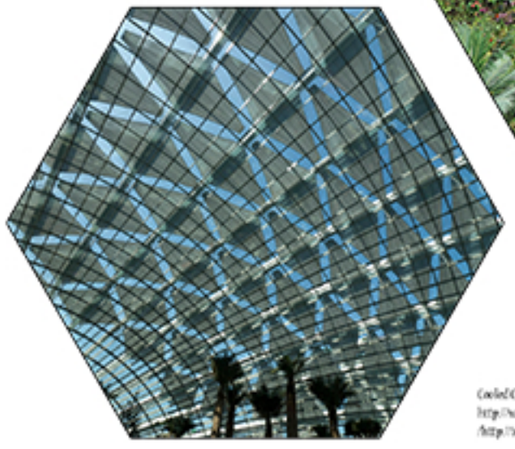
Location: Prague, Czech Republic
Built: 1998
Architect: Eva Jiricna

http://www.sacymarking.com/sacymarks/WMSCZK_Prague_Castle_Orangery_Prague
http://www.sedproject.cz/en/projects/reconstruction-of-prague-castle-orangery/kategorie/chronology/budouta/1999

Gardens by the Bay

Located in Marina Bay, Gardens by the Bay is a key project in delivering the Singapore Government's vision of transforming Singapore into a 'City in a Garden'. At a total of 101 hectares, the Gardens by the Bay project comprises three distinct waterfront gardens – Bay South, Bay East and Bay Central. The commission to design the 54 hectare Bay South garden was won in 2006 by a team led by Grant Associates and including Wilkinson Eyre Architects, Atelier One, Atelier Ten, Land Design and Davis Langdon and Seah. The Flower Dome tells the story of plants and people in the Mediterranean climate zone, and how the plants cultivated in these regions will gradually become endangered as temperatures rise. It has a planted footprint of more than 10.100 sq m and aims to bring alive the experience of seasonal change for visitors more used to Singapore's eternally tropical climate and lush green vegetation. From the lavender fields and olive groves of the Cultivated Worlds section to the baobab and pachypodium trees in the Strange Worlds area, the visitor is presented with a unique collection of plants.

Location: Singapore
Built: 2012
Architect: Wilkinson Eyre Architects



Cooled Conservatories at Garden by the Bay / Wilkinson Eyre Architects. 20 Jan 2013. ArchDaily
http://www.gardensbythebay.com.sg/en.html
http://www.visitsingapore.com/see-do-singapore/nature-wildlife/parks-gardens/gardens-by-the-bay

Development of Program Facilities

Providing visitors to a location with information on the areás attraction, lodging, maps and other items relevant to botanical garden, detailed information on events. Located near the entrance of visitor center to welcome visitors
Contain information desk and cover approximately 15-20 m2

Store primarily selling souvenirs relating Prague Botanical Garden, also books on botany, horticulture, botanical art, photography, handmade collections relating Czech culture. Gift Shop carries a variety of botanically themed items.
Gift Shop wil cover approximately 20-25 m2

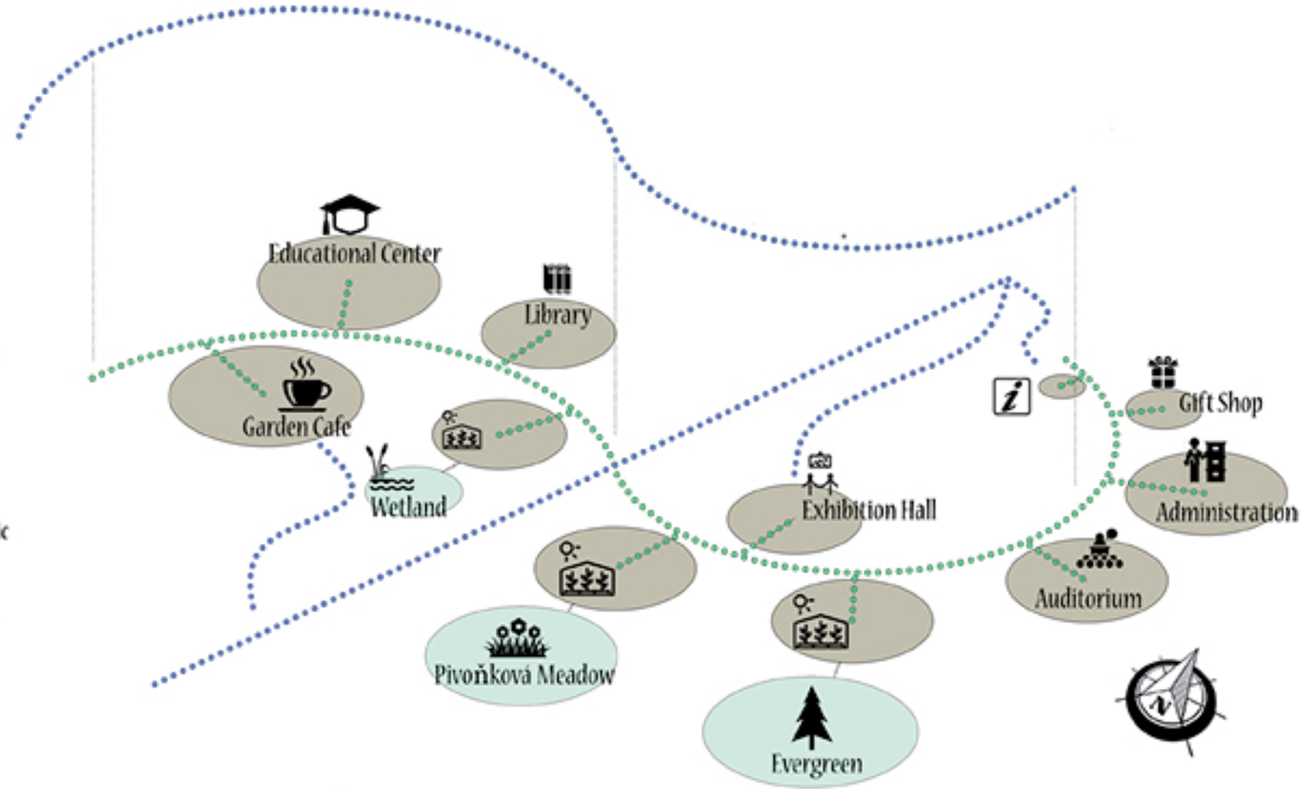
Providing exhibition concerned with preservation, education and demonstration of specific items relevant Czech flora and fauna to attract visitors interest and curiosity.
Hall will cover approximately 50-60 m2

To host special activities such as performing art, conducting cultural events, professing lectures and carrying out various presentations and seminars. As it could be used for all occasions.
Auditorium will cover approximately 180-200 m2

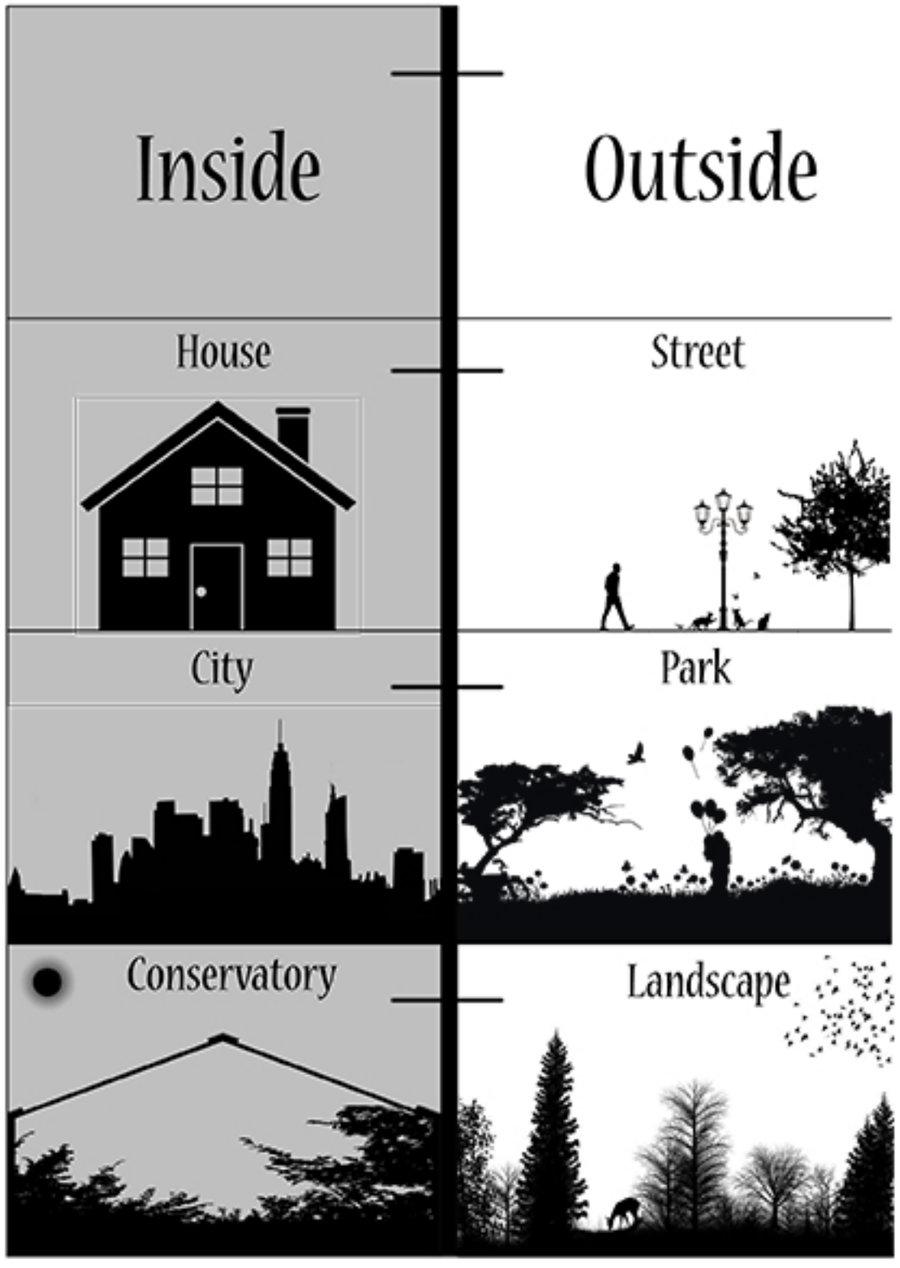
A set of day to day activities that related to financial planning, record keeping, billing personal, physical distribution and logistic within the Botanical Garden. Organizing the all events and activities relevant education, preservation and maintenance of garden and having responsibilities of ensuring that administration activities within garden run efficiently, by proving structure to other employees throughout the activities. Containing one director office with its secretary room, three offices for employees, meeting room and small kitchen for daily hydrate and relax.

To provide experienced-based education that increasing understanding, appreciation and conservation of plants and natural world and inspire people of all ages, backgrounds and abilities to think and act in sustainable way. Center offers a diversity of programs and experiences for visitors to explore the wonders of nature and present variety of class topics, including plant adaption, seeds, rainforest ecology, trees, pollination and other nature related topics.
The Education Center enables the Prague Botanic Garden to significantly expand programs for early childhood education and to train a wide audience of early childhood caregivers and educators in the theory and practice of nature play.
The center will include three multi-use classrooms with semi open ateliers. Also, Center will have library with many books on themes of botany, nature study, gardening, conservation, floral and landscape design, botanical illustration and more.

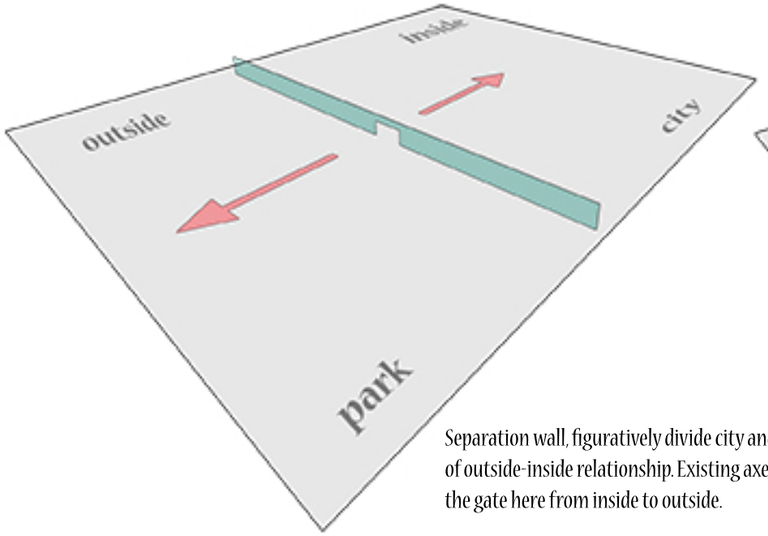
From cultural standpoint, garden cafe largely will serve as center of socail interaction whie drinking their beverages. Semi-open garden cafe also will serve to visitors with local pastry and foods with spectecualar views across the Prague Botanical Garden.
Cafe will cover approximately 60-80 m2.



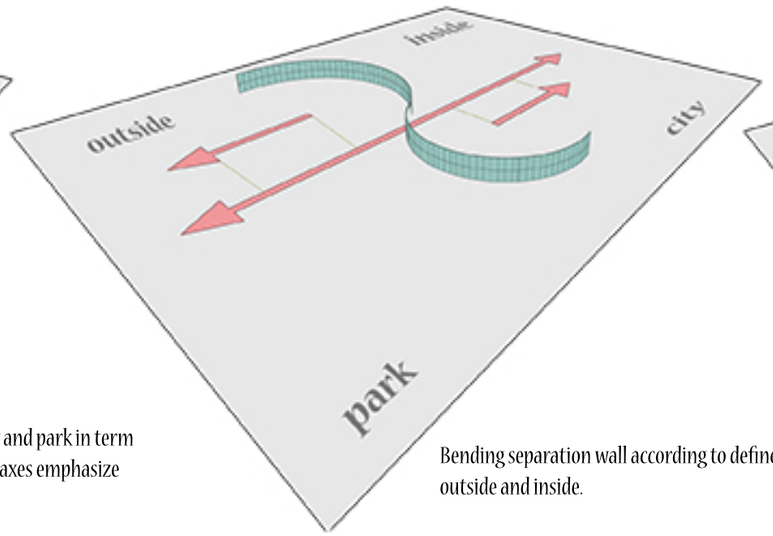
Design Project



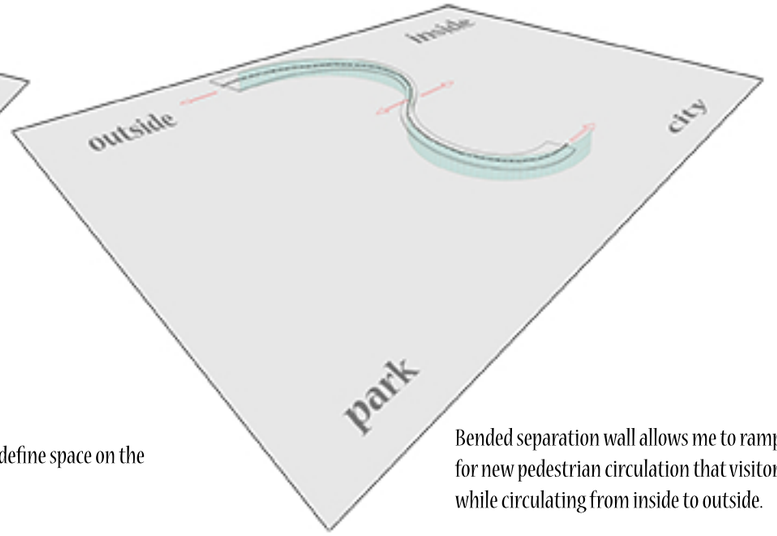
The concept of design is creating wall which separate city and botanical park as an inside outside spaces, to define program facilities according to their function and relation with city and garden. Direction of wall have been oriented according to the sun path to enable to get sufficient daylight for conservatories. The wall also formulates the circulation of visitors which has different purposes such as educative, garden visit, or administrative. Structure of conservatory has been designed with sustainability as a start point, with every consideration given to passive climate control techniques.



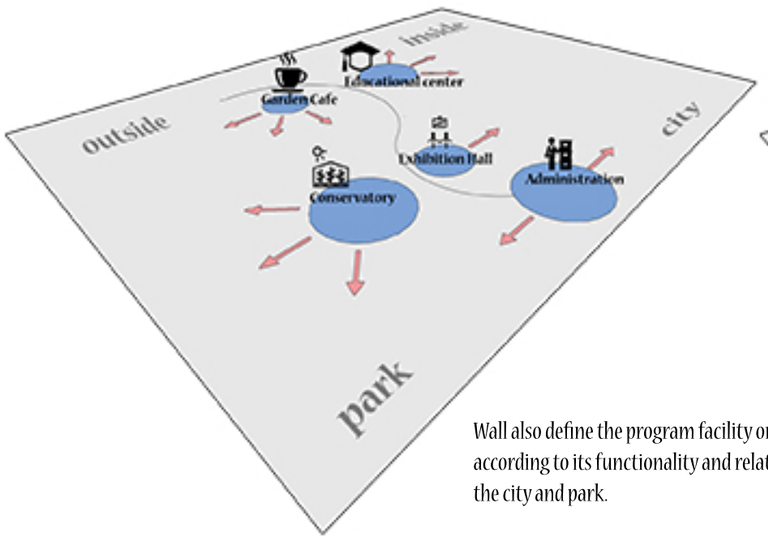
Separation wall, figuratively divide city and park in term of outside-inside relationship. Existing axes emphasize the gate here from inside to outside.



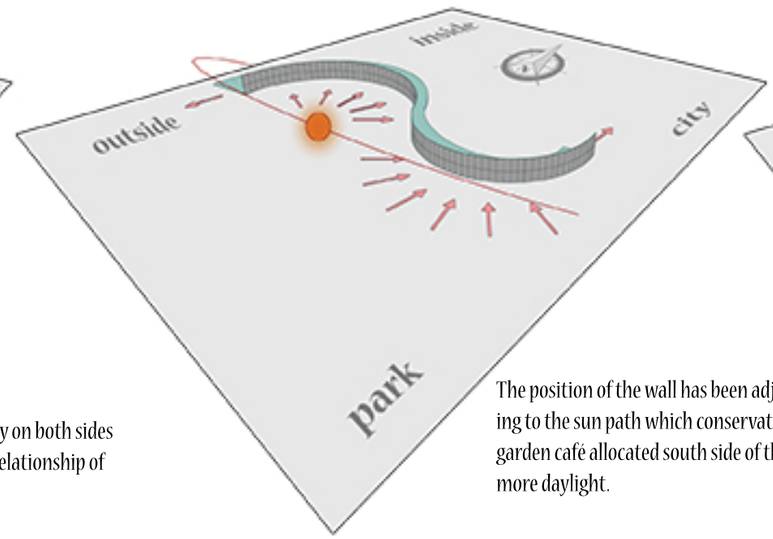
Bending separation wall according to define space on the outside and inside.



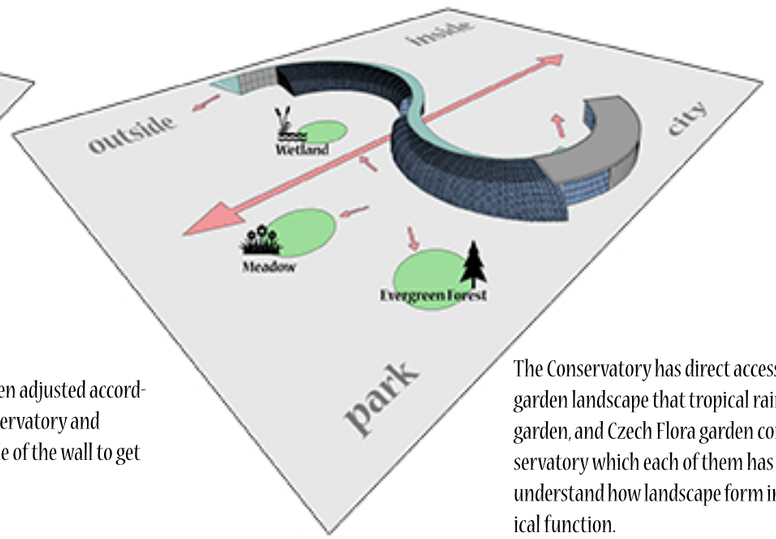
Bended separation wall allows me to ramp along the wall for new pedestrian circulation that visitor can enjoy while circulating from inside to outside.



Wall also define the program facility on both sides according to its functionality and relationship of the city and park.



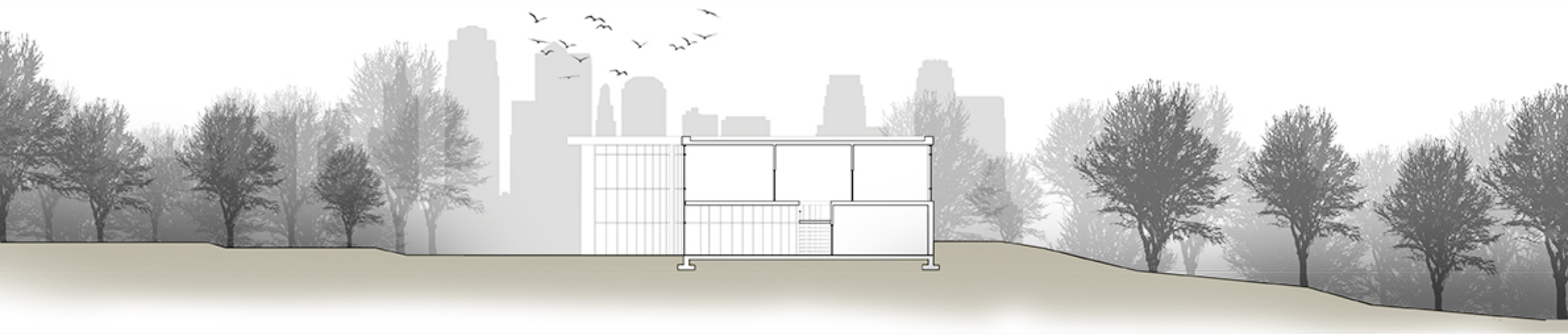
The position of the wall has been adjusted according to the sun path which conservatory and garden café allocated south side of the wall to get more daylight.

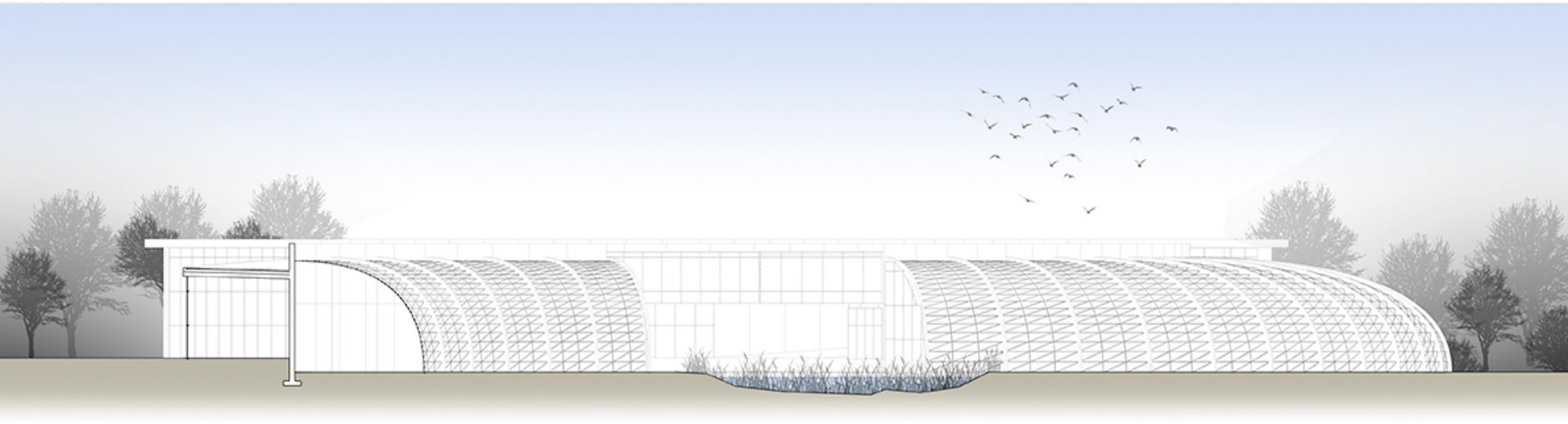


The Conservatory has direct access to the existing garden landscape that tropical rainforest, desert garden, and Czech Flora garden consist of the conservatory which each of them has connectivity to understand how landscape form influences ecological function.

Axonometric Plan

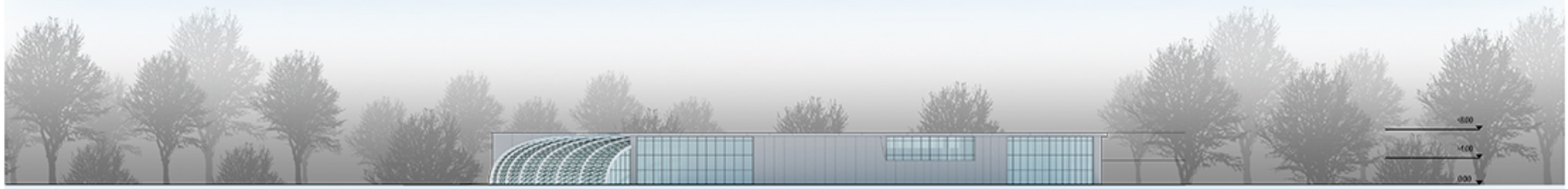
Sections
1/500



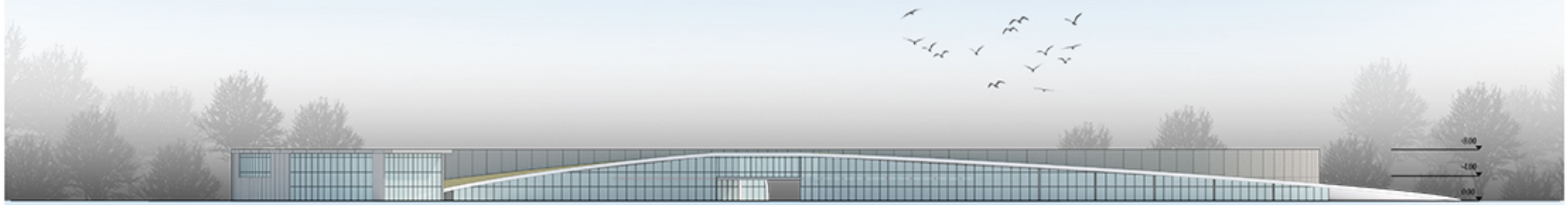


South Elevation

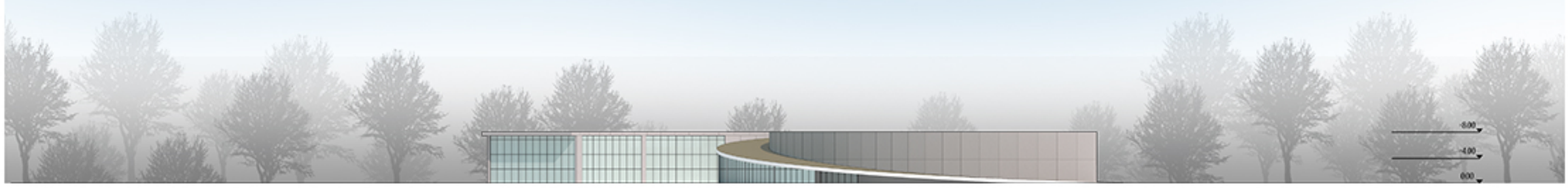
East Elevation



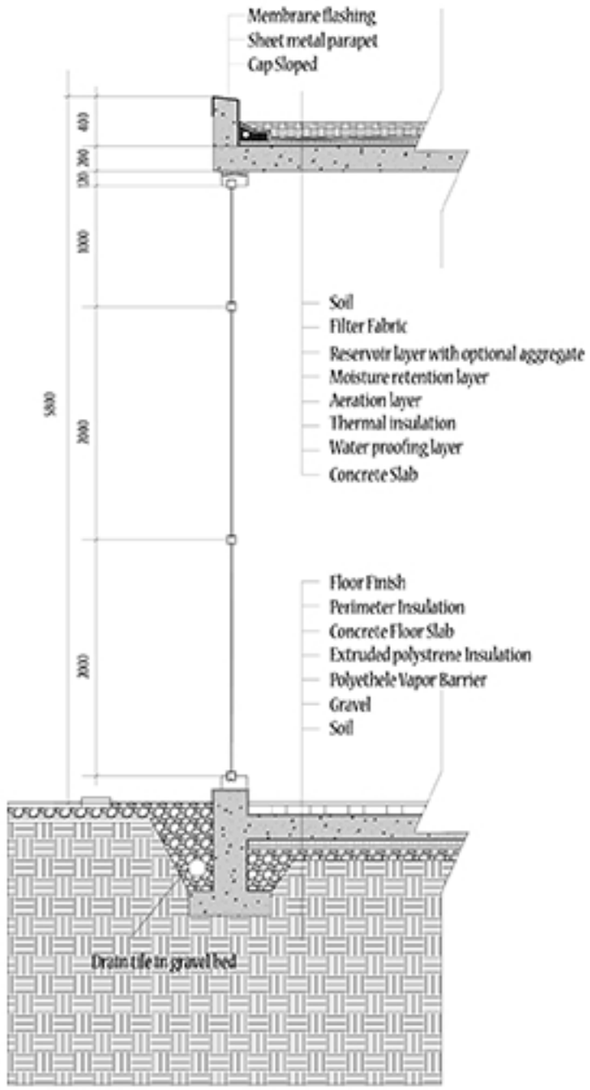
North Elevation

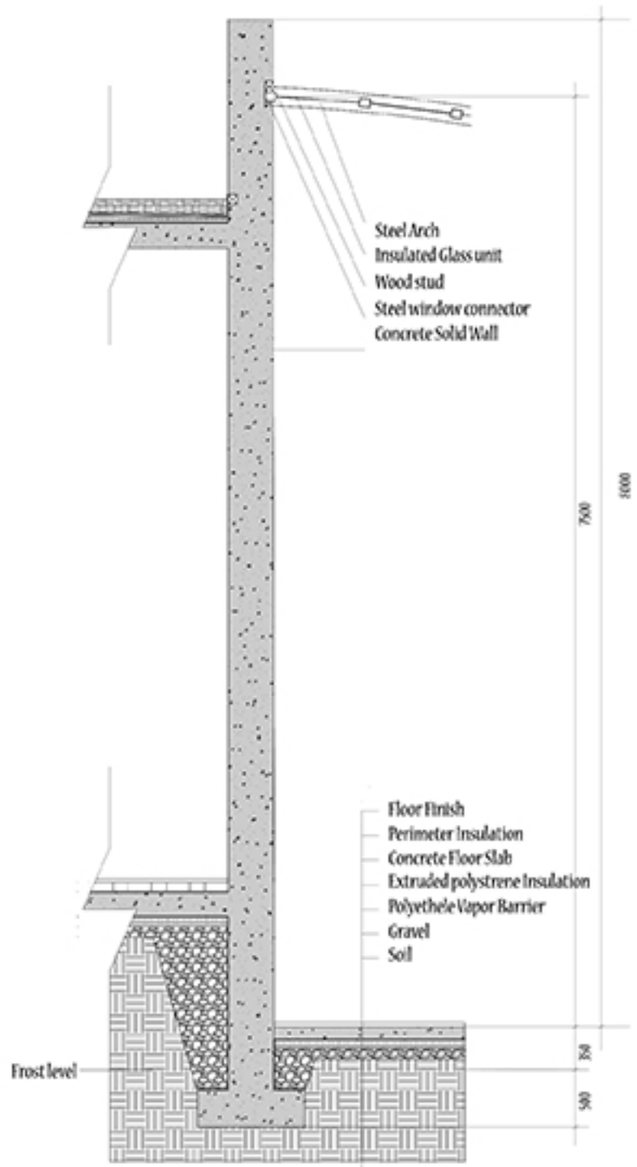


West Elevation

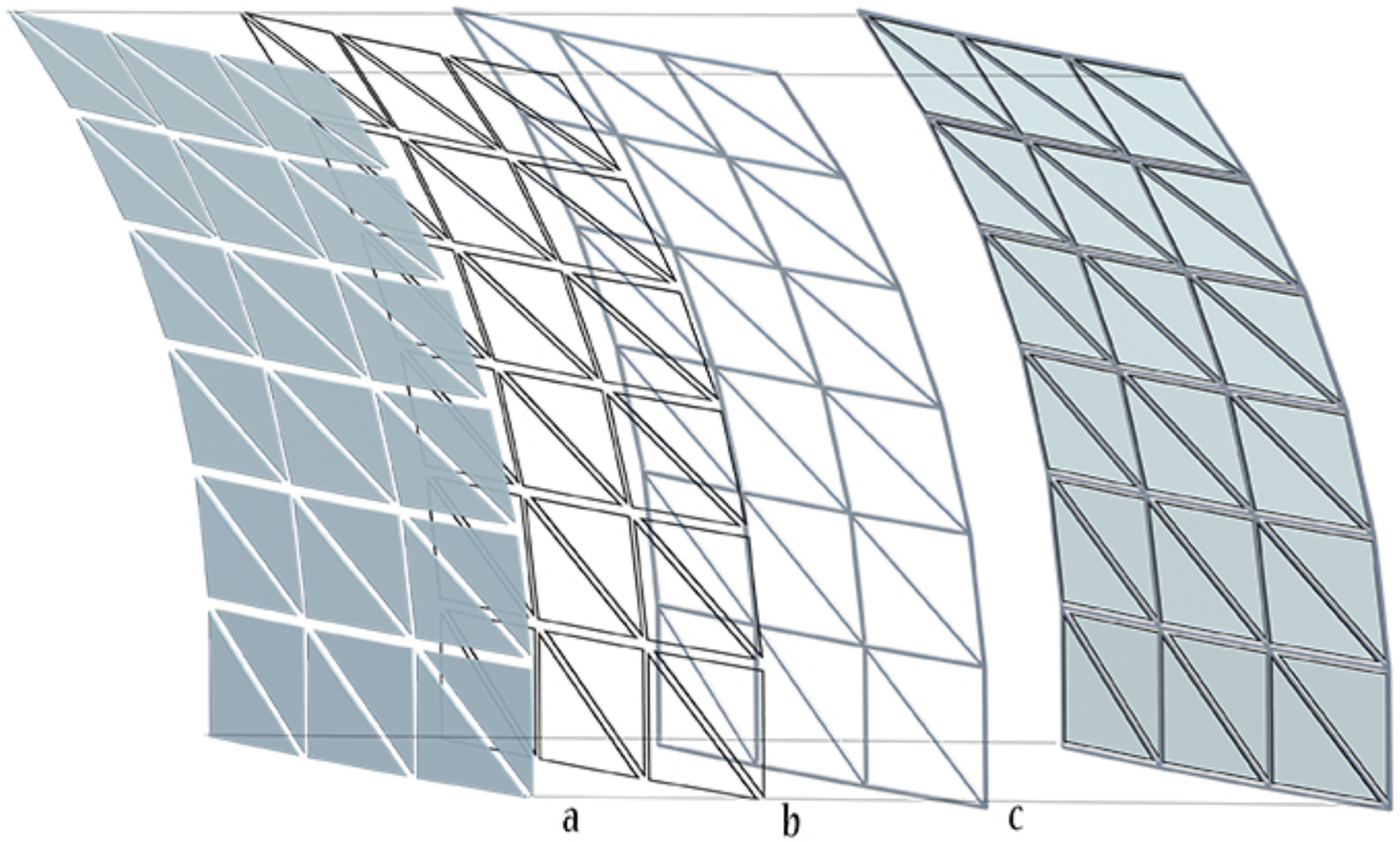


1/750


Membrane flashing
Sheet metal parapet
Cap Sloped
400
300
120
1000
5800
2000
2000
Soil
Filter Fabric
Reservoir layer with optional aggregate
Moisture retention layer
Aeration layer
Thermal insulation
Water proofing layer
Concrete Slab
Floor Finish
Perimeter Insulation
Concrete Floor Slab
Extruded polystrene Insulation
Polyethele Vapor Barrier
Gravel
Soil
Drain tile in gravel bed

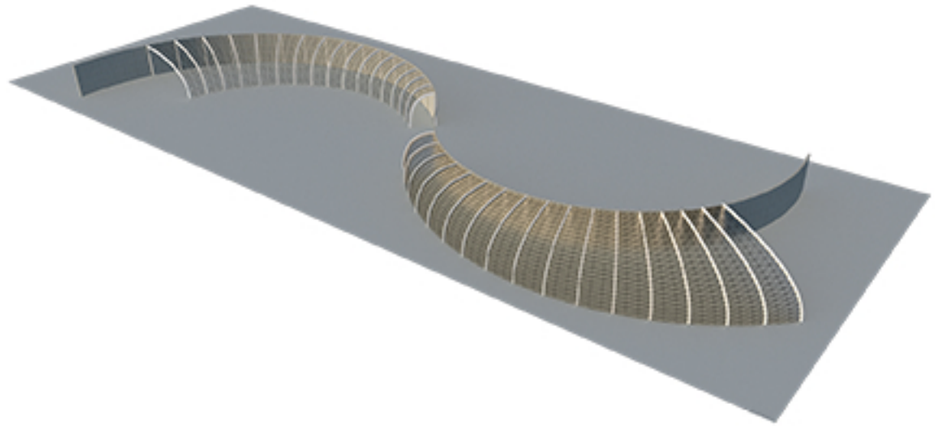

Steel Arch
Insulated Glass unit
Wood stud
Steel window connector
Concrete Solid Wall
8000
7500
Floor Finish
Perimeter Insulation
Concrete Floor Slab
Extruded polystrene Insulation
Polyethele Vapor Barrier
Gravel
Soil
Frost level
250
500

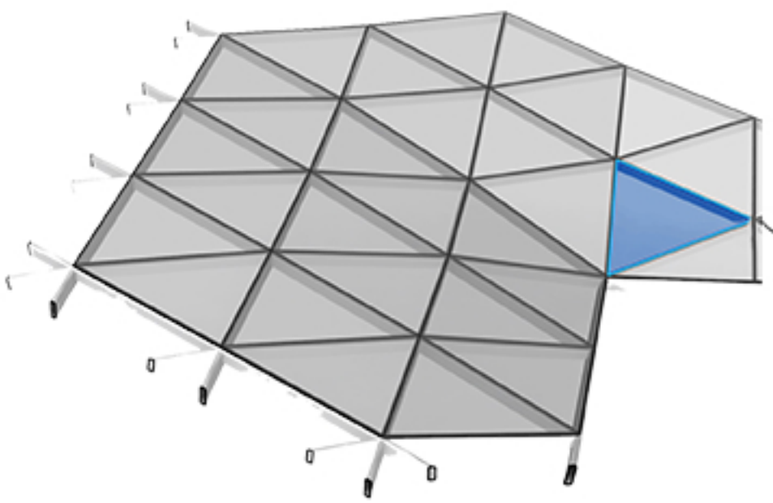
Diagrid Detail

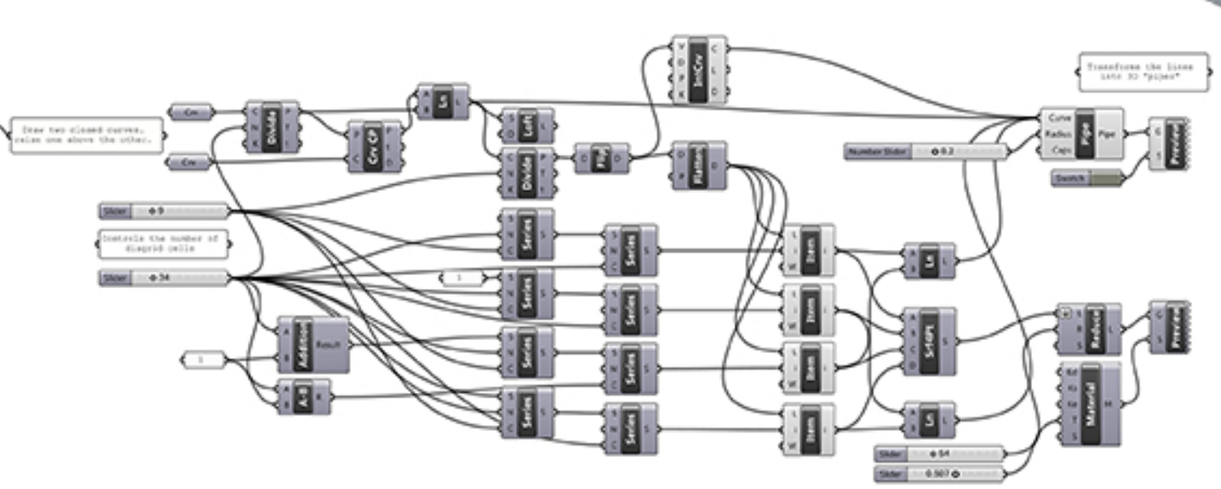


The geometry of the single module plays a major role in the external axial force distribution, as well as in conferring shear and bending rigidity to the conservatory structure. In normal diagrid structure, concentric load and high diagrid angles support is enough but in this case of eccentric and diagrid angles are small that require beams to support all eccentric load.

a. Insulated Glass Unit
b. Steel Window Connector
c. Facade Structure/steel 100mm diameter



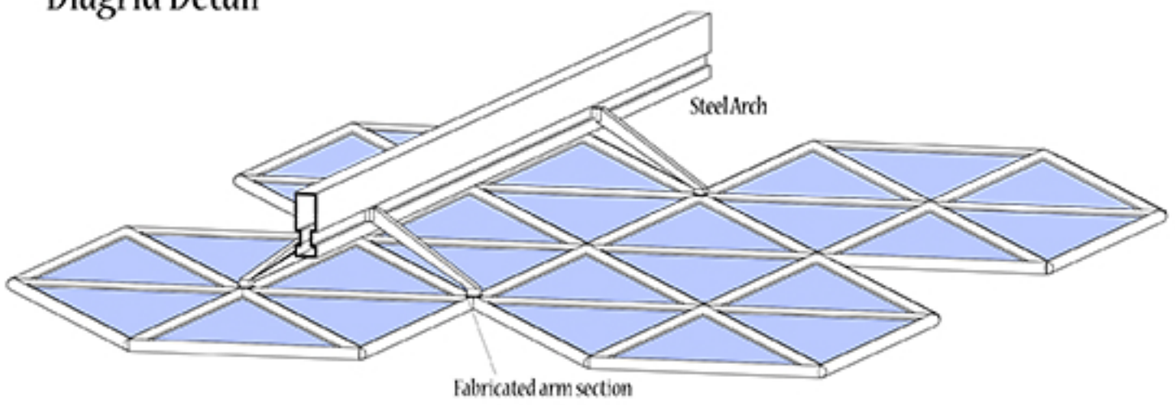


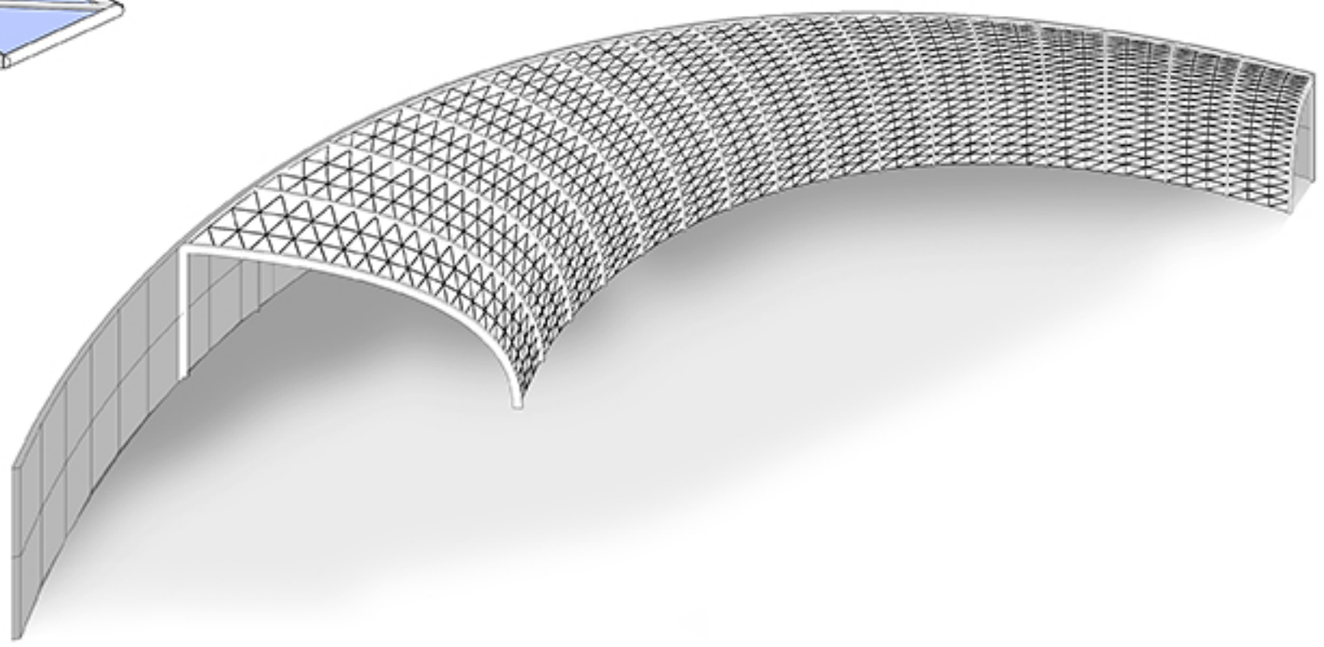


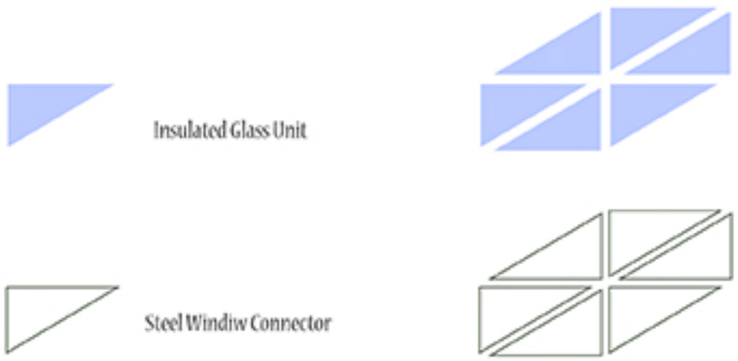
http://www.co-de-it.com/wordpress/code/grasshopper-code
http://thedigitalengineer.blogspot.cz
//https://explodebreps.wordpress.com/grasshopper-definitions/diagrid-structure

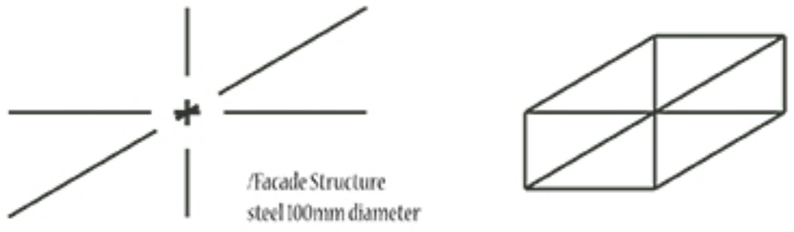
Diagrid Detail

The Conservatory is a semicircular diagrid model in wrought steel and glass. One of the main advantage of this system is more space and more daylight.The diagrid is a framework of diagonally intersecting metal tubes that is used in the construction of buildings and roofs.It requires less structural steel than a conventional steel frame.





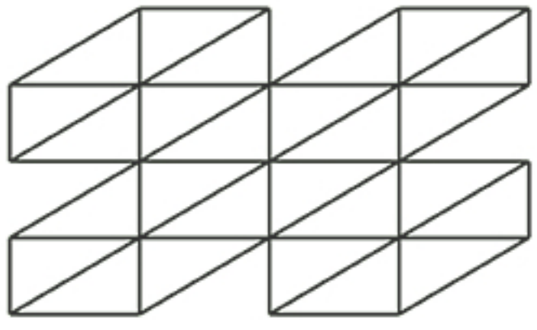


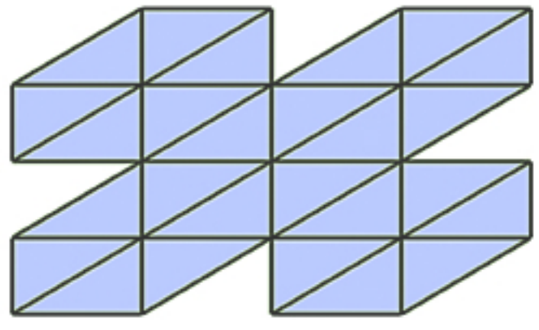


Welding the stell members togetherwith the connection nodes

Attaching the steel window frames to steel members

Single Connection

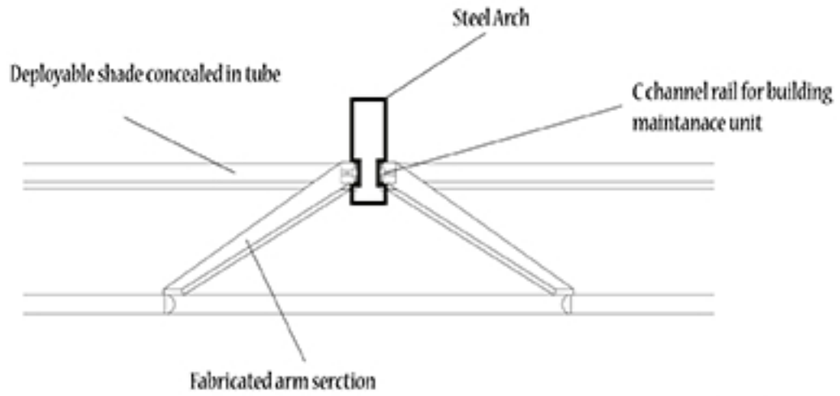


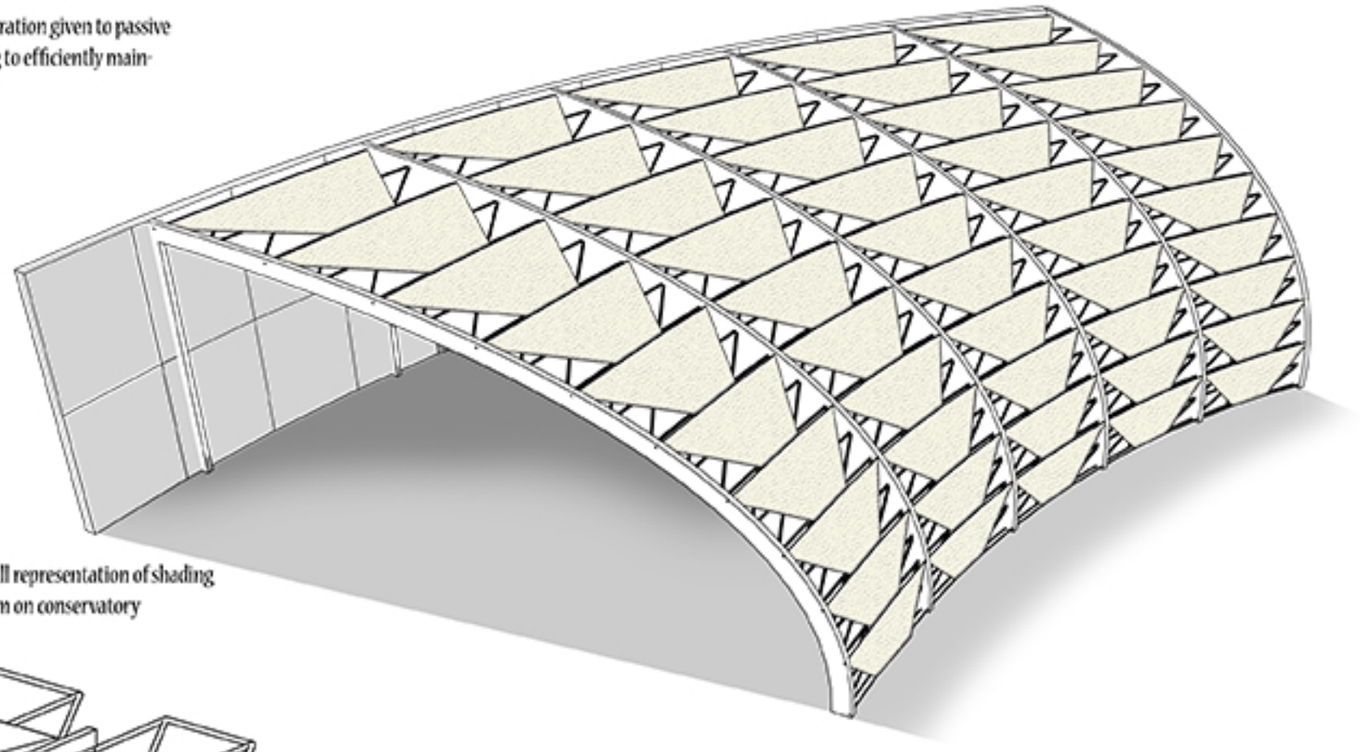


Multiple Connection

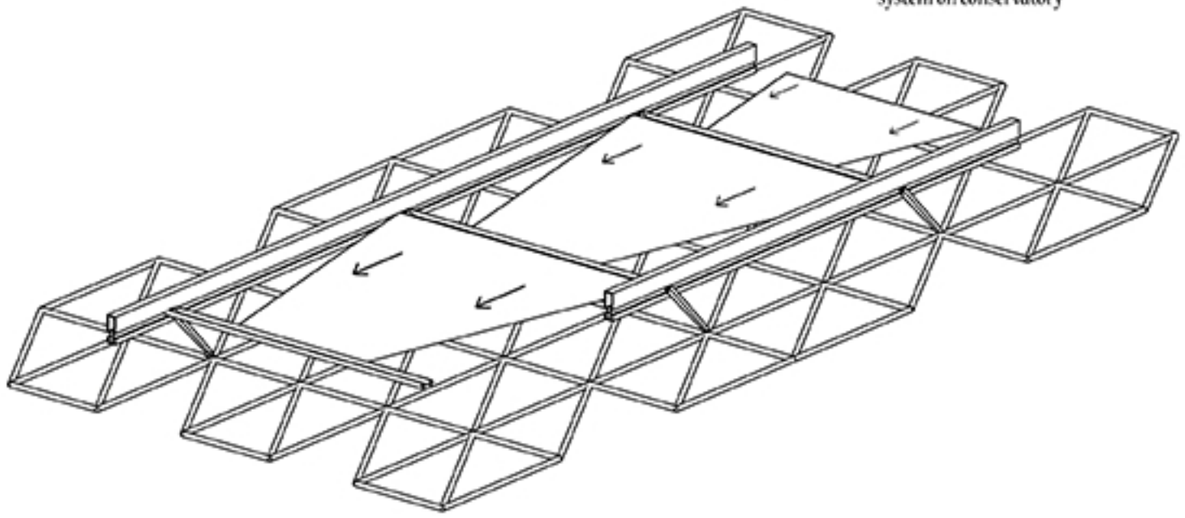
Shading System

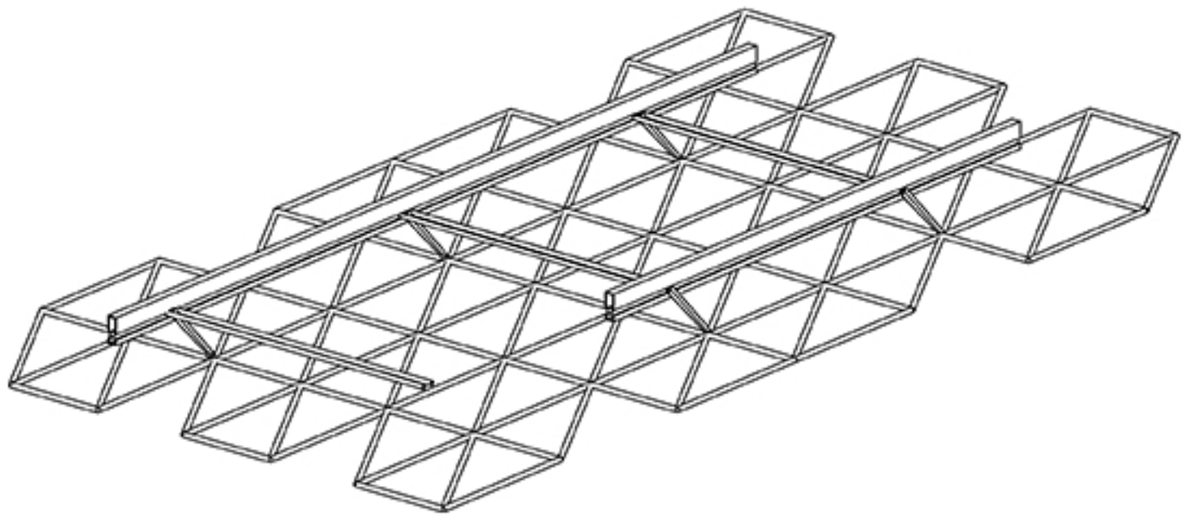
The curvilinear conservatory structures have been designed with sustainability as a starting point, with every consideration given to passive climate control techniques. A computer-controlled shading system have been integrated into the fabric of the building to efficiently maintain the climate within.





Overall representation of shading system on conservatory



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