Move on with wind

Exploring a new living mode in the public space from the perspective of urban scale ventilation design under the pandemic situation

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Basic information

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Architecture and urban space design(2020 Autumn)

Abstract

As of May 2nd, there have been over 152 million covid-19 infections worldwide. It is true that many activities have been switched to remote mode, but many still need physical contact. The thesis aims to explore a new living mode in the urban public space under the pandemic situation from the perspective of urban scale ventilation design.

In the thesis, urban furniture (extended to be explained as every object that accommodates various activities of users and adds comfort and character to urban public space) is used as intervention to improve pedestrian wind comfort and create circulation that separates people. First, experiment is conducted on a simplified virtual context to study the specific impact that intervention has on wind environment. The result of the experiment is the urban furniture which is re-shaped according to wind flow and the re-organized pedestrian circulation which helps people to keep social distance.

As the consideration of Goteborg context, Gullbersvass is perceived as an anonymous part of the city today, but it is planned for a completely new district that connects five districts with 2000 people living and working here. The selected site is in Bergslagsgatan, within Gullbersvass. From Vision 2035 Goteborg, the selected site will be transformed into central area of Goteborg with high building and population density. Urban public space will be more expected here because people's need to have outdoor activities, which makes this area a suitable site to test the research process and outcome.

The procedure from virtual context experiment is applied on the site and after that all the interventions are combined as a prototype. An urban living room proposal is transformed from the component and circulation of the prototype.

The result of the thesis is an urban living room proposal consisting of urban park, entertainment and retail space. Instead of an anonymous place today, the site will be the social, culture and shopping hub which not only satisfies the requirement of people working or living surrounding it, but attracts visitors from other districts. All these experiences are based on the contribution to improved wind comfort and well-organized pedestrian circulation regulated by wind environment which put emphasis on social distancing.

Keywords: post pandemic, urban public space, ventilation design, pedestrian wind comfort, social distancing

Content

Theoretical framework

1.1 Background and purpose

As of March 15th, there have been more than 120 million Covid-19 infections worldwide, The COVID-19 pandemic has created such significant change in the world that the measures taken to combat it's social, economic, and health impacts have been compared to warlike mobilization on a global scale. Despite news of pending vaccines, many countries are reporting an increase in positive test cases and excess deaths, indicating the threat is far from over (Khan,2021). It is true that many activities has been switched to remote mode, but many still need physical contact. Therefore, a new living mode need to be explored under this pandemic context.

Over the past year, many architects have done a lot of research on this topic. One of them is Naghman Khan, in the article "The Importance of Ventilation Strategy Design for Mitigating COVID-19" he tried to point out the importance of applying CFD simulation to help designers to achieve adequate ventilation.The innovative part of this article is that wind simulation is used as an intervention to provide a covid-19 management strategy. But the focus of this article is on indoor space. So whether it is possible to apply this method on urban scale?

Urban public space is the most densely populated area in the city. Urban furniture (refer to a whole range of items, including bike racks, bus stops, bollards, planters, seats, picnic tables, water fountains, streetlights, parasols; the list goes on. All things which we may not pay much attention to on a day-to-day basis, but which add comfort and character to our public spaces) (Pegman, 2018), as an important part of public space, shapes how we feel and act in the public space. So I hope to use urban furniture as intervention and start from urban scale ventilation design to explore the new living mode in urban public space.

1.2 Aim

The thesis aims to propose an urban living room consisting of urban park, entertainment and retail space in Gullbersvass. It strives for a sustainable urban public space which put emphasis on urban scale wind comfort and the people circulation based on the wind comfort. The advantage of this is that pedestrian wind comfort of this area gets improved and people can keep social distance by naturally following the circulation regulated by the wind environment, which help to reduce infection in the pandemic

urban park

entertainment space

retail space

1.3 Project with similar objective

Figure 1. Temperature colored streamlines showing the fresh air intakes supplying air to the room (Khan, N 2021). CC-BY.

Over the past year, many architects have done a lot of research on this topic. One of them is Naghman Khan, in the article "The Importance of Ventilation Strategy Design for Mitigating COVID-19" he tried to point out the importance of applying CFD simulation to help designers to achieve adequate ventilation.

CFD simulation can be used to test ventilation strategies of large and complex structures, this ability is useful not only for the design of new buildings but also when considering refurbishment and mitigation strategies for existing buildings (Khan,2021).

The innovative part of this article is that wind simulation is used as an intervention to provide a covid-19 management strategy. But the focus of this article is on indoor space. So whether it is possible to apply this method on urban scale?

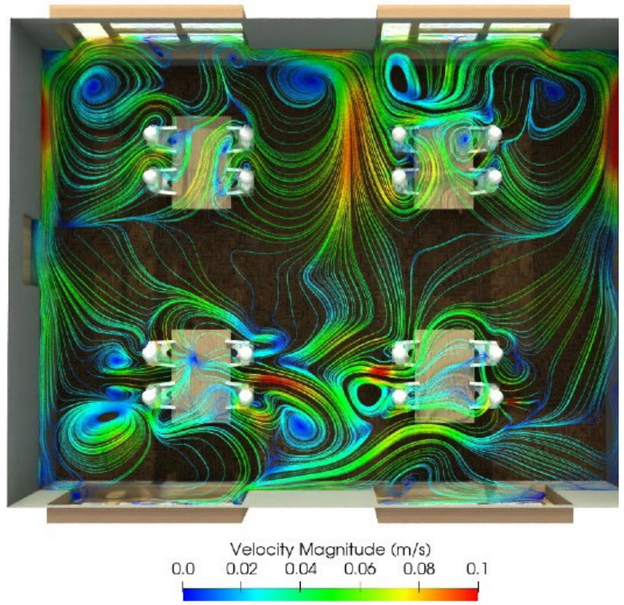


Figure 2. Velocity contours for the baseline case (Khan, N 2021). CC-BY.

1.4 CFD

Computational Fluid Dynamics (CFD) is a branch of fluid mechanics that uses numerical analysis and data structure to analyze and solve problems that involve fluid flows. CFD has been playing an increasingly important role in building design. The information provided by CFD can be used to analyze the impact of building exhausts to the environment, to predict smoke and fire risks in buildings, to quantify indoor environment quality, and to design natural ventilation systems. (Wikipedia, 2021)

CFD has been widely used in ventilation study in buildings to find the thermally comfortable environment with acceptable indoor air quality by regulating indoor air parameters (air temperature, relative humidity, air speed, and chemical species concentrations in the air). CFD finds an important role in regulating the indoor air parameters to predict the ventilation performance in buildings. The ventilation performance prediction provides the information regarding indoor air parameters in a room or a building even before the construction of buildings. (Wikipedia, 2021)

CFD can also be applied to assess *pedestrian wind comfort* on urban scale by giving a concise view of how wind velocity and direction are typically distributed at a particular location (Giraldo, 2021).

1.5 Pedestrian Wind Comfort

what is it?

If you are a sharp-eyed person, you might have noticed that in some specific locations, there is a greater tendency for strong gusts to develop. So, there must be some correlation between the wind and the surrounding buildings causing the gusts. In the world of engineering, this is referred to as pedestrian wind comfort. Pedestrian wind comfort is the branch of wind engineering dedicated to studying wind effects, what causes them, how they develop, and how the urban environment can be designed to control them. (Giraldo, 2021)

why is it important?

Any building construction, be it a high- or low-rise building, bridge or tunnel, will have an impact on its surrounding environment. Wind flow disruption is one of the many possible impacts. Especially in urban areas, wind effects such as tunnel throttling or vorticity can be created. If not planned beforehand, these effects can even be harmful or dangerous to people using or even nearby the affected facilities (Giraldo, 2021).

By assessing pedestrian wind comfort, urban master planners can predict the behavior of wind flow around proposed buildings while they are in the design phase. Wind speeds and other parameters can be calculated at pedestrian levels, and a comfort assessment can be made using specific *criteria*. This allows for improvements to be directly implemented into the design and assessed in cycles until a satisfactory construction plan is achieved (Giraldo, 2021).

assessment criteria

	Comfort Category	Wind speed(m/s)
	Sitting	≤2.7
	Standing	≤3.8
	Strolling	≤4.7
	Walking	≤5.5
	Uncomfortable	> 5.5
	Exceeded	> 25

Figure 3. Example of mechanical wind comfort criteria (Giraldo, G 2021). CC-BY.

Wind velocity can be translated into different levels of pedestrian wind comfort by this assessment criteria.

1.6 Tools introduction

DepthmapX

DepthmapX is an open-source and multi-platform spatial analysis software for spatial networks of different scales. The software was originally developed by Alasdair Turner from the Space Syntax group as Depthmap, now open-source and available as depthmapX (UCL, 2020).

It works at a variety of scales from buildings and small urban areas to whole cities or states. At each scale, the aim of the software is to produce a map of spatial elements and connect them via relationship (for example, intervisibility, intersection or adjacency) and then performs a graph analysis of the resulting network. The objective of the analysis is to derive variables which may have social or experiential significance (UCL, 2020).

In my thesis, I will use depthmapX to simulate the visibility and accessibility situation and use it to locate the areas with best visibility and easiest accessibility. These areas will be the boundary of site.

IBOFlowCitySimulation

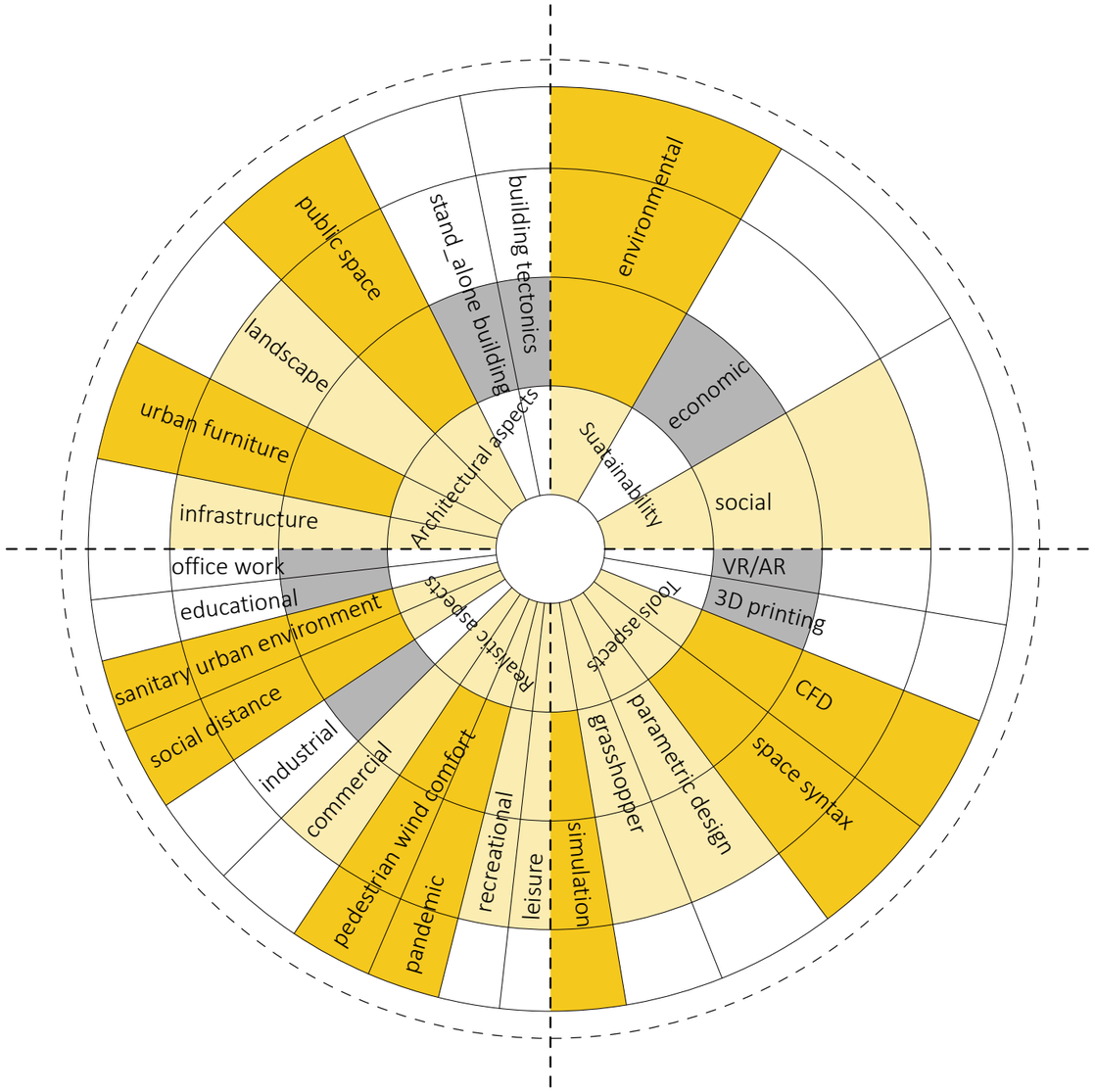
IBOFlowCitySimulation is a CFD (computer fluid dynamics) software developed at Fraunhofer-Chalmers Research Centre. In the thesis I will use this software to simulate wind environment and use wind velocity information from the simulation to assess pedestrian wind comfort.

1.7 Thesis question

If a certain amount of daily agendas still need to be carried out physically under pandemic context, what kind of activity space do we need in the urban public space?

Is it possible to form a activity space from the perspective of urban scale ventilation design to respond to pandemic situation?

1.8 Delimitation diagram



This thesis aims to explore a new living mode in public space from urban scale ventilation design under the pandemic situation. Different from Conventional ventilation design on the building scale, pedestrian wind comfort is an important indicator in the urban scale ventilation strategy. Wind simulation is based on CFD technology. Some other actants that influence space quality such as radiation, noise and water system will not be considered. Urban furniture is treated as intervention. Through re-organization that is based on the wind environment, urban furniture creates an activity space. The circulation of the space regulates people's movement so they can keep social distance which helps to reduce infection. The economic issues and realistic efficiency related to the space will not be discussed.

1.9 Method

The thesis is a research by design project. There are three main phases: background research, context study and project design.

Phase 1. Background research

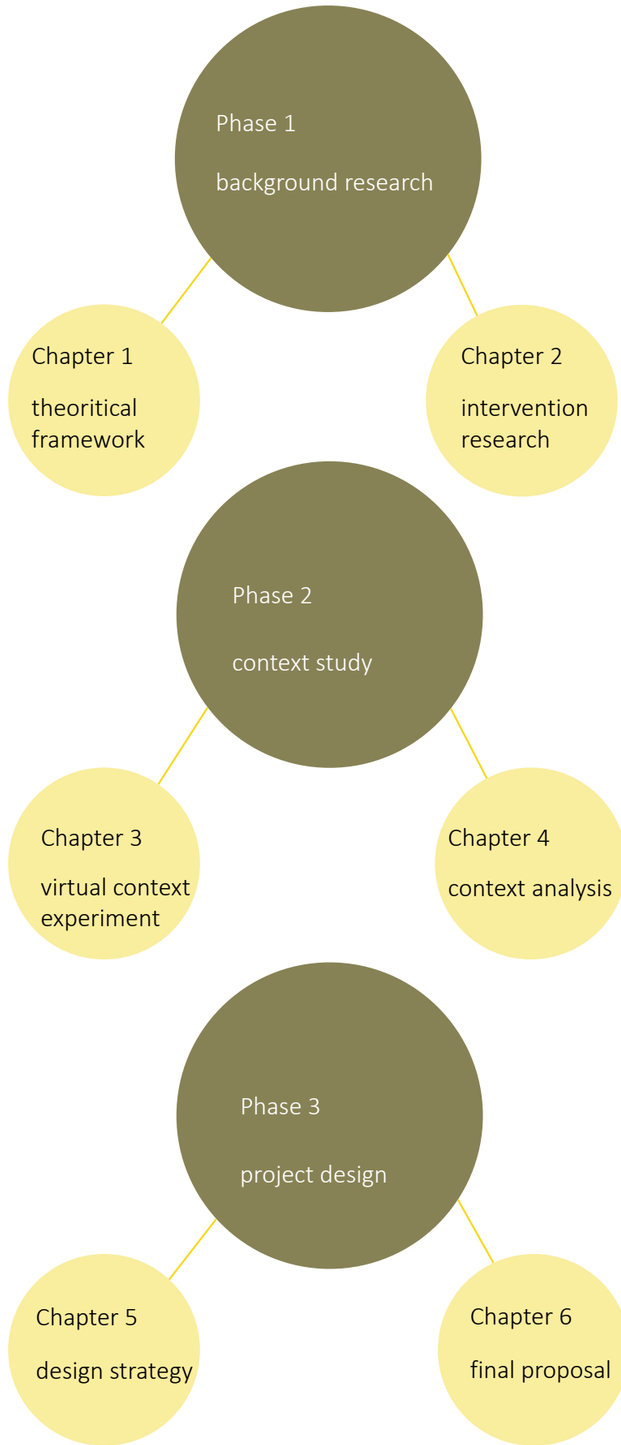
This phase includes theoretical framework and intervention research. It has a case study on a project which has the similar objective and introduction to the software that I will use in the later phase. There is also introduction to urban furniture and how it is transformed to intervention to influence wind situation.

Phase 2. Context study

This phase consists of virtual context experiment and context analysis. Virtual context experiment focuses on test the effectiveness of the intervention in improving pedestrian wind comfort and context analysis focuses on choosing a site and studying the surrounding facilities and existing program and the wind environment. This phase aims to get control of using intervention to adjust wind environment and prepare for the next phase.

Phase 3. Project design

This phase involves design strategy and final proposal. The procedure from virtual context experiment is applied on the site and after that all the interventions are combined as a prototype. An urban living room proposal is transformed from the component and circulation of the prototype consisting of urban park, entertainment and retail space.



Intervention research

2.1 Urban furniture introduction

Urban furniture, originally means all the furniture items you find in the outdoors – in our public spaces, streets, parks, shopping centers, housing developments, etc. Things like park benches and litter bins. They're usually fixed in place and have a specific purpose – i.e., for sitting on, or for throwing your rubbish into (Pegman, 2018).

Sometimes also called street furniture, these items allow people to enjoy a more comfortable experience in the outdoors. They can considerably improve the quality of life for the inhabitants of a city or town – just imagine a park with nowhere to sit. And unfortunately, we have all seen rubbish blowing around because there wasn't an adequate place for people to throw it away (Pegman, 2018).

In this thesis, I hope to extend the interpretation of urban furniture as every objects that accommodate various activities of users and add comfort and character to urban public space. Urban furniture will be used as intervention to optimize wind behavior.

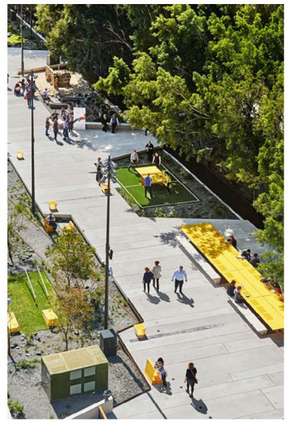


Figure 4,5,6,7. Example of urban furniture (pinterest). CC-BY.

2.2 Urban furniture category

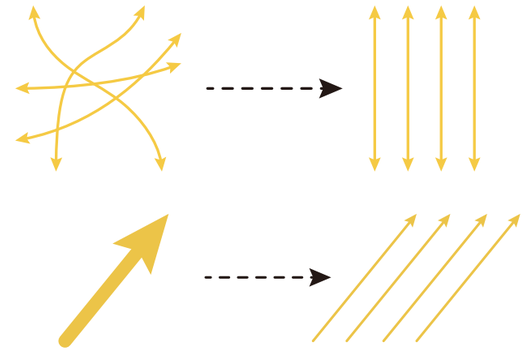
linear urban furniture

strongly directional

separates the spatial continuum

dynamic, directional, and directing

movement and tension



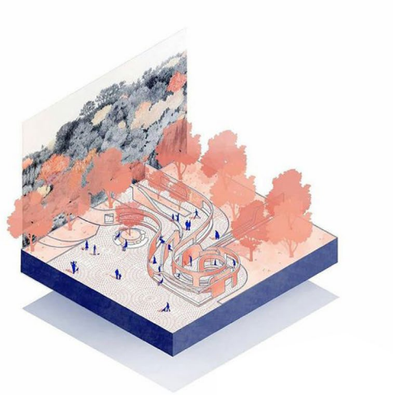


Figure 8,9,10. Example of urban furniture (pinterest). CC-BY.

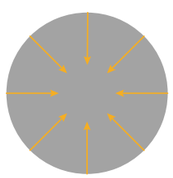
planar urban furniture

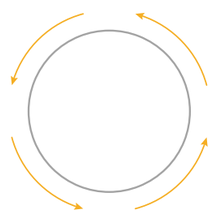
two dimensional

fundamental for all events and activities

expansion, extension, and relaxation

filling, spreading or outlining





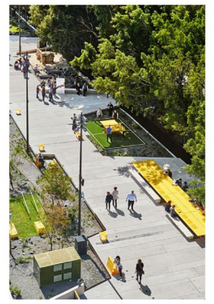
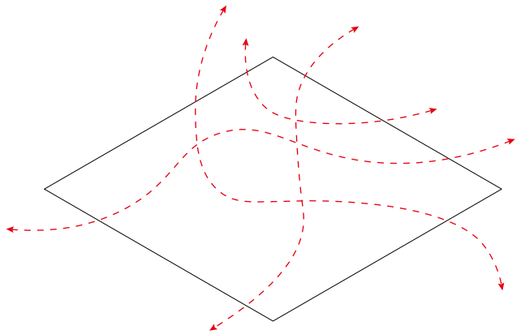


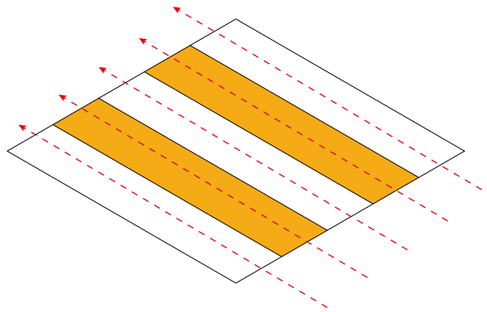
Figure 11,12,13. Example of urban furniture (pinterest). CC-BY.

2.3 Urban furniture generation

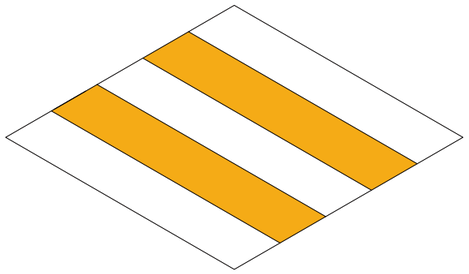
colored path- linear urban furniture

guide movement

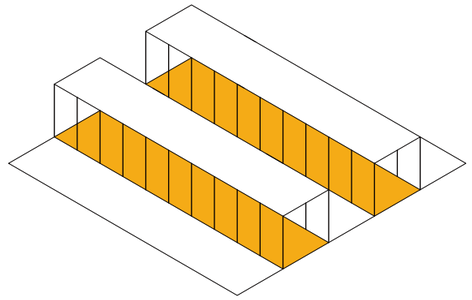




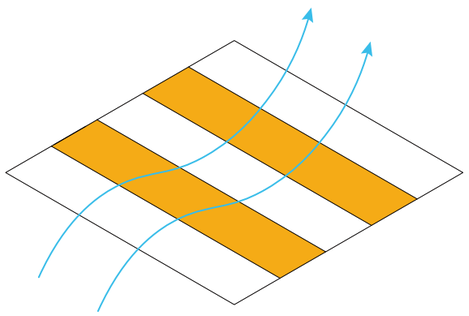
transformation



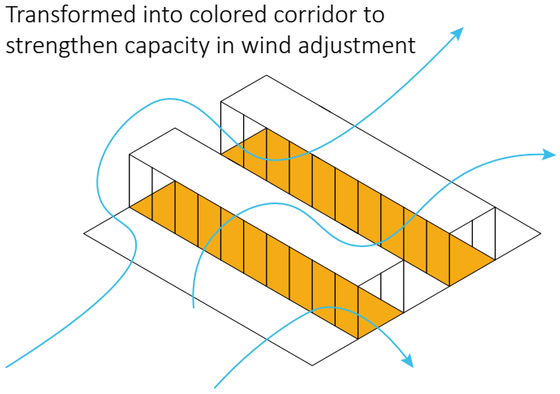
Current form



Transformed into colored corridor to strengthen capacity in wind adjustment



Almost have no impact on wind situation

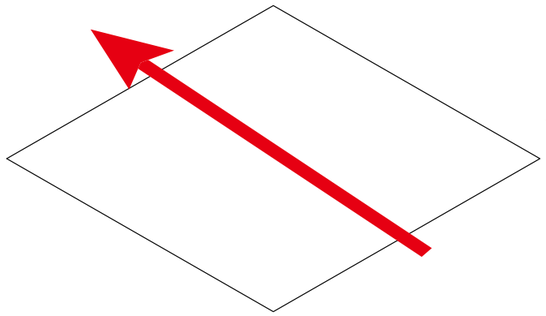


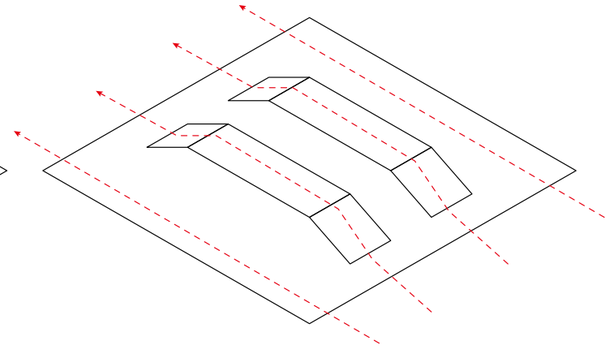
Have certain impact on wind flow

Colored path, as a linear urban furniture, has the function to guide movement in urban public area. It is transformed to colored corridor to increase the capacity in adjusting wind situation. It is used as intervention in the later phase.

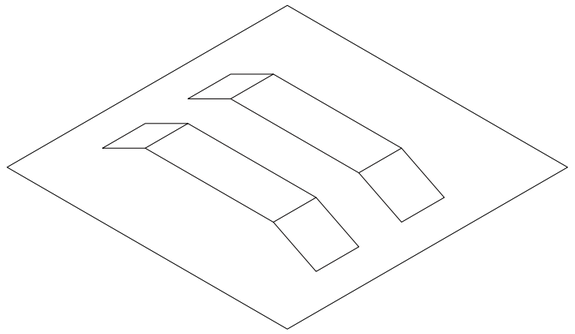
staircase- linear urban furniture

separate movement

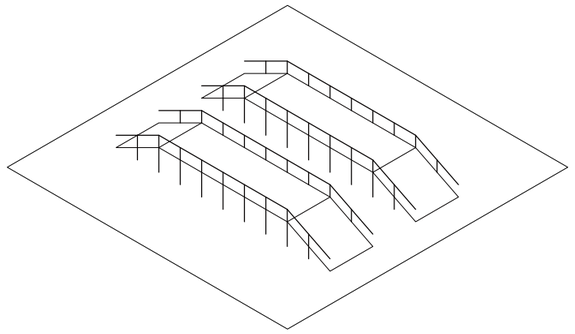




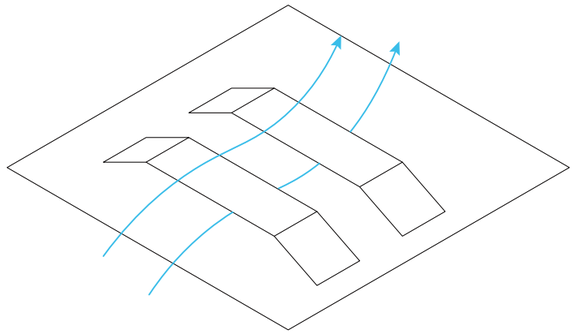
transformation



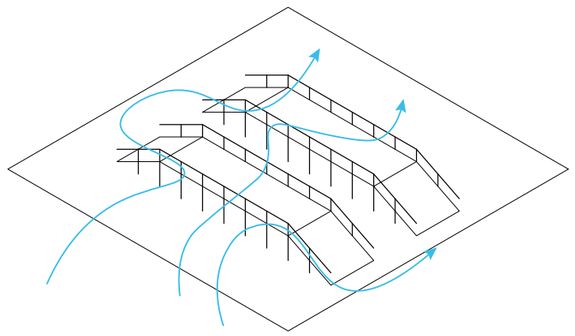
Current form



Add vertical elements handrail and supporting structure



Almost have no impact on wind situation

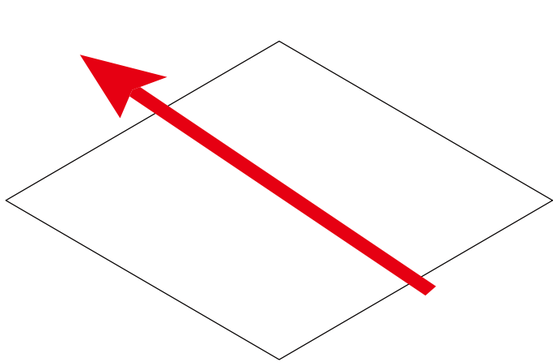


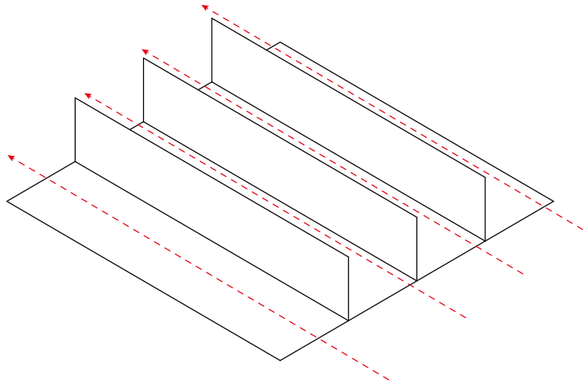
Have certain impact on wind flow

Staircase can separate a mainstream into several movements. Through transformation of adding vertical elements, it has certain impact on wind flow so it is selected as intervention to optimize velocity situation in the virtual context experiment.

maze- linear urban furniture

separate movement

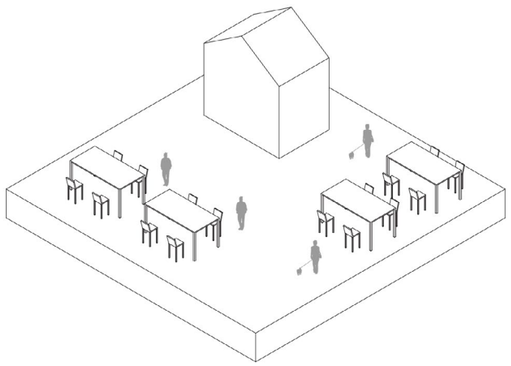




Different from colored path and staircase, maze itself has the function in both separating movements and modifying wind environment so it is also selected as intervention to participate the ventilation design.

commercial spot- planer urban furniture

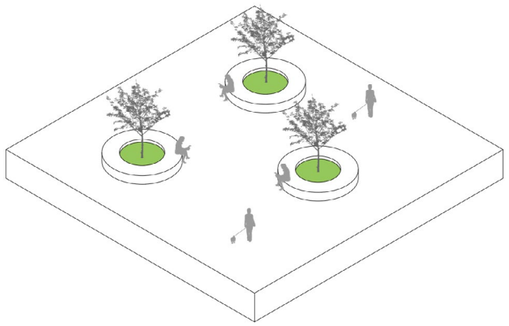
accommodate events



Commercial spot such as fast food or cafe enrich the diversity of activities in urban public spaces

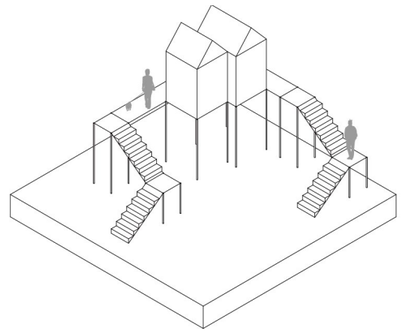
bench- planer urban furniture

accommodate events

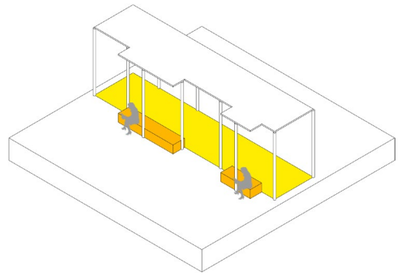


Leisure facility such as benches provides people place to stay in the urban public space

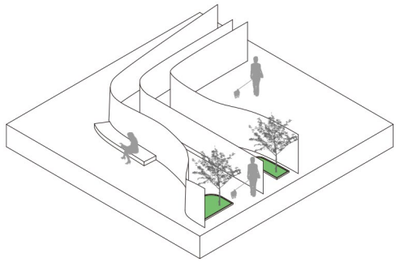
combinations



Staircase combined with commercial spot



Colored path combined with bench



Maze combined with bench

In some context, linear furniture could be combined with planar furniture, so there will form some really interesting combinations. These combinations help to both guide movements and accomdate events.

summary

linear urban furniture / planar urban furniture	Colored path	Staircase	Maze
Bench	Combination 1		Combination 2
Commercial spot		Combination 3	

Through investigation and transformation of urban furniture, 3 linear furniture, 2 planar furniture and 3 combinations of them are chosen as design elements and function as intervention to optimize wind environment.

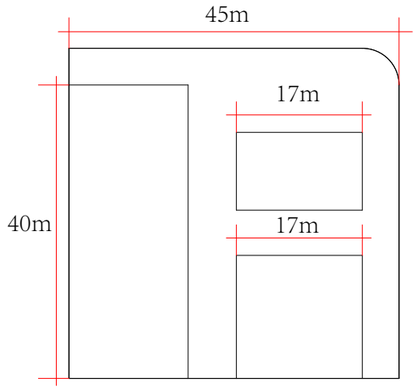
Virtual context experimentation

3.1 Purpose and expected results

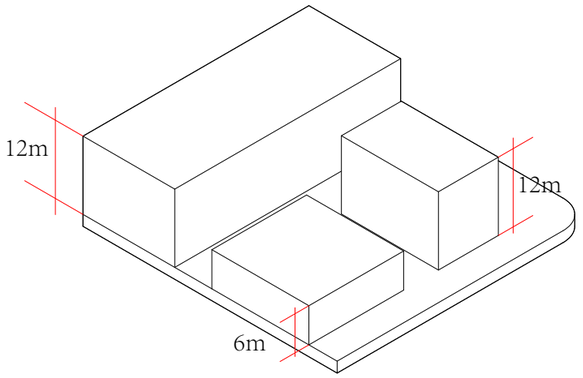
After determining the category and form of intervention, I will conduct experiment on a virtual context. The purpose of this is to study the specific impact that the intervention can have on the wind environment under a simplified context by minimizing the impact that unrelated factors may have on the experiment result. First, I will use depthmapX to locate the areas with best visibility and easiest accessibility and then put the intervention in these areas. After that, I will use Iboflow to assess the pedestrian wind comfort and reshape the intervention based on the pedestrian wind comfort. The assessment criteria will be applied to translate the wind velocity which is the wind simulation result from Iboflow to pedestrian wind comfort. The result of this chapter is wind-based intervention and the re-organized pedestrian circulation regulated by the wind environment, which naturally separates the mainstream into several movements.

3.2 Virtual context introduction

Plan

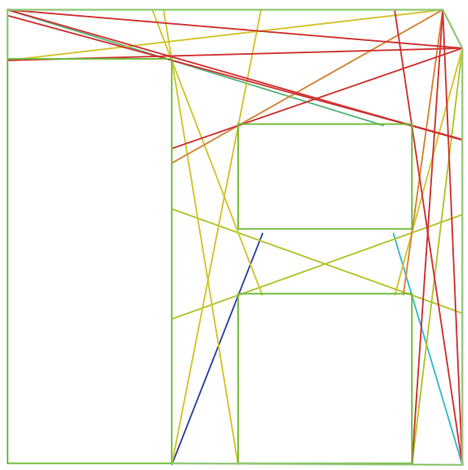


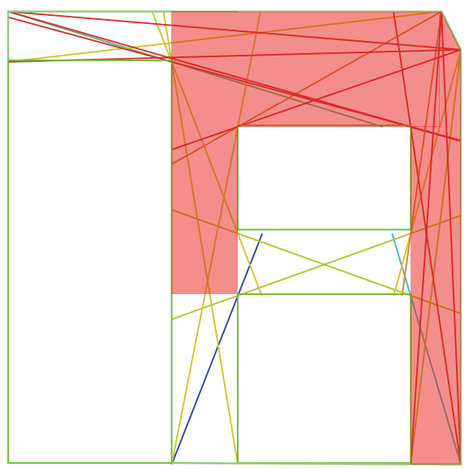
Axonometric



The virtual context consists of a platform and 3 buildings in different measurement. In next step, I will use space syntax to define the specific location to put intervention.

3.2 Accessibility simulation





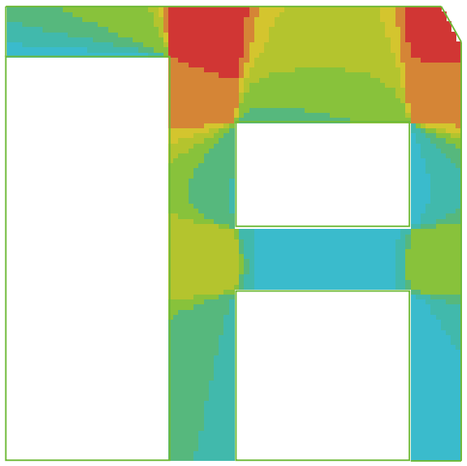
SPATIAL CONNECTIVITY

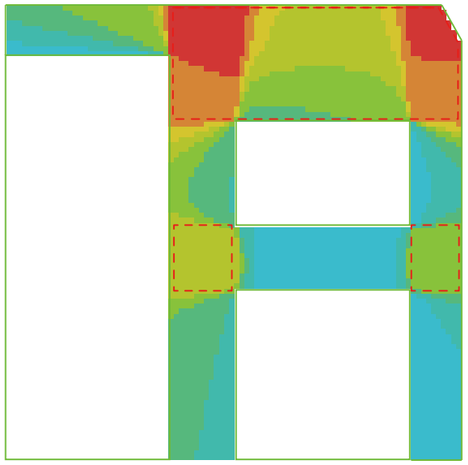
HIGH

LOW

Area with easy accessibility

3.3 Visibility simulation





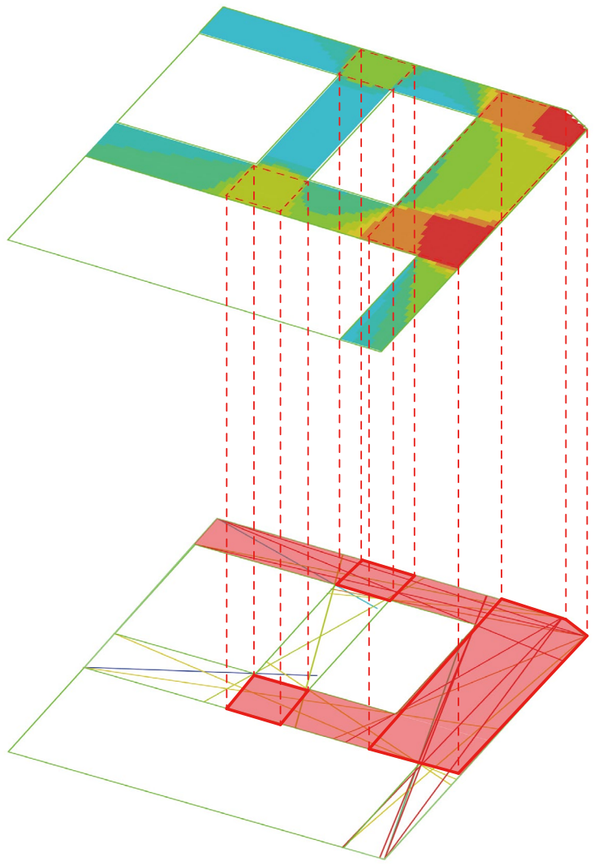
VISIBILITY

VISIBLE

INVISIBLE

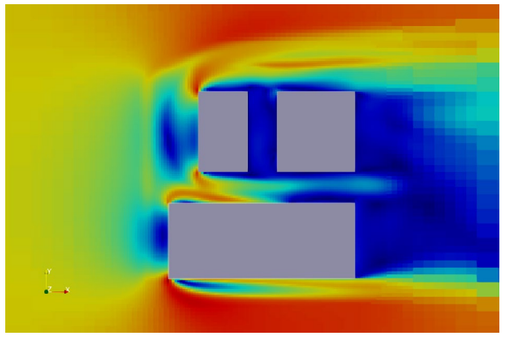
Area with good visibility

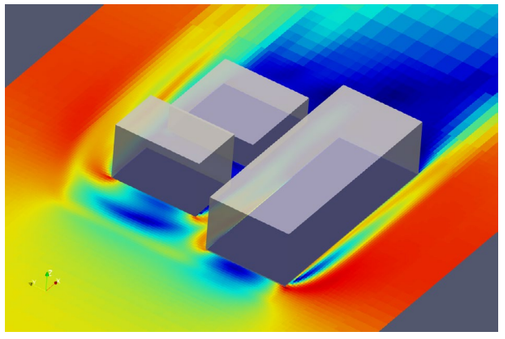
3.4 Mapping



These mapped areas have the best visual situation and easiest accessibility which means people tend to gather here so intervention in these areas will be effective.

3.5 Wind velocity situation without intervention





Velocity (m/s)

8.0e+00

7

6

5

4

3

2

1

0.0e+00

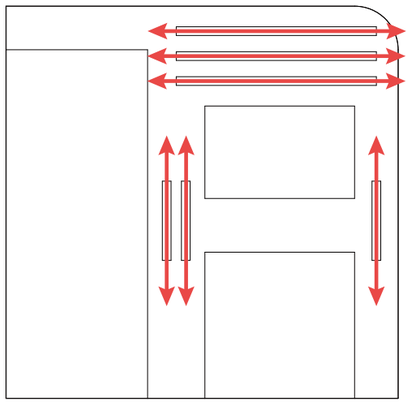
CFD simulation input parameters

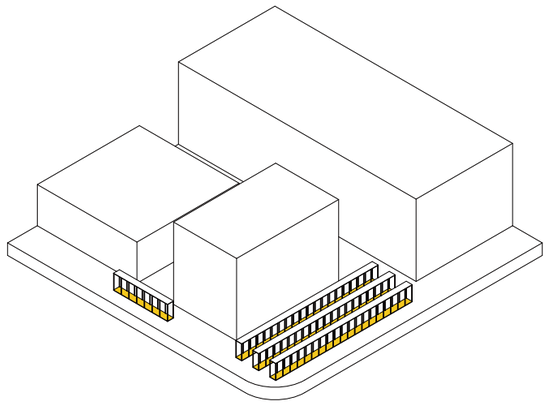
Input wind velocity: 5m/s
wind tunnel direction: from west to east

According to the translation rules from wind velocity to pedestrian wind comfort, area with wind velocity over 5.5m/s will make pedestrian feel uncomfortable and is not suitable for any activities. Therefor here the area with color from orange to red should be decreased and I will use this as a qualitative evaluation standard to assess the effectiveness of the intervention in improving wind comfort.

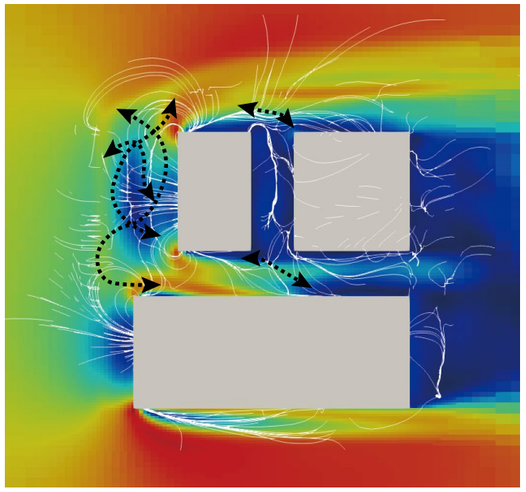
3.6 Intervention colored path and bench

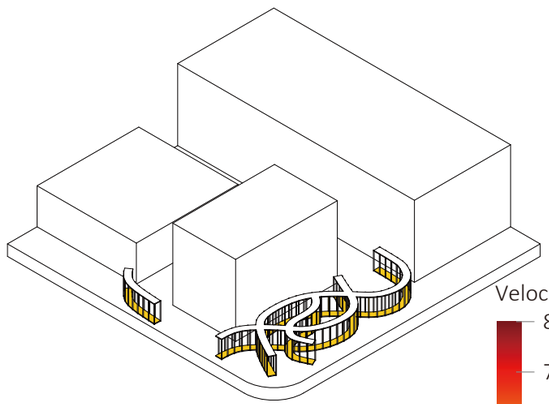
generation process

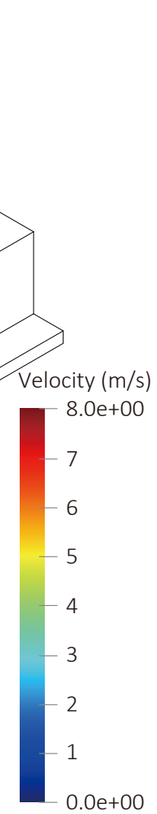




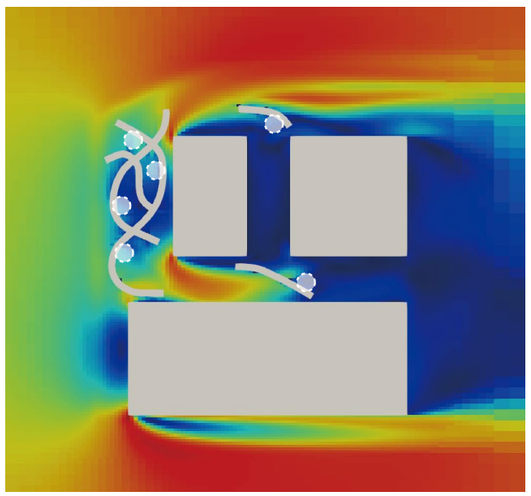
Step1: put the colored path in the selected areas regularly

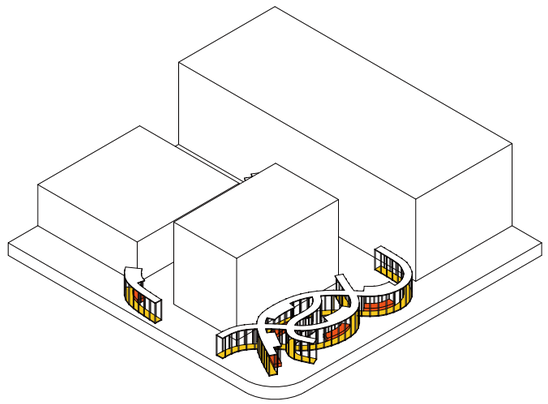




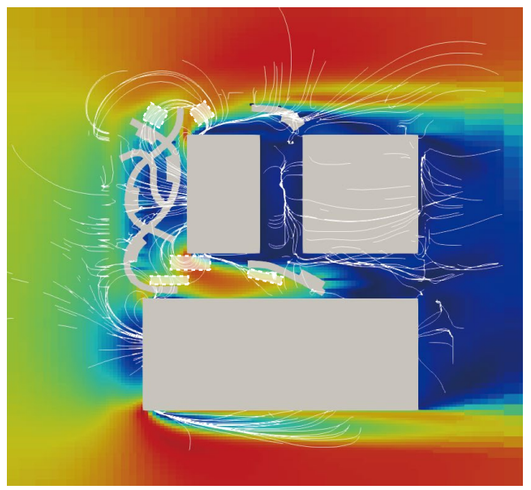


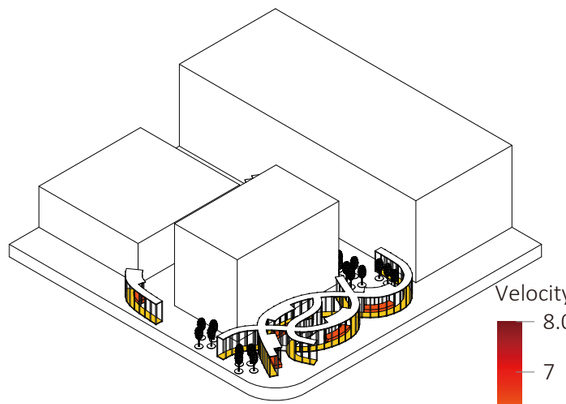
Step2: twist the colored path against wind flow to lower wind velocity

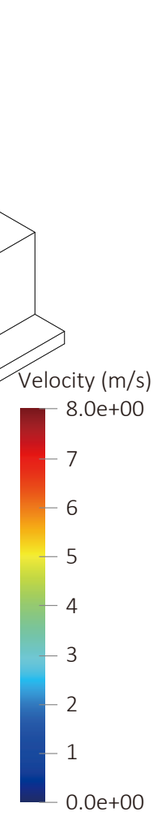




Step3: add benches in the low velocity area

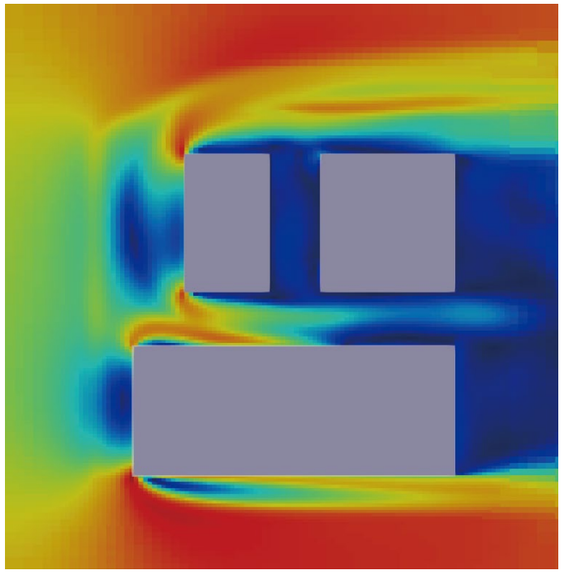


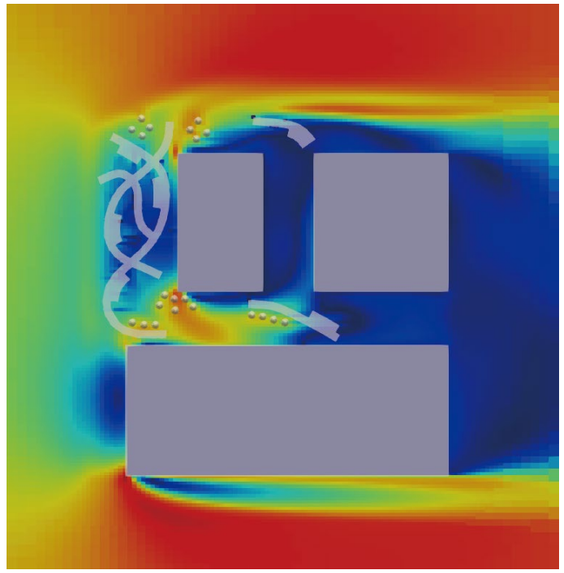




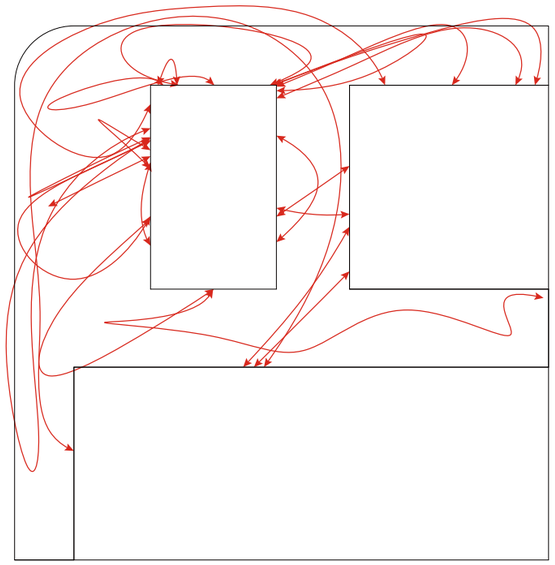
Step4: add greenery to further block wind

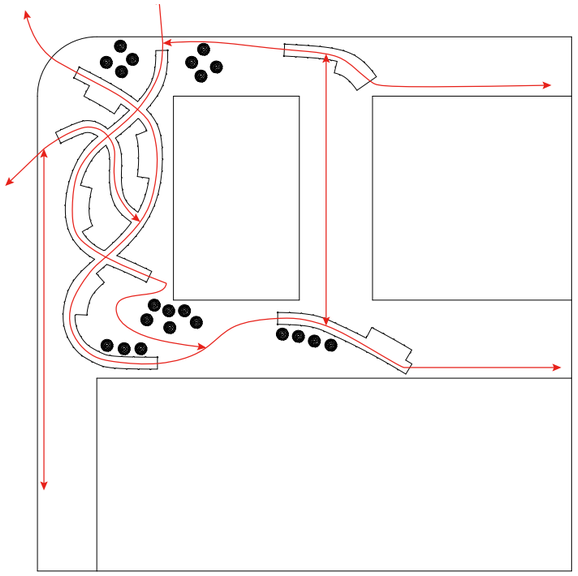
velocity contrast

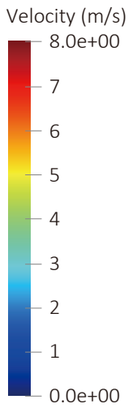




pedestrian circulation contrast

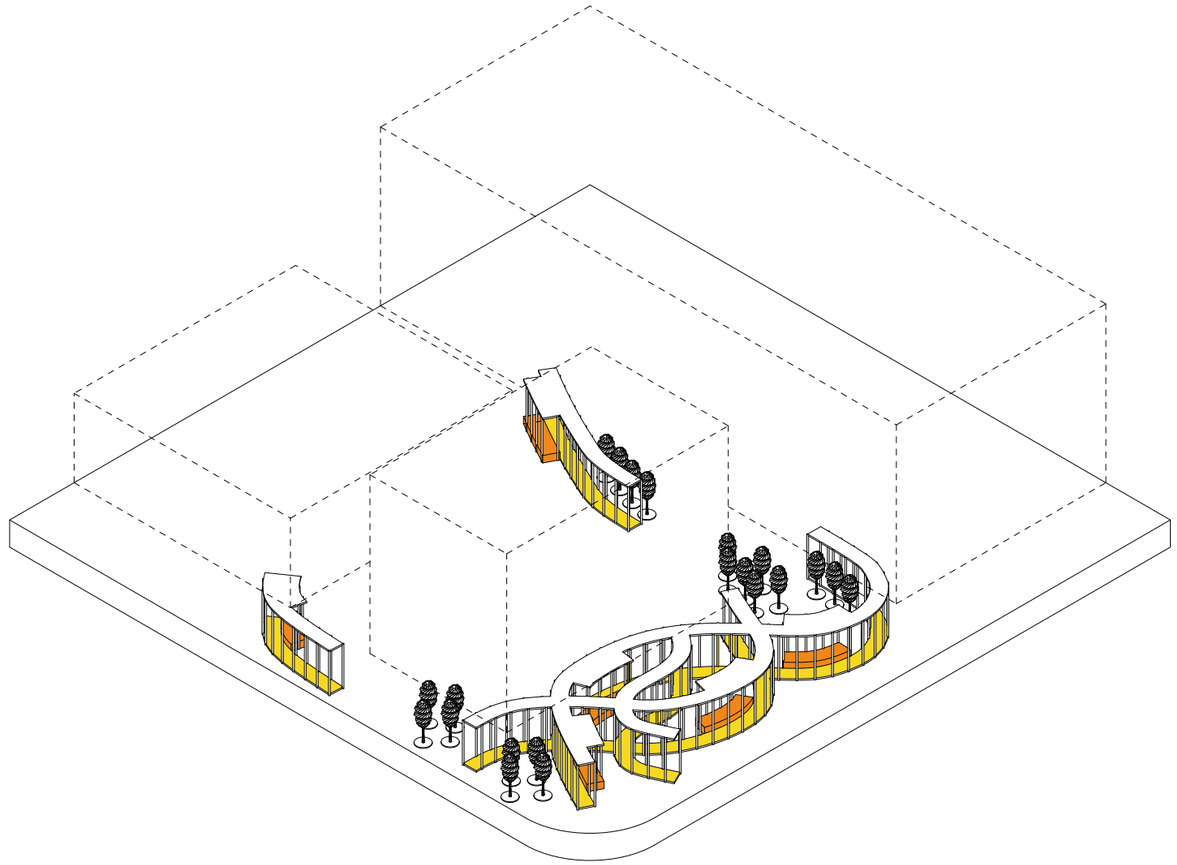






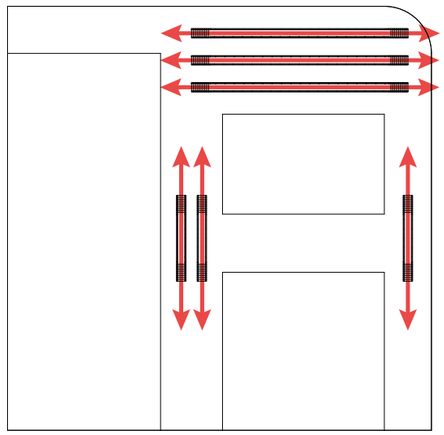
From the velocity contrast, we can see that compared with wind situation without any intervention, colored path and bench reduce the high velocity area (over 5.5m/s), according to the qualitative evaluation standard, the pedestrian wind comfort gets improved.

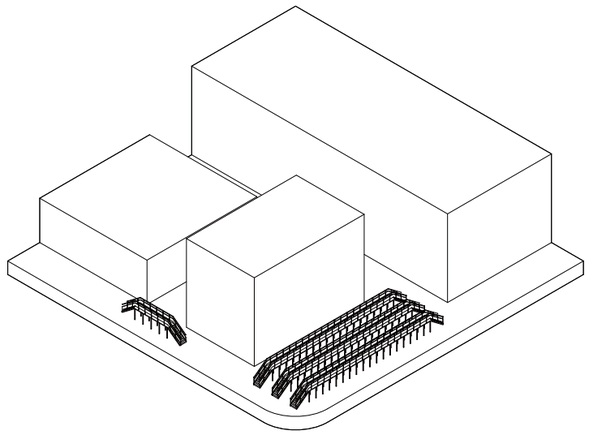
From the circulation contrast, we find that compared with the circulation without intervention, which is disordered, the circulation regulated by colored path and bench is more efficient, which helps people to keep social distance.



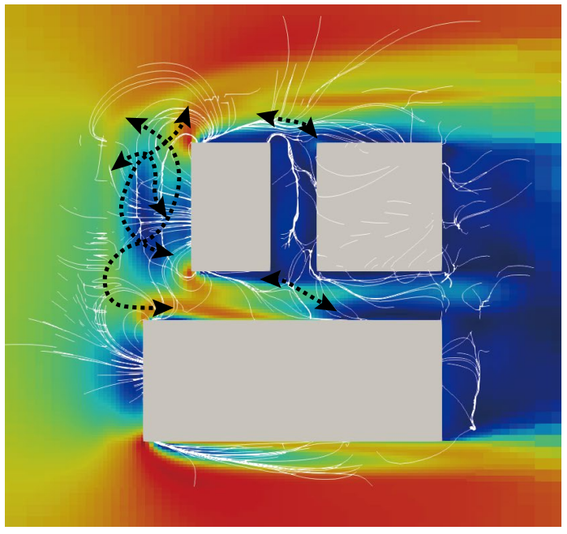
The axonometric drawing shows the result of intervention colored path and bench. The intervention forms a space which involves several colored corridors and benches. The colored corridors re-organize the circulation of pedestrians so they can easily keep social distance and the benches provide them spots to stay where the wind environment is suitable. All these intervention and pedestrian contribute to an urban scale wind comfort environment.

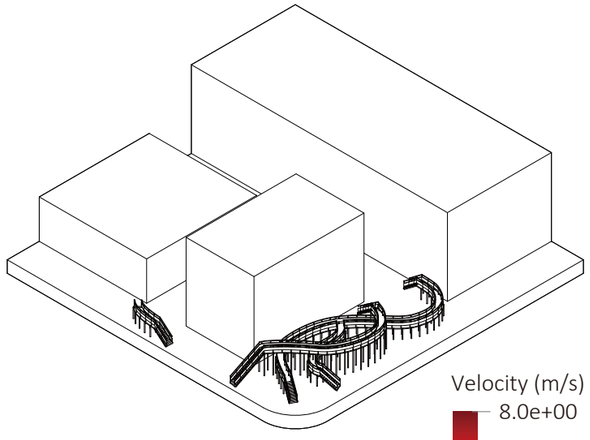
3.7 Intervention staircase and commercial spot

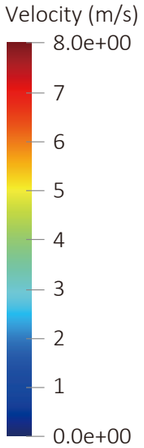




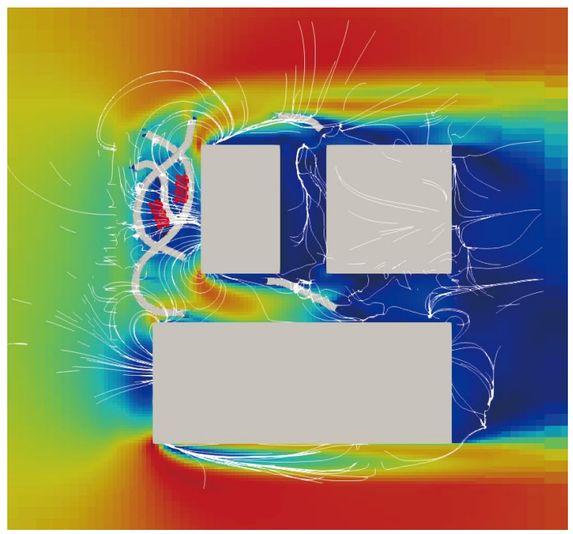
Step1: put the staircases in the selected areas regularly

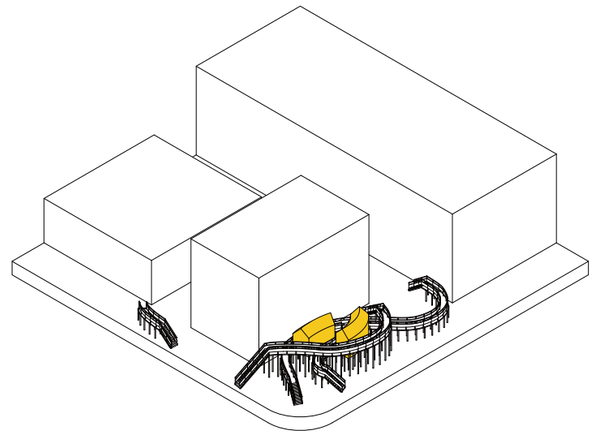




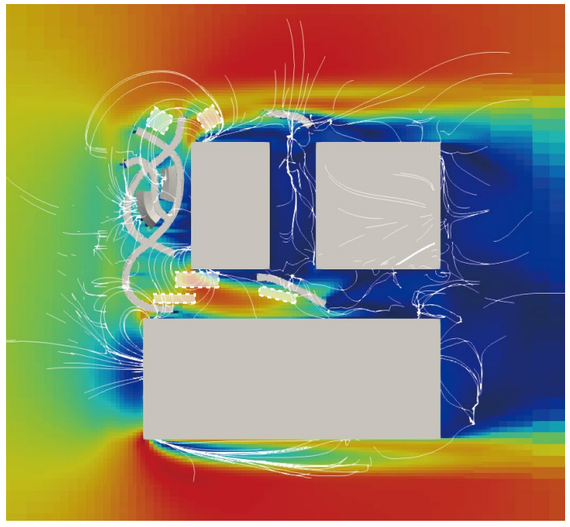


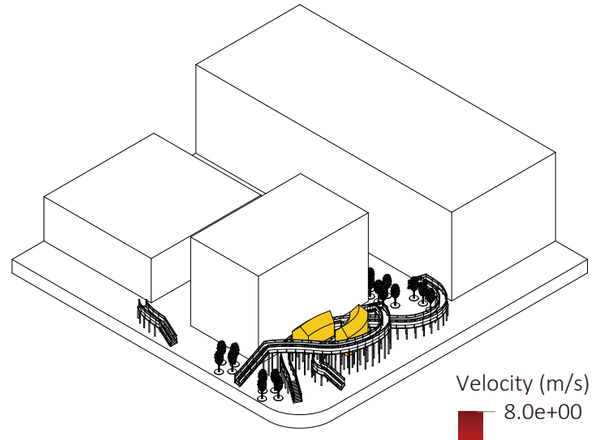
Step2: twist the staircases against wind flow to adjust wind environment

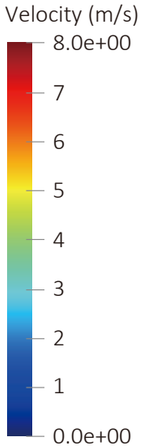




Step3: add commercial spots to accommodate various events

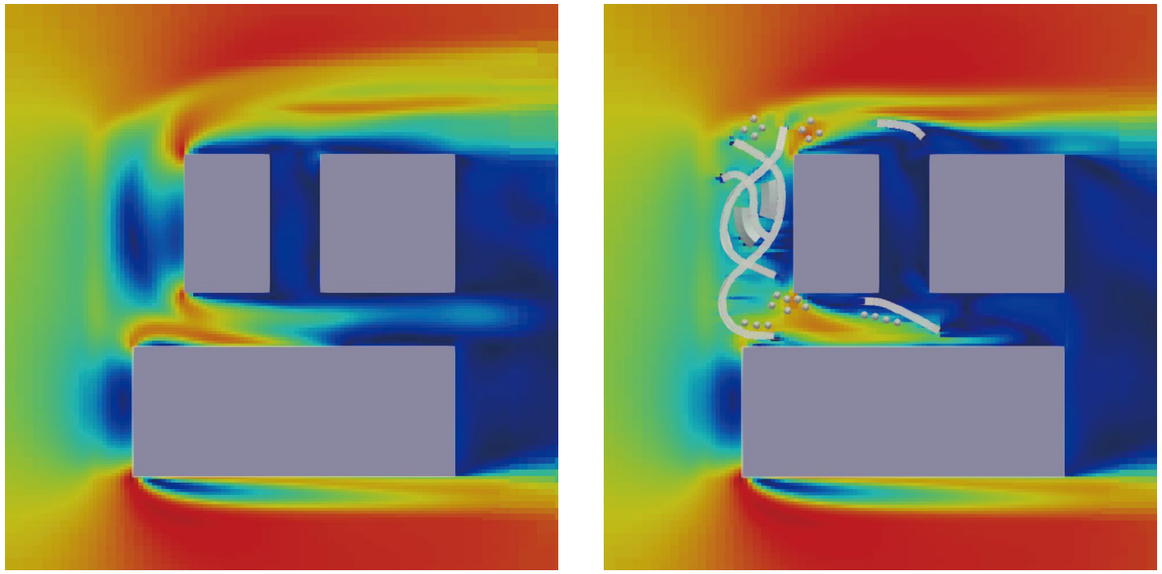




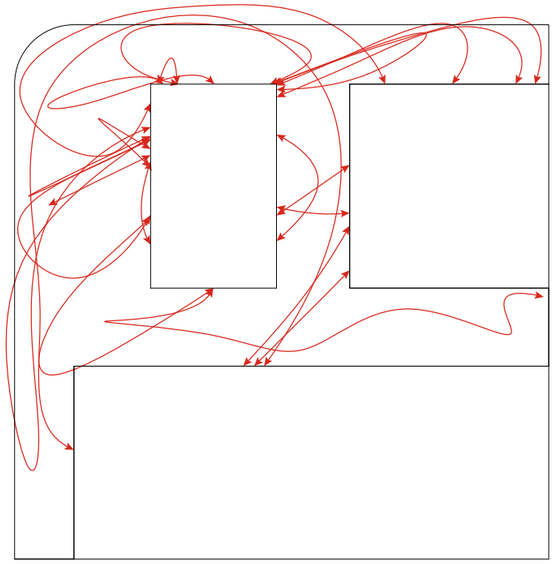


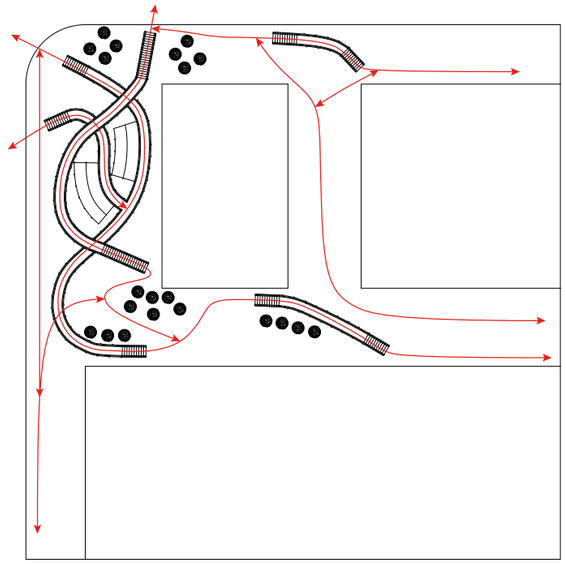
Step4: add greenery to further adjust wind environment

velocity contrast



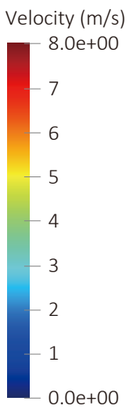
pedestrian circulation contrast

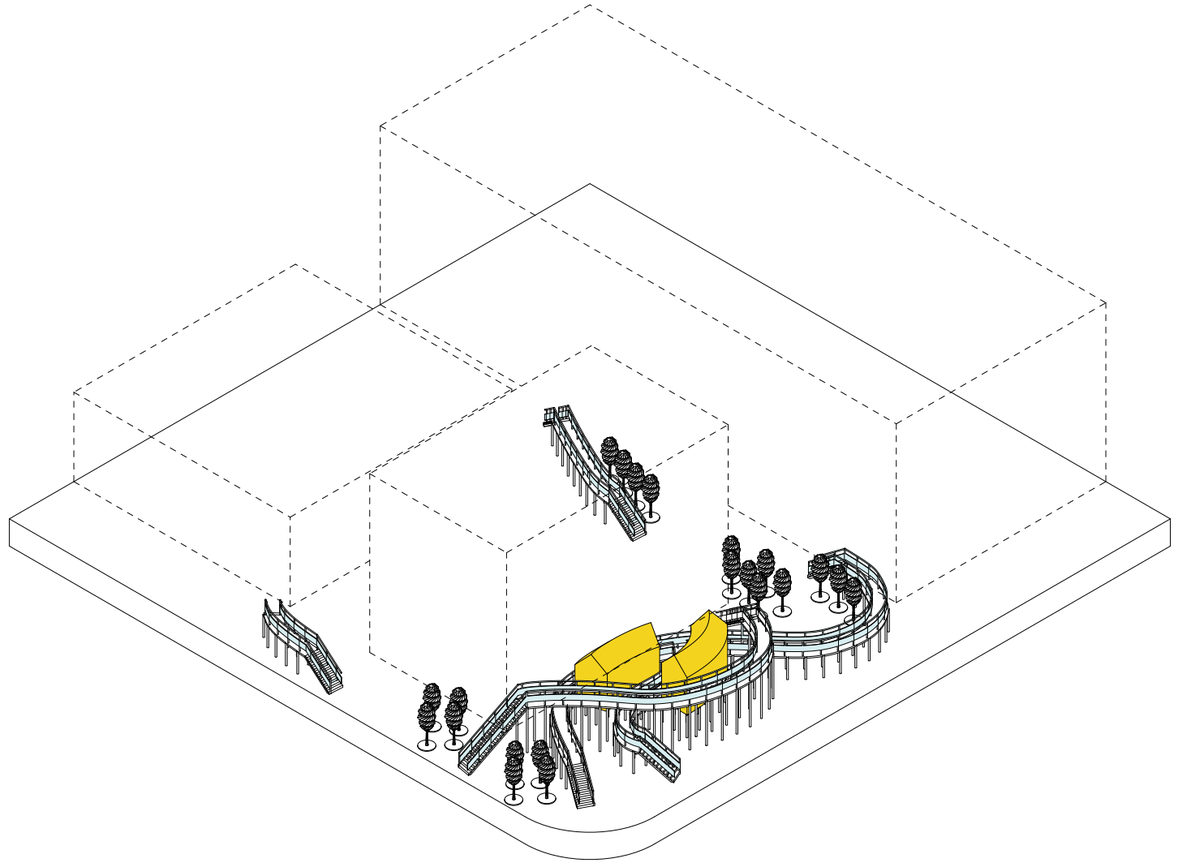




The velocity contrast shows that the intervention staircase and commercial spot decrease the area with velocity over 5.5m/s, this proves the effectiveness of the intervention in optimizing wind environment.

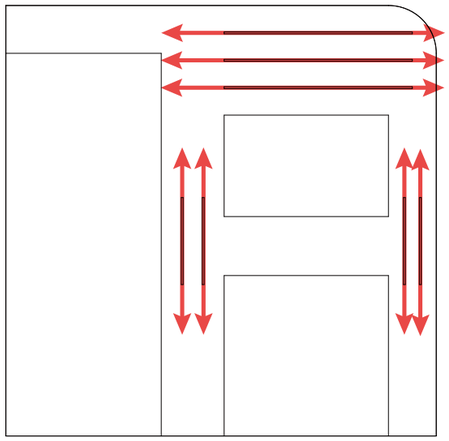
The circulation contrast demonstrates that the circulation formed by staircases and commercial spots is more effective in separating movements and avoiding unnecessary intersection.

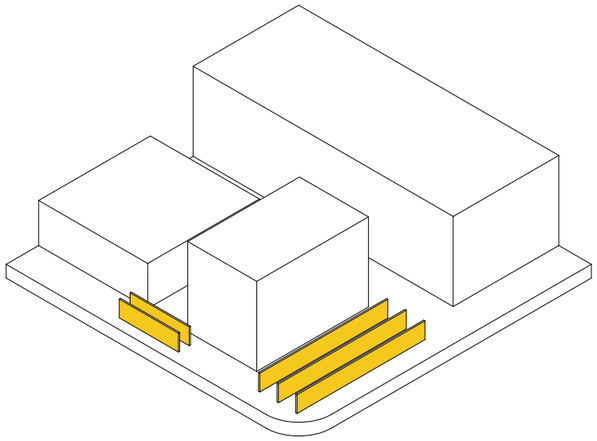




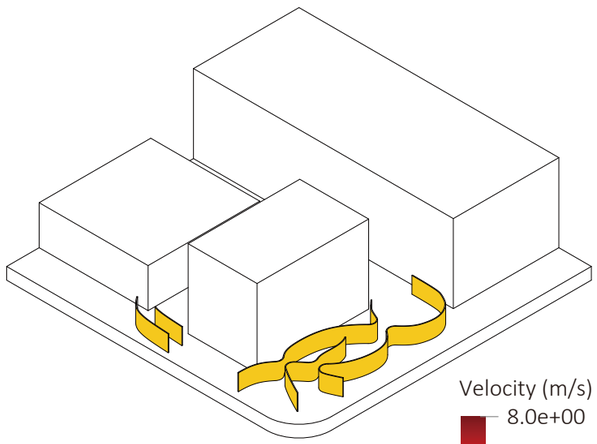
The axonometric drawing shows how the staircases and commercial spots are organized by wind situation. The space consists of 5 staircases and 2 commercial spots. The staircases are arranged at different height with commercial spots following the shape, offering pedestrians the option to pass through the area at various height or to stay at these commercial pavilions to shop or have a drink.

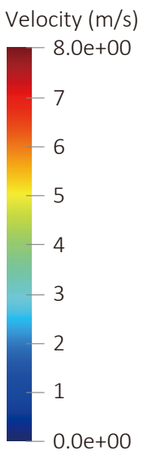
3.8 Intervention maze and bench



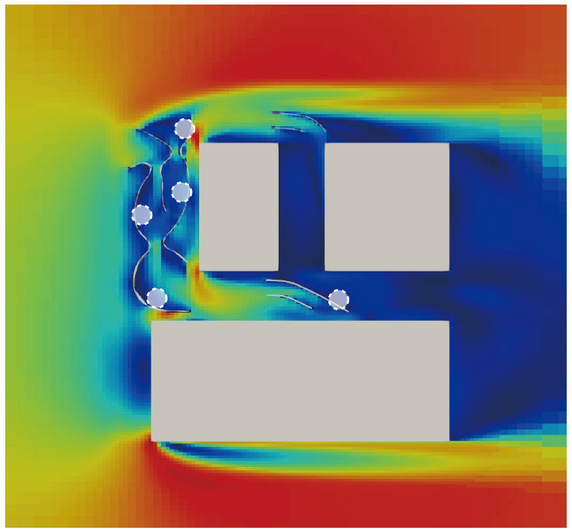


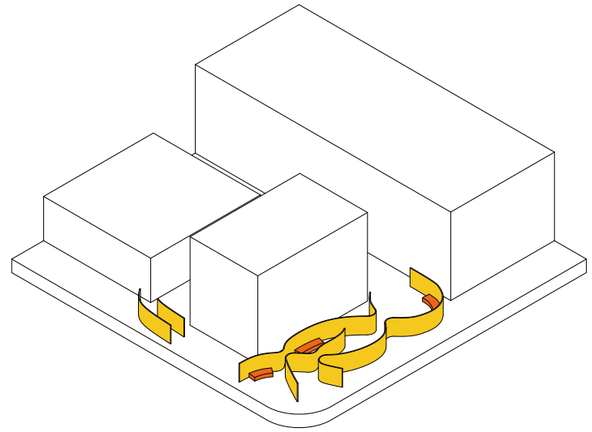
Step1: put the mazes in the site regularly



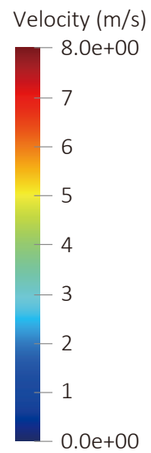


Step2: twist the mazes against wind flow to lower wind speed

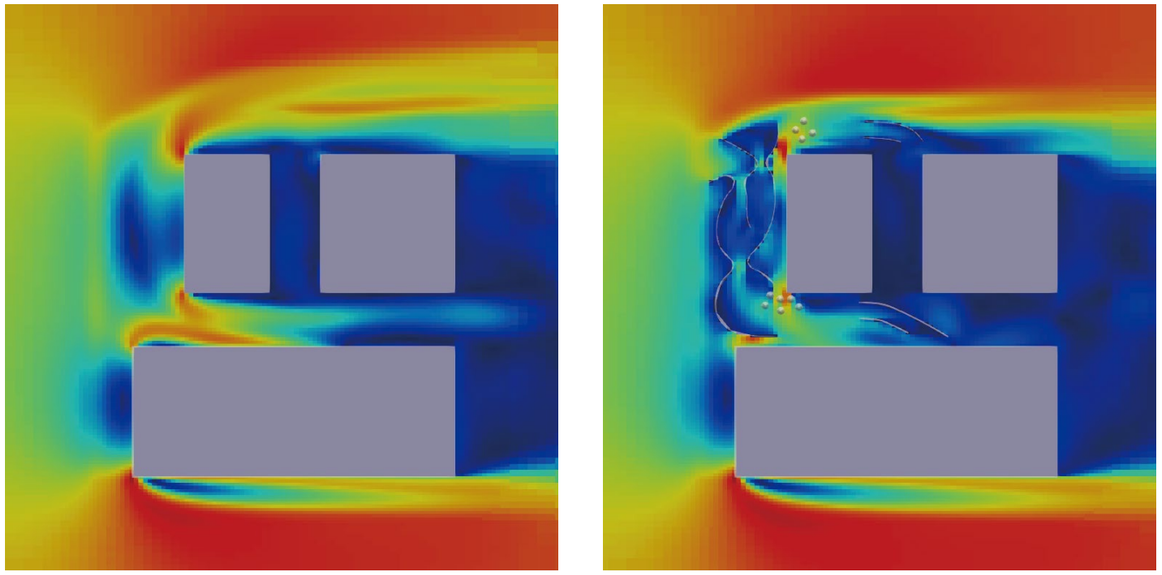




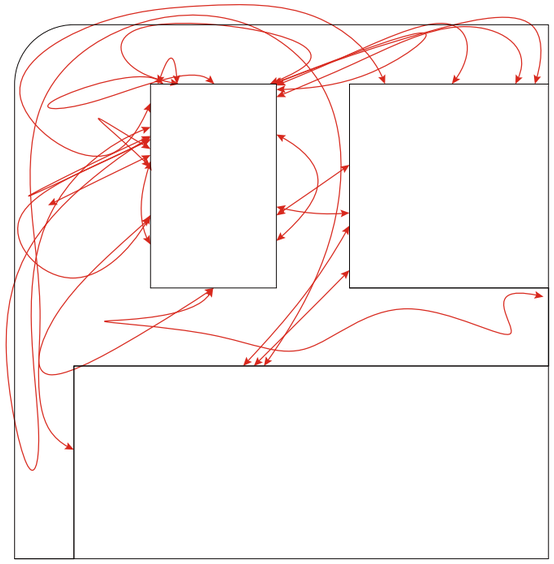
Step3: put benches to low velocity area

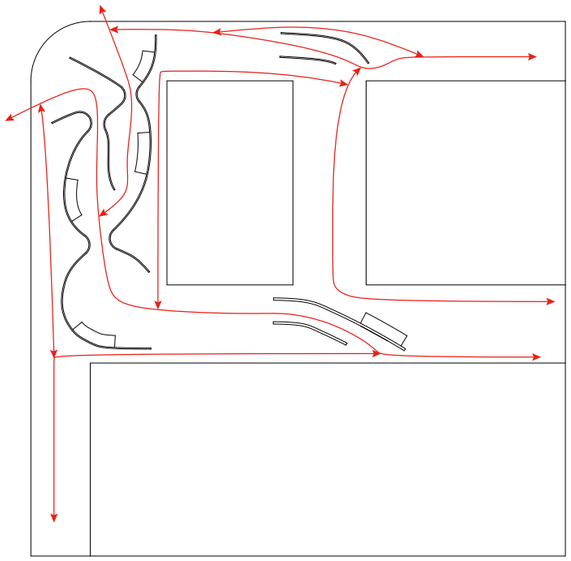


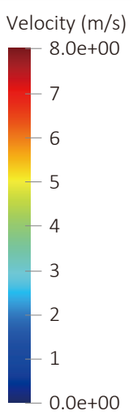
velocity contrast



pedestrian circulation contrast

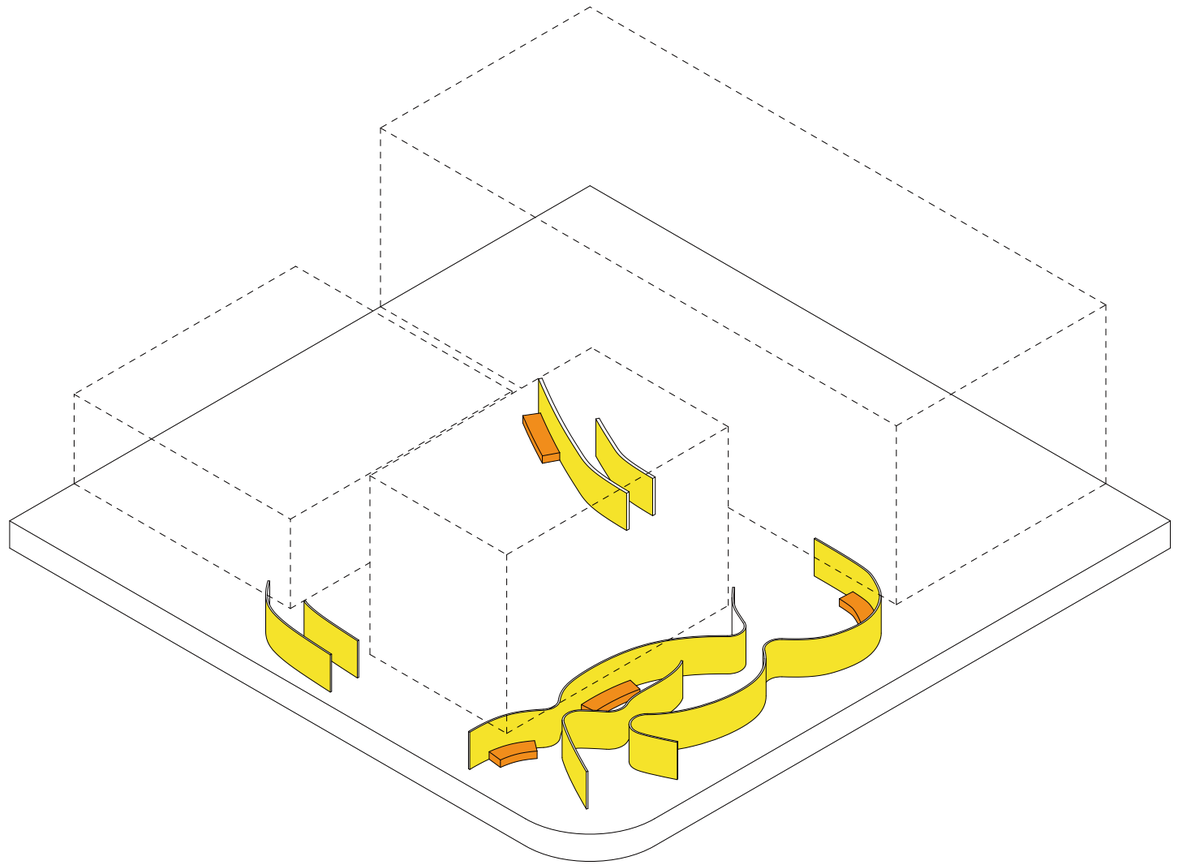






The wind velocity contrast between site without intervention and space formed by maze and bench shows that the high velocity area (over 5.5m/s) is reduced, so the pedestrian wind comfort is improved.

The circulation contrast between site without intervention and space regulated by maze and bench demonstrates that the circulation formed by the intervention is more efficient in separating pedestrians so people can easily keep social distance by naturally following the circulation.



The axonometric drawing shows the result of intervention maze and bench shaped by wind flow. 7 vertical walls separate the mainstream into several movements so social distancing is emphasized and benches offer pedestrians spots to rest where the wind situation is suitable.

Context *analysis*

4.1 History evaluation

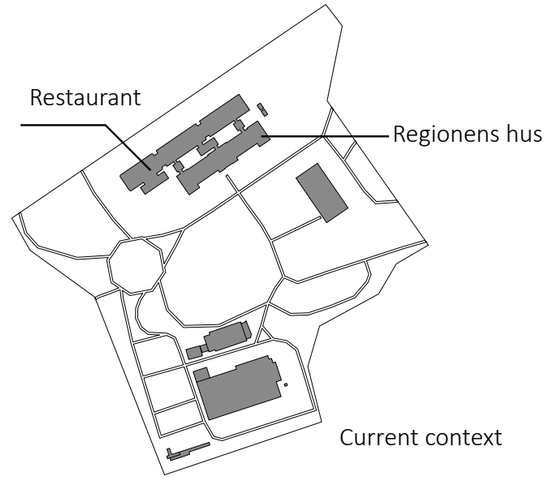
Figure 14 Gullbersvass History. (AUSD Studio 2021). CC-BY.

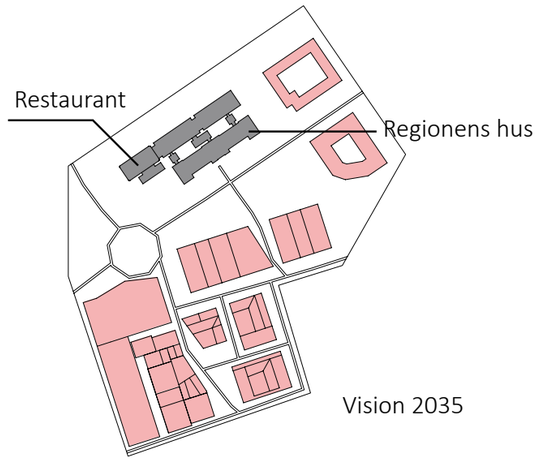
4.2 Current situation

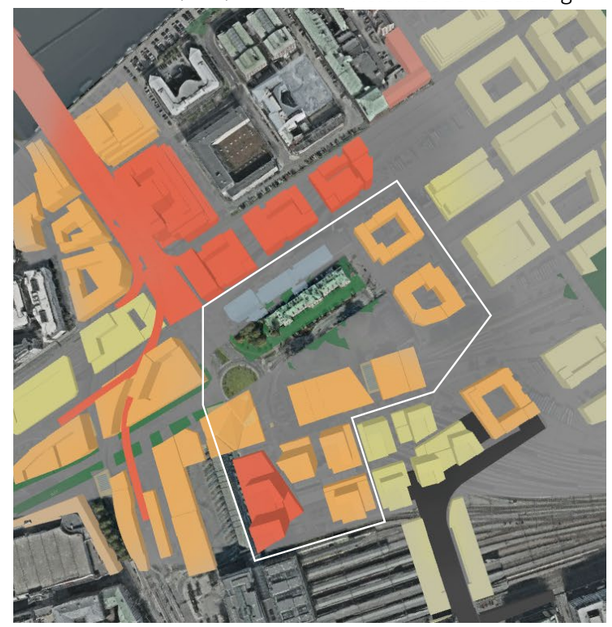
Today, Gullbergsvass can be perceived as an anonymous part of the city, but here it is planned for a completely new district that connects five districts. 20,000 people will live in Gullbergsvass and as many will work here. The area will be expanded mainly after 2025, but already now there are ideas to make it more accessible and perhaps develop the quay route along Drömmarnas quay and Falutorget.

4.3 Vision 2035 Goteborg

Figure 15 Vision 2035. (n.d.). CC-BY.





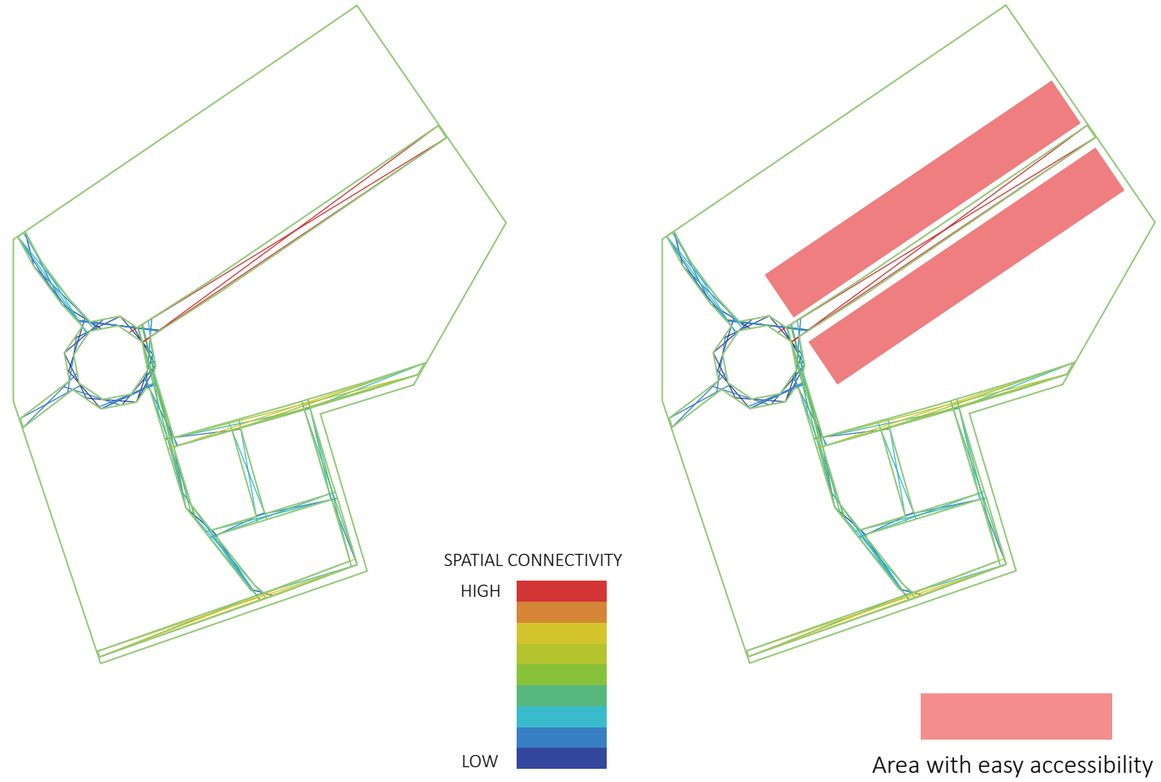


According to Vision 2035, Gullbersvass will be made as an inclusive, attractive and sustainable area in central Goteborg. The old port and industrial areas will be transformed into new residential areas and working areas up to a total building area of 5 million ㎡ and will be designed in a way that connects the whole city, embraces the water and reinforces the regional center.

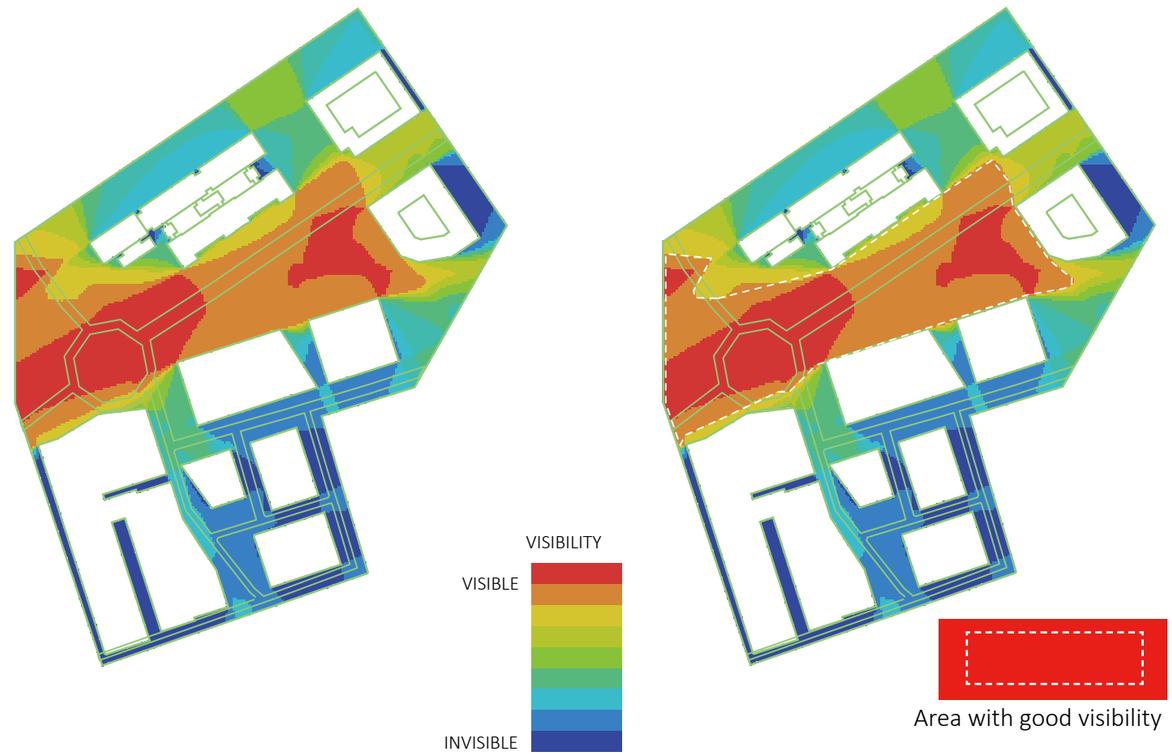
From Vision 2035 we can find that the selected site will be transformed into central area of Goteborg with high building and population density. In this situation, urban public space becomes more expected here because people's need to have activities in outdoor space. I will use intervention from previous chapter to create urban public space which accommodates various events and responds to pandemic situation.

Design strategy

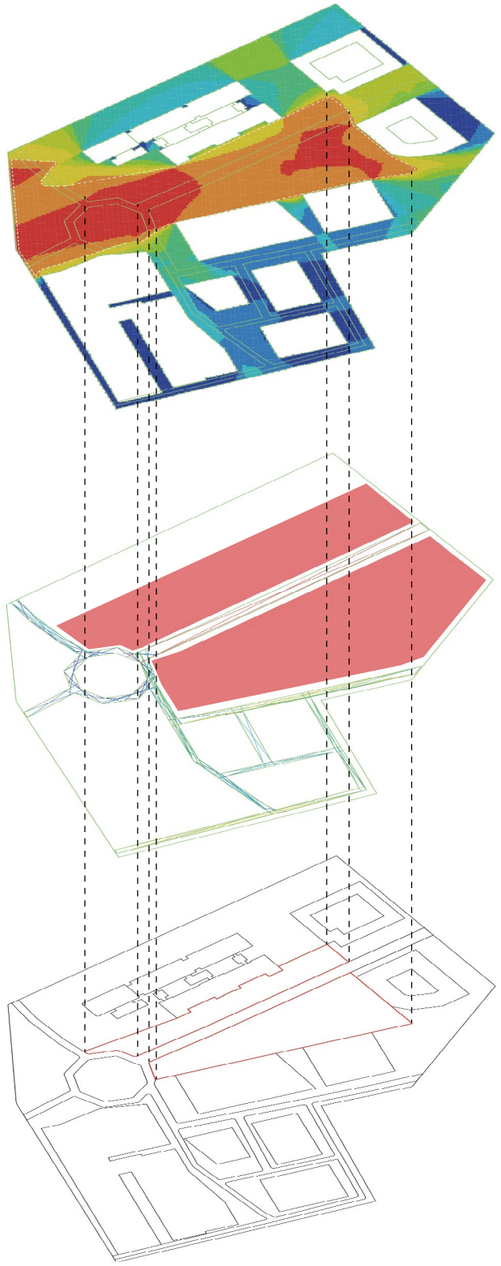
5.1 Accessibility situation

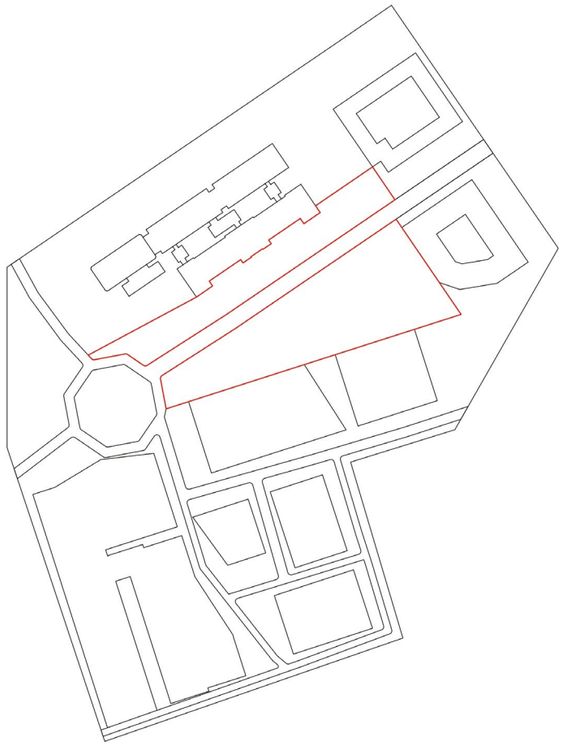


5.2 Visibility situation



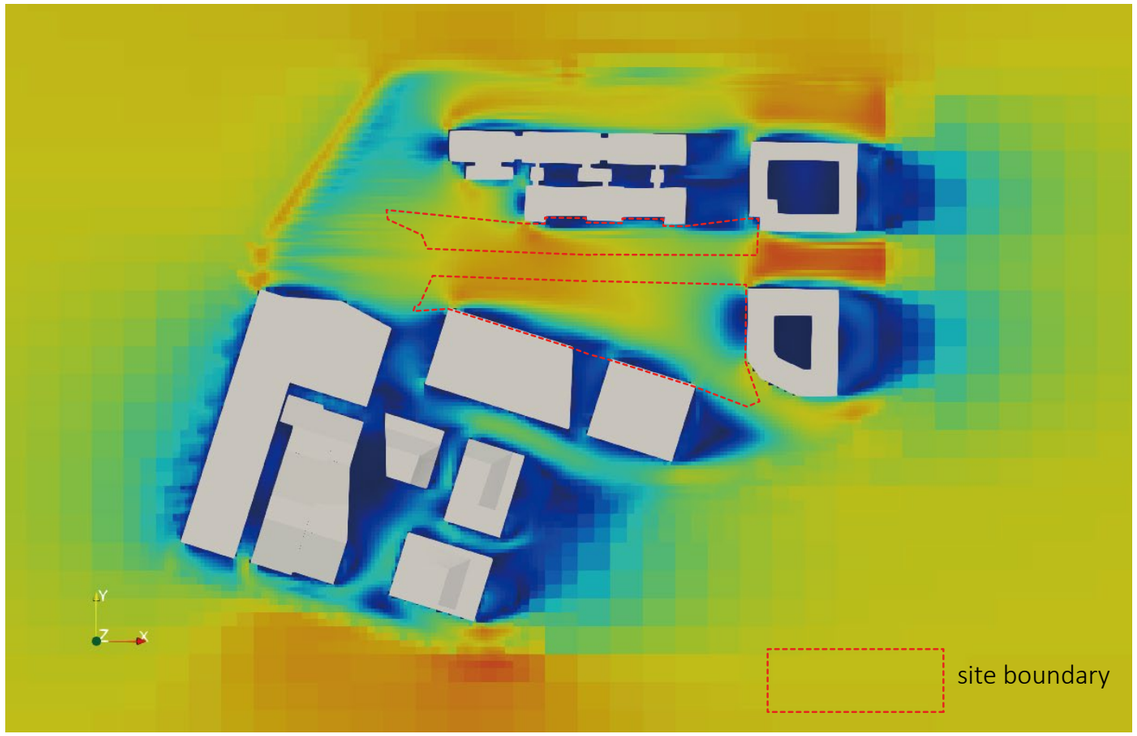
5.3 Mapping

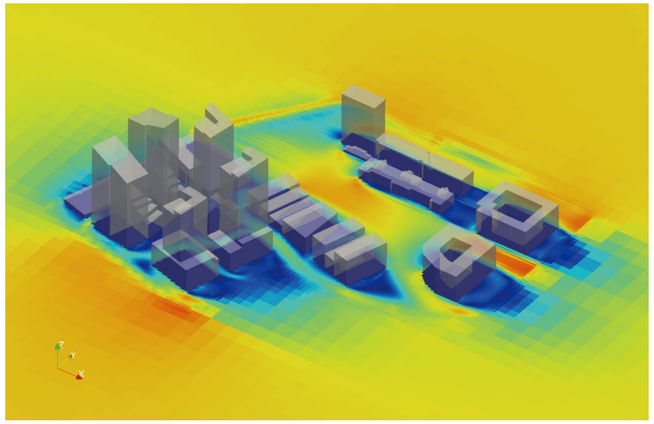


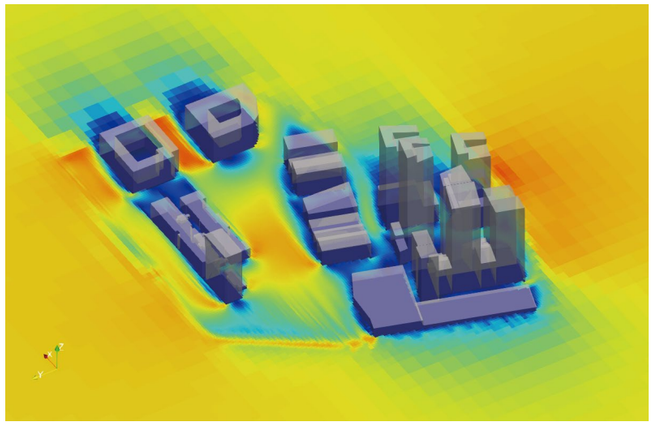


These mapped areas have the best visual situation and easiest accessibility which means people tend to gather here so intervention in these areas will be effective.

5.4 Wind velocity situation





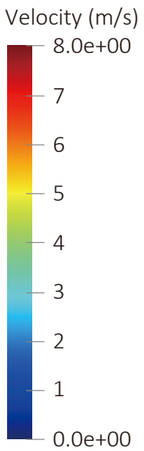


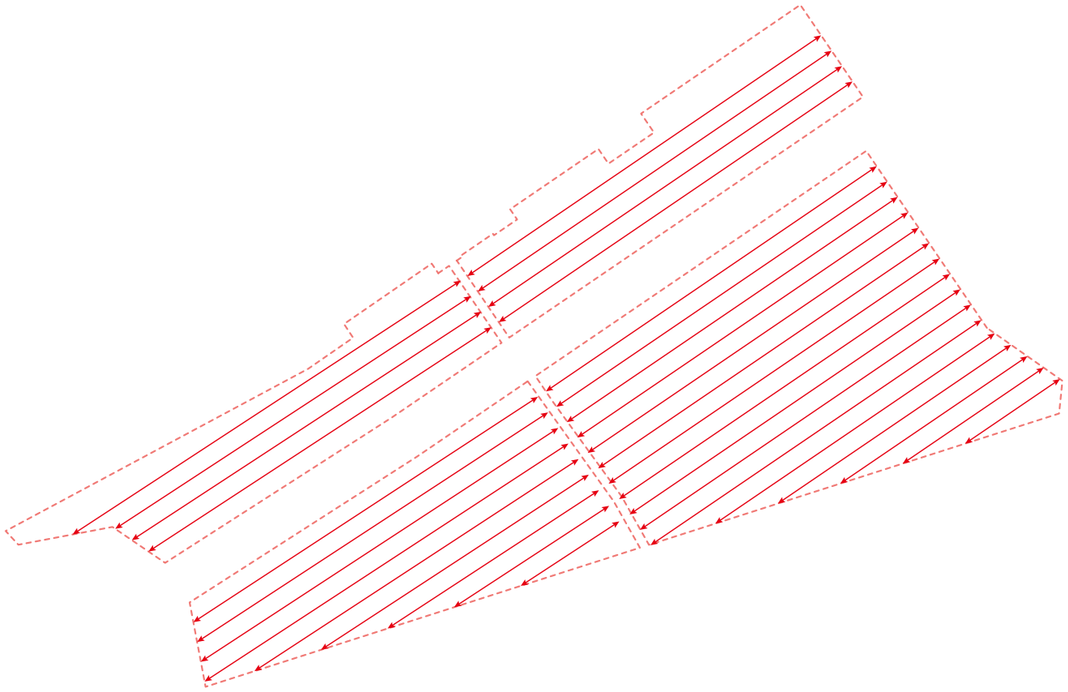
CFD simulation input parameters

Input wind velocity: 5m/s (annual average wind velocity in Gothenburg)

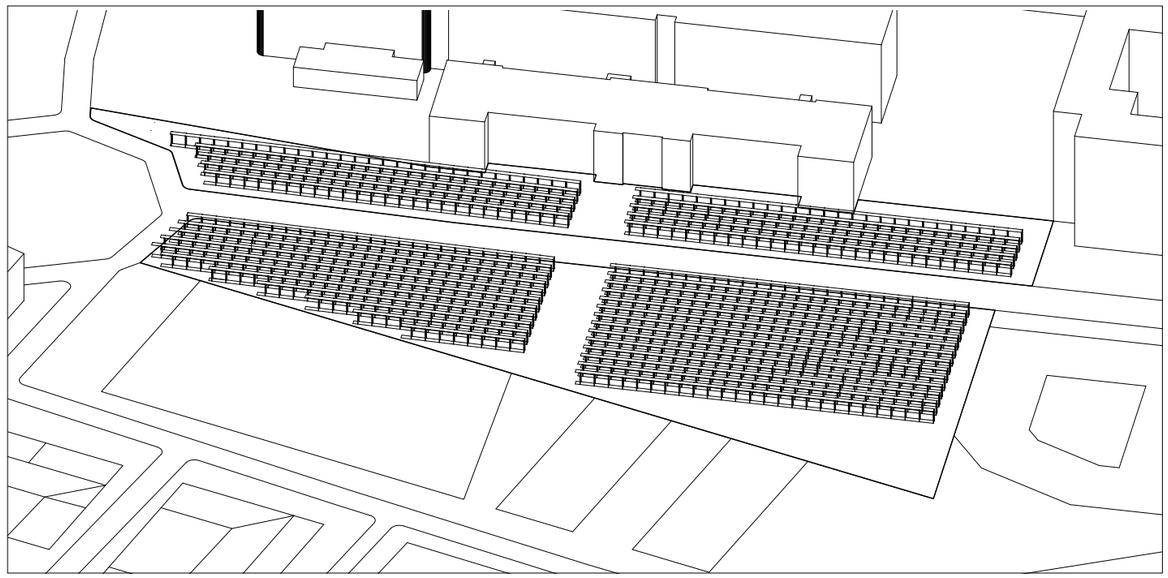
wind tunnel direction: from southwest to northeast (annual average wind direction in Gothenburg)

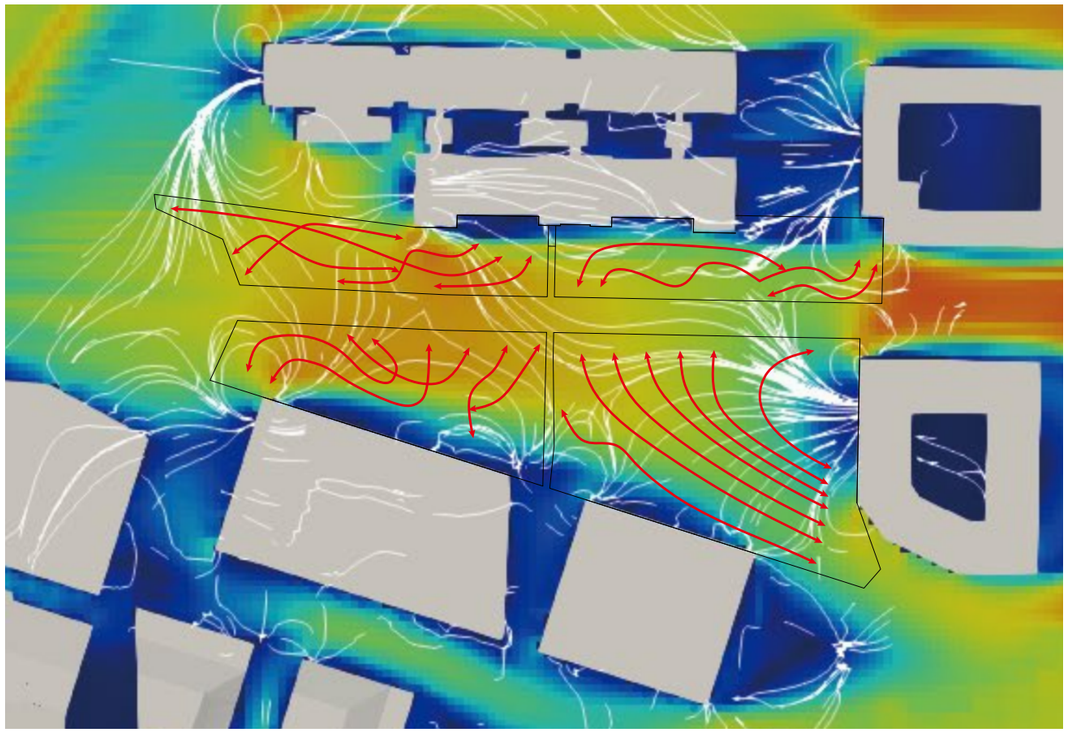
According to the translation rules from wind velocity to pedestrian wind comfort, area with wind velocity over 5.5m/s will make pedestrian feel uncomfortable and is not suitable for any activities. Therefor here the area with color from orange to red should be decreased and I will use this as a qualitative evaluation standard to assess the effectiveness of the intervention in improving wind comfort.



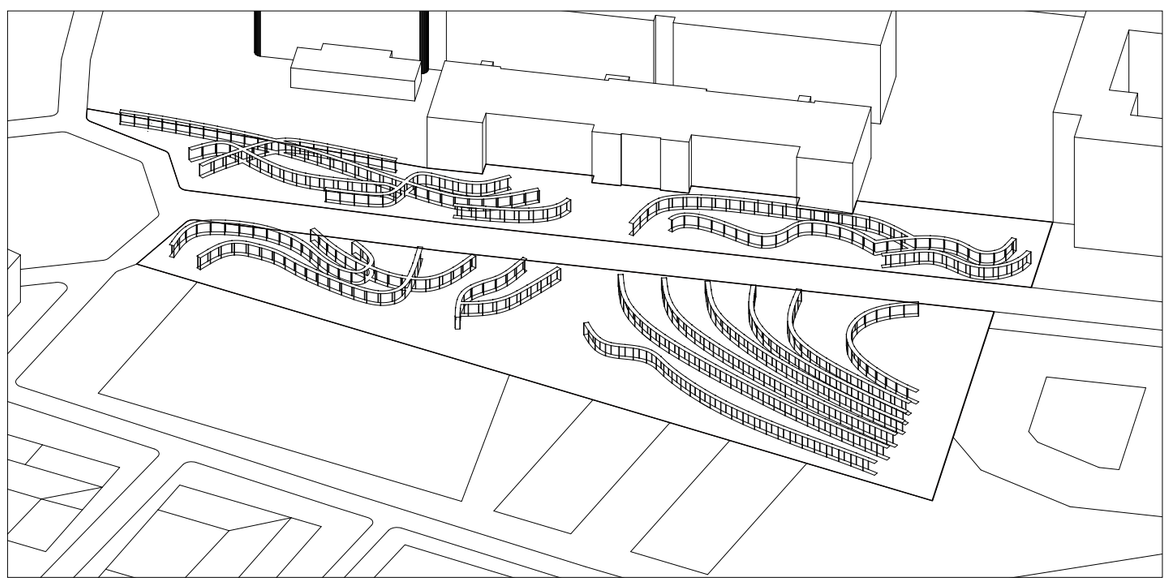


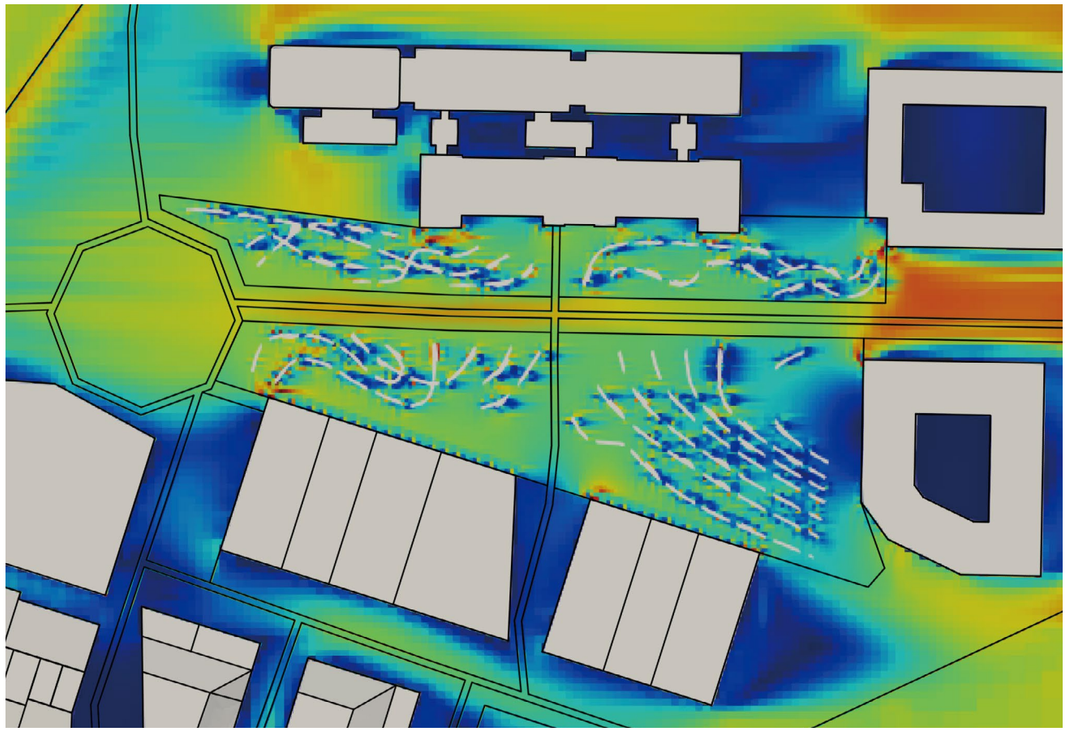
Step1: Put the colored path regularly in the site



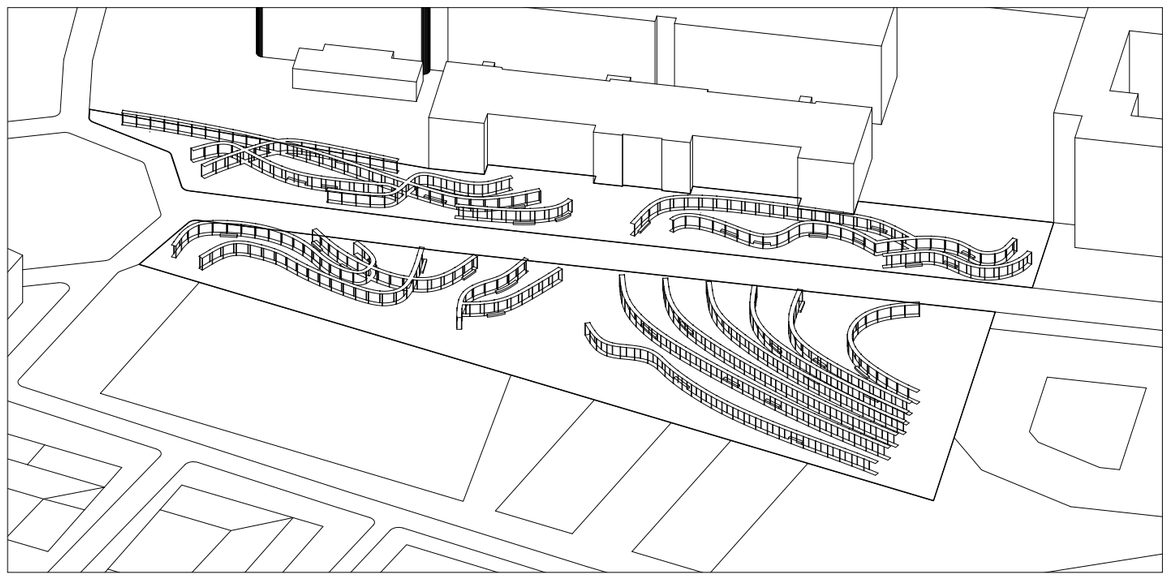


Step2: Twist the colored path against wind flow to lower wind velocity

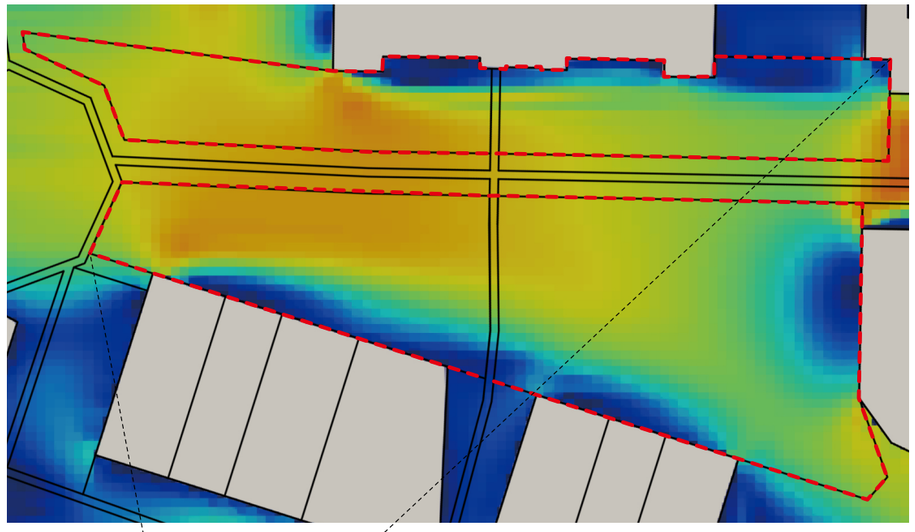




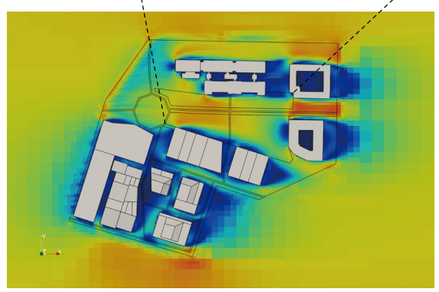
Step3: Add benches in low velocity area



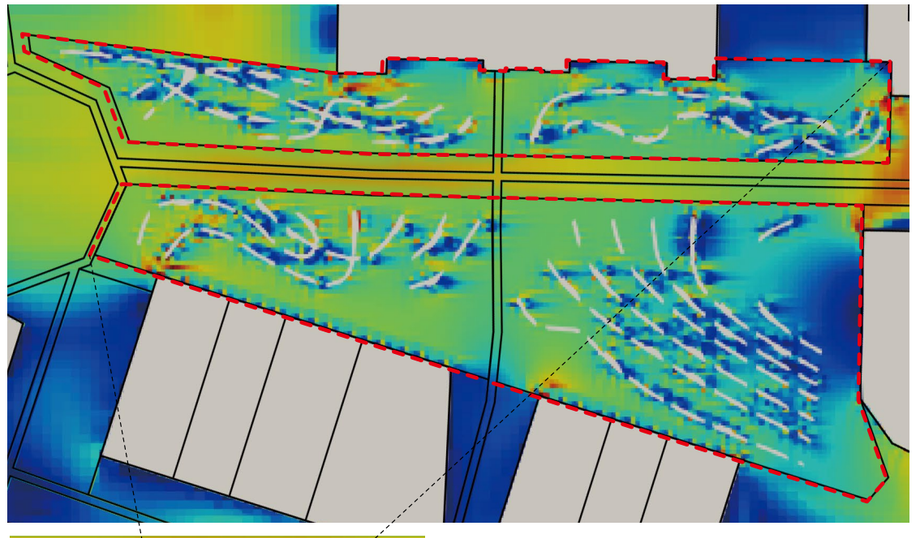
Wind velocity contrast



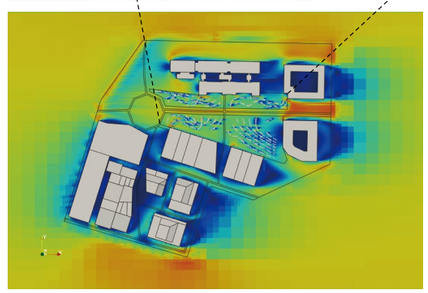
Velocity situation without intervention

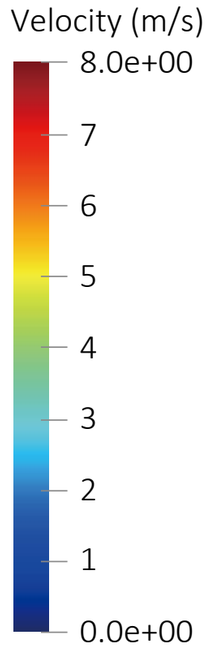


Site boundary



Velocity situation with colored path and bench





Circulation contrast

circulation without intervention

circulation formed by colored path and bench

Summary

Velocity contrast

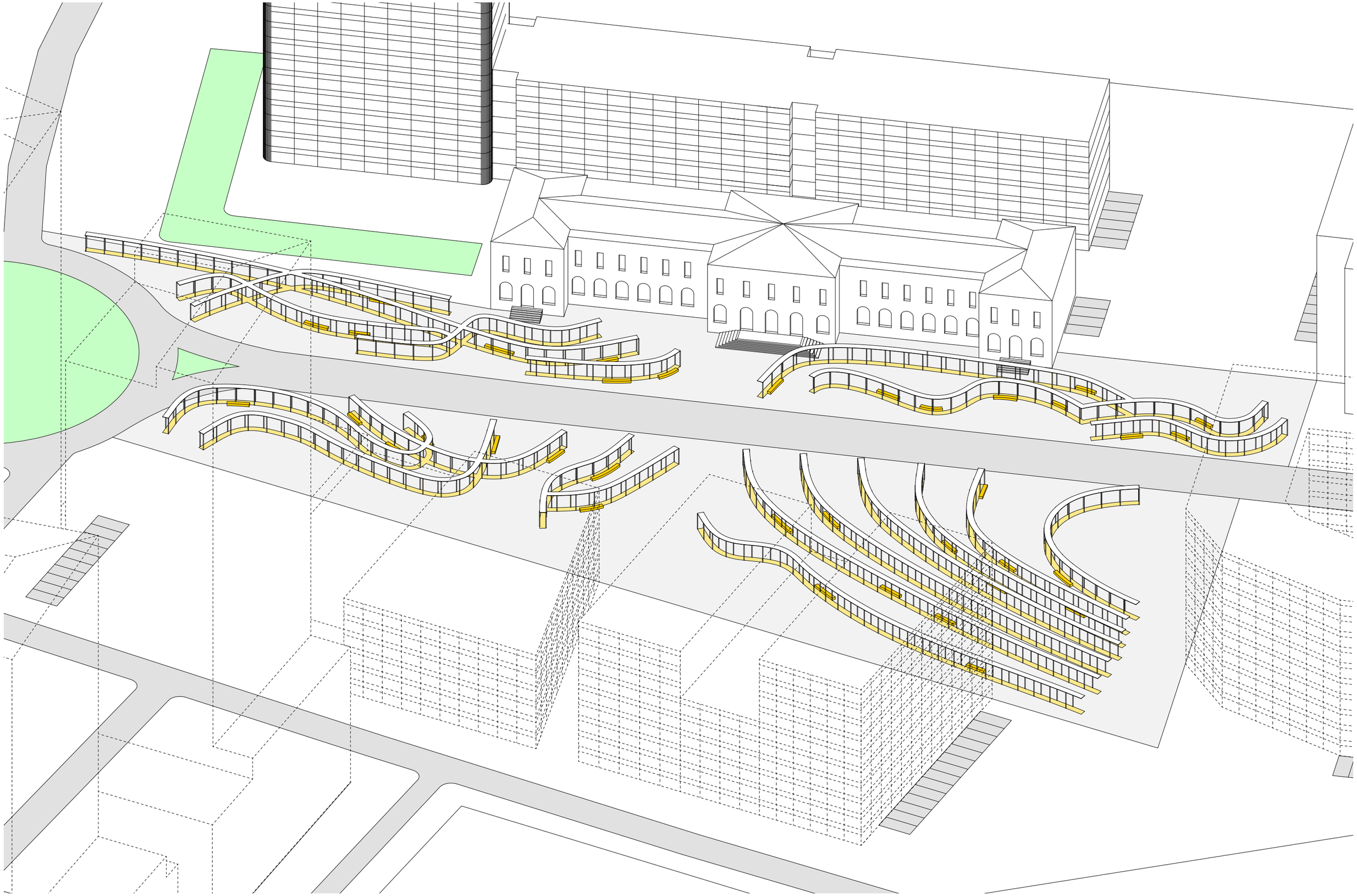
From the velocity contrast, we can see that compared with wind situation without any intervention, colored path and bench reduce the high velocity area (over 5.5m/s), according to the qualitative evaluation standard, the pedestrian wind comfort gets improved.

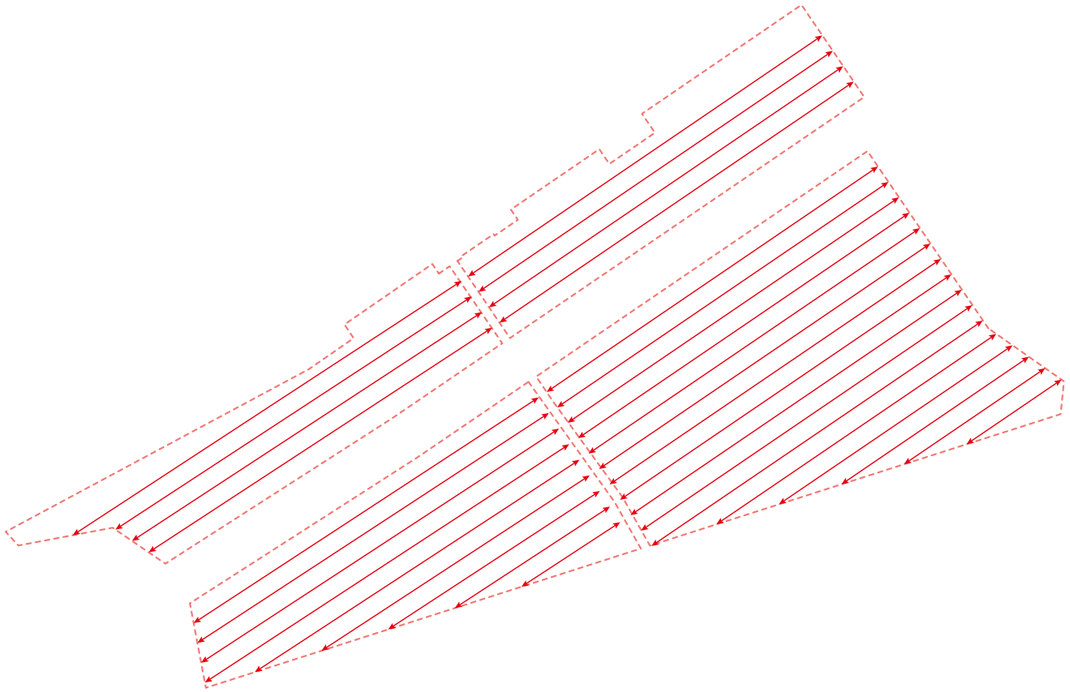
Circulation contrast

From the circulation contrast, we find that compared with the circulation without intervention, which is disordered, the circulation regulated by colored path and bench is more efficient, which helps people to keep social distance.

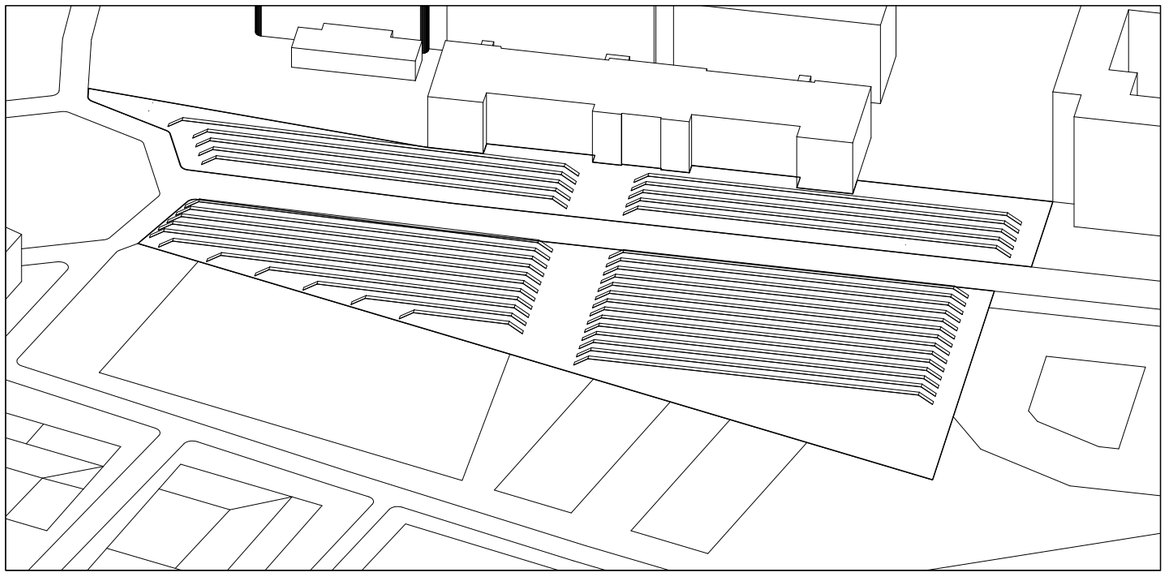
Result

The axonometric drawing in the next page shows the result of intervention colored path and bench. The intervention forms a space which involves 20 colored corridors and 36 benches. The colored corridors re-organize the circulation of pedestrians so they can easily keep social distance and the benches provide them spots to stay where the wind environment is suitable. All these intervention and pedestrian contribute to an urban scale wind comfort environment.

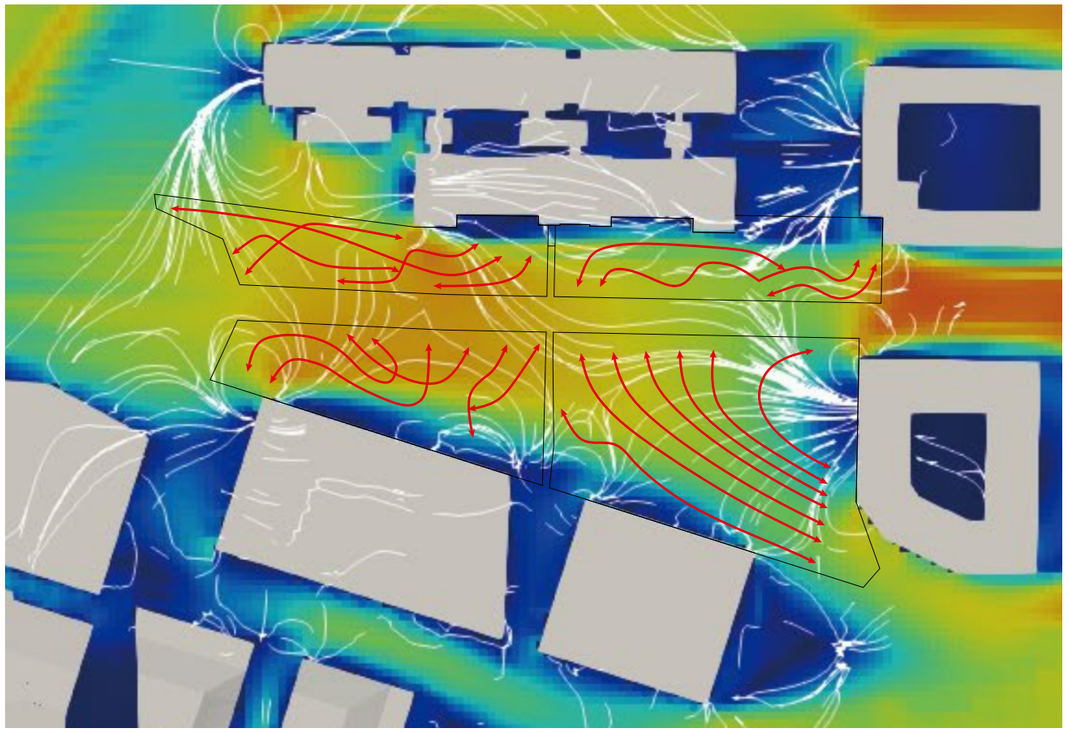




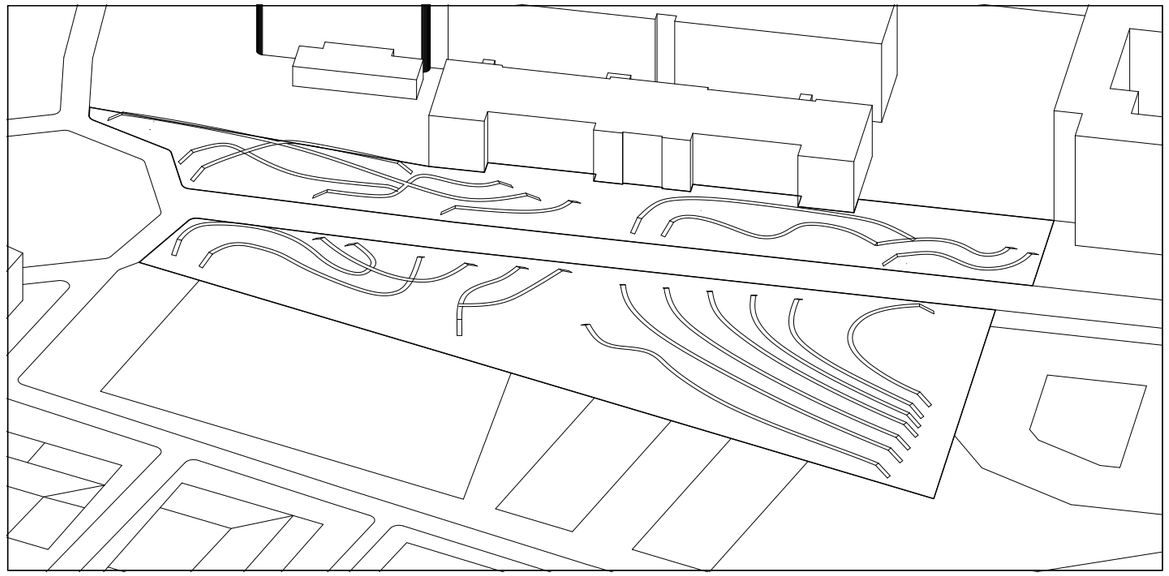
Step1: put the staircase regularly in the site



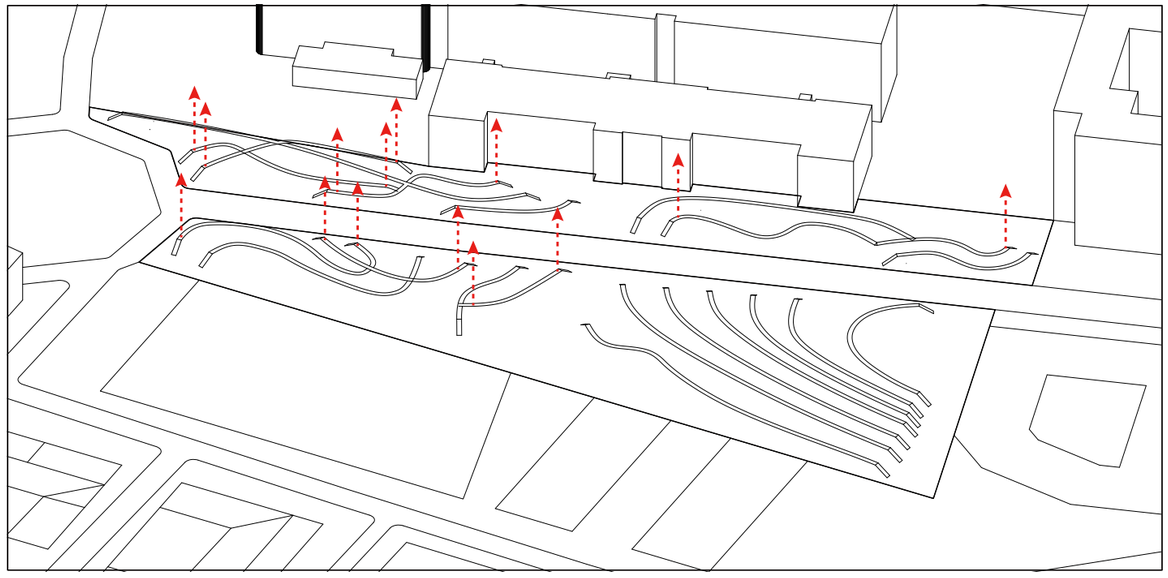
5.6 Intervention staircase and commercial spot



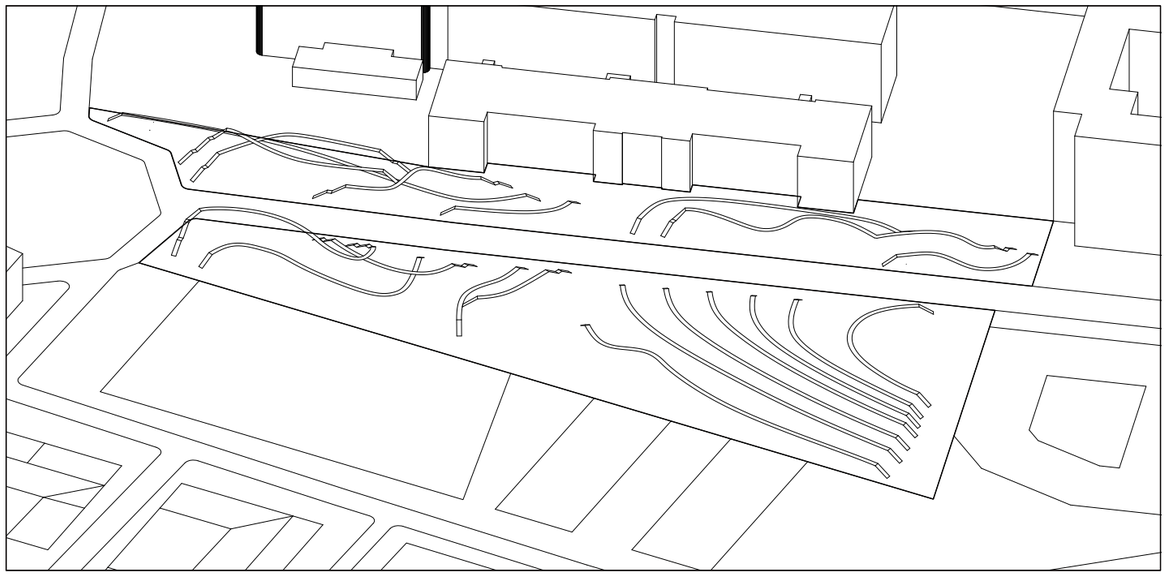
Step2: Twist the staircase against the wind flow to lower the wind velocity



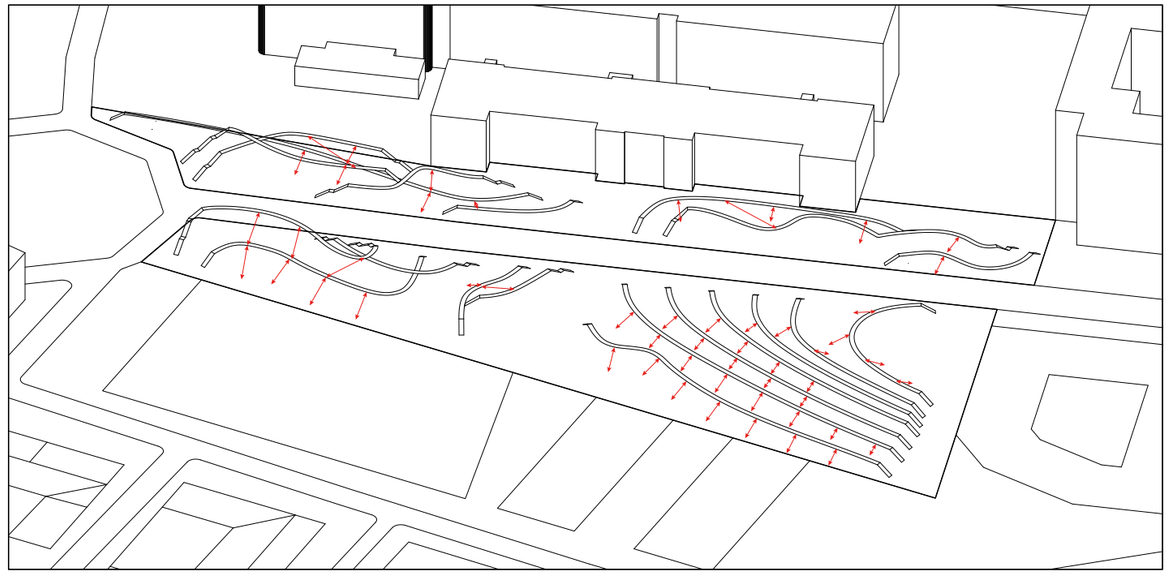
5.6 Intervention staircase and commercial spot



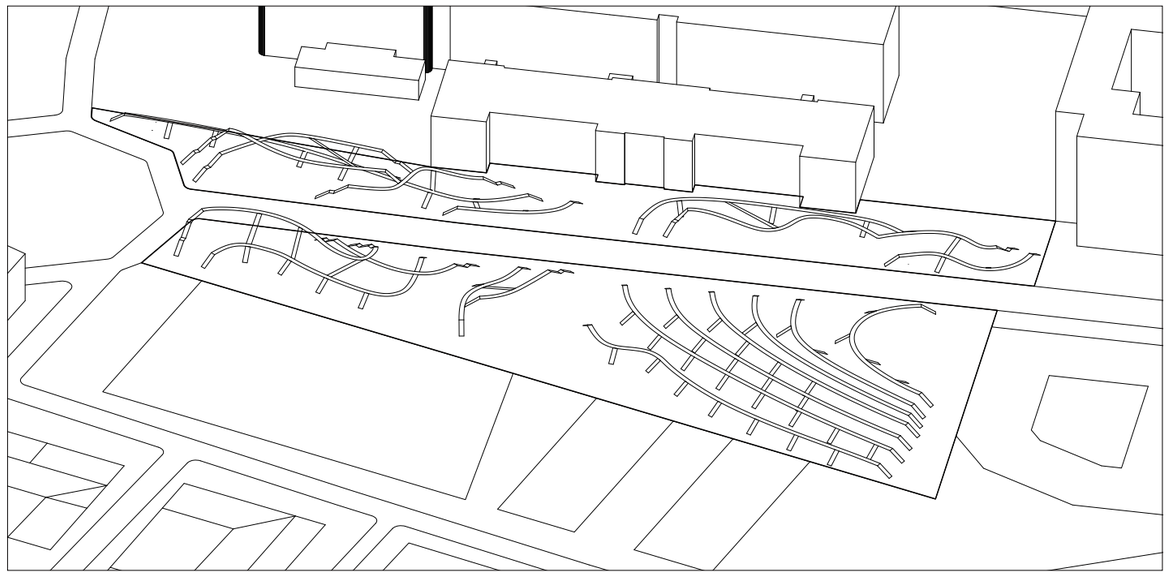
Step3: Lift the staircase in different height

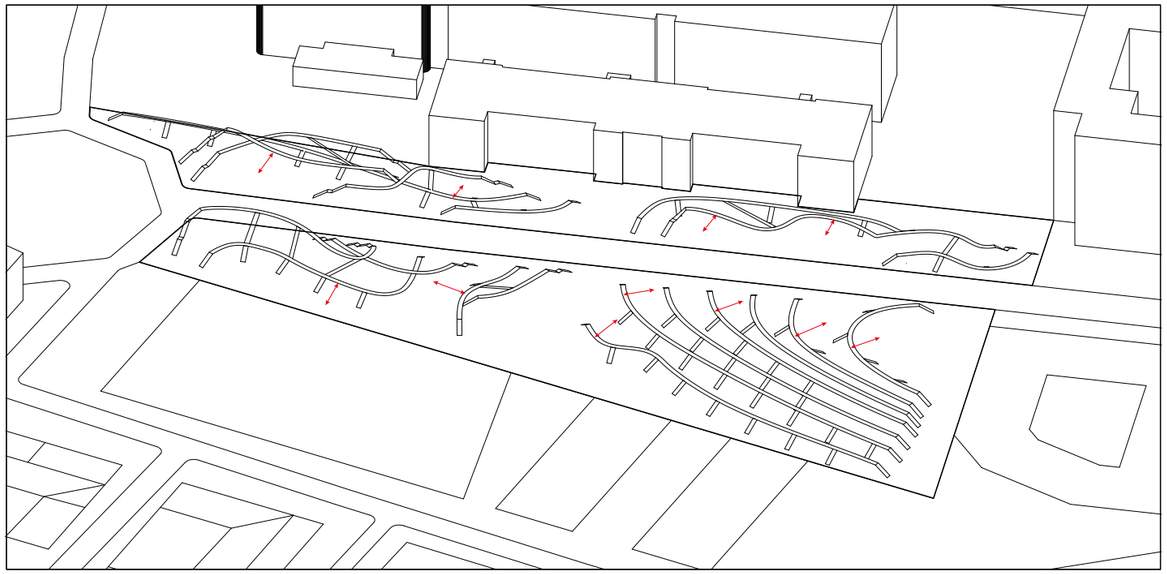


5.6 Intervention staircase and commercial spot

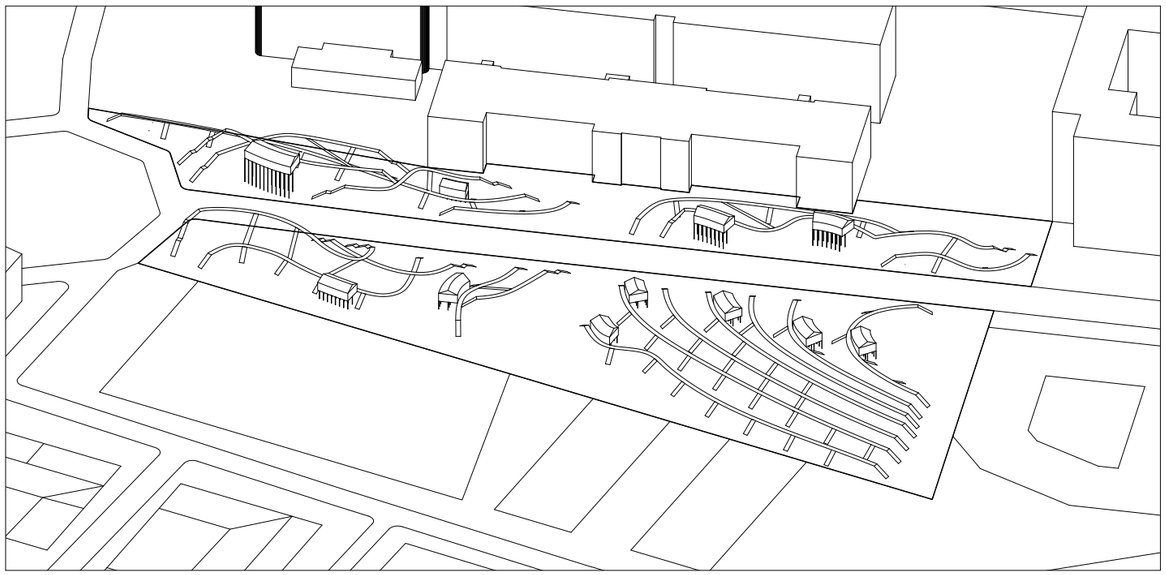


Step4: Add connection between the staircases

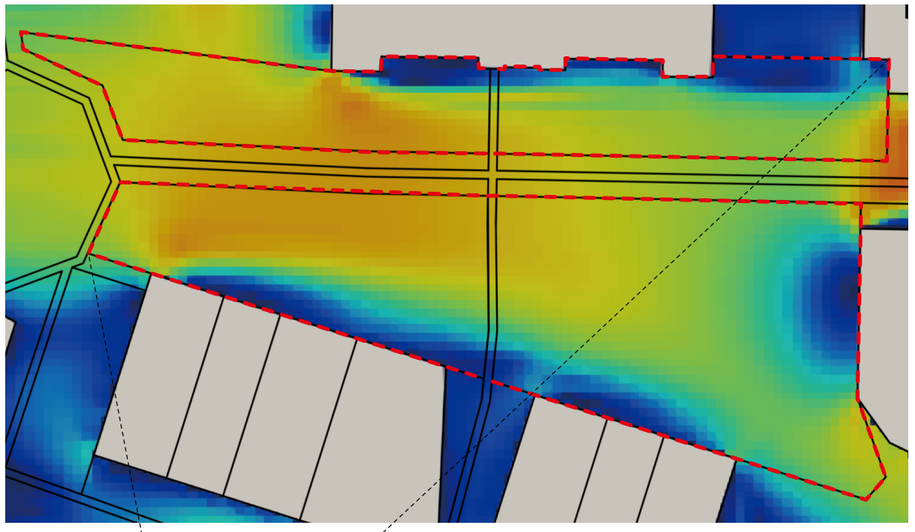




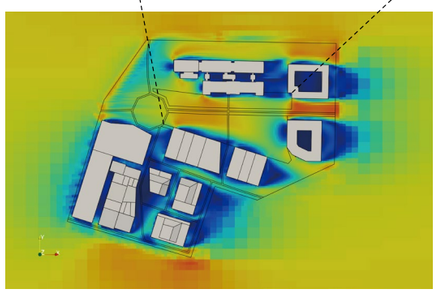
Step5: Add commercial spots to accommodate events



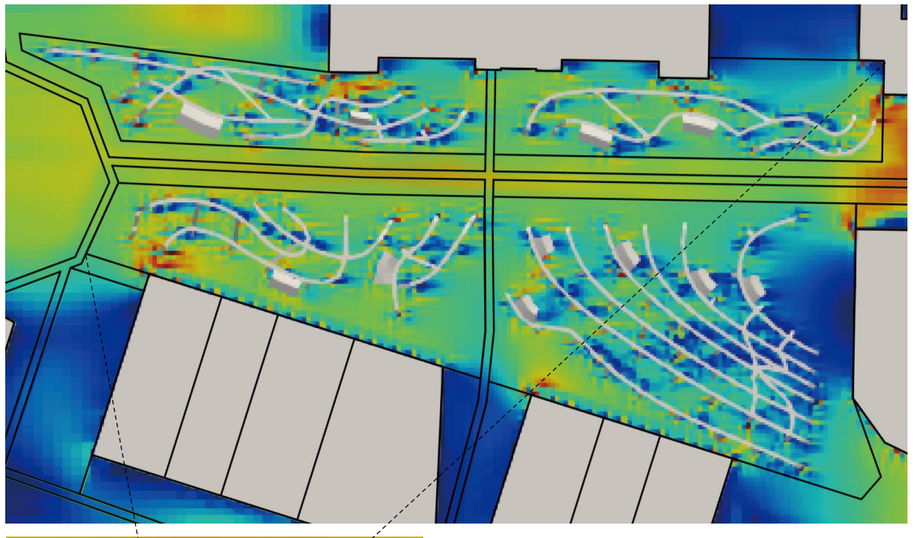
Wind velocity contrast



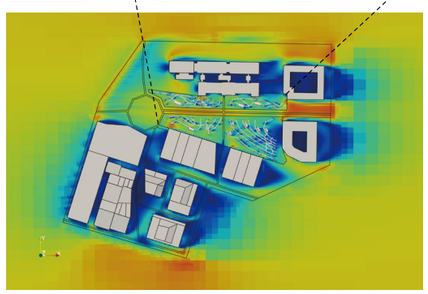
Velocity situation without intervention

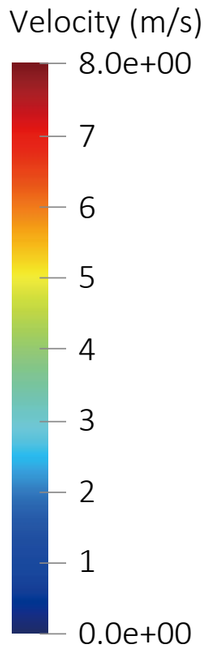


Site boundary



Velocity situation with staircase and commercial spot





Circulation contrast

circulation without intervention

circulation formed by staircase and commercial spot

Summary

Velocity contrast

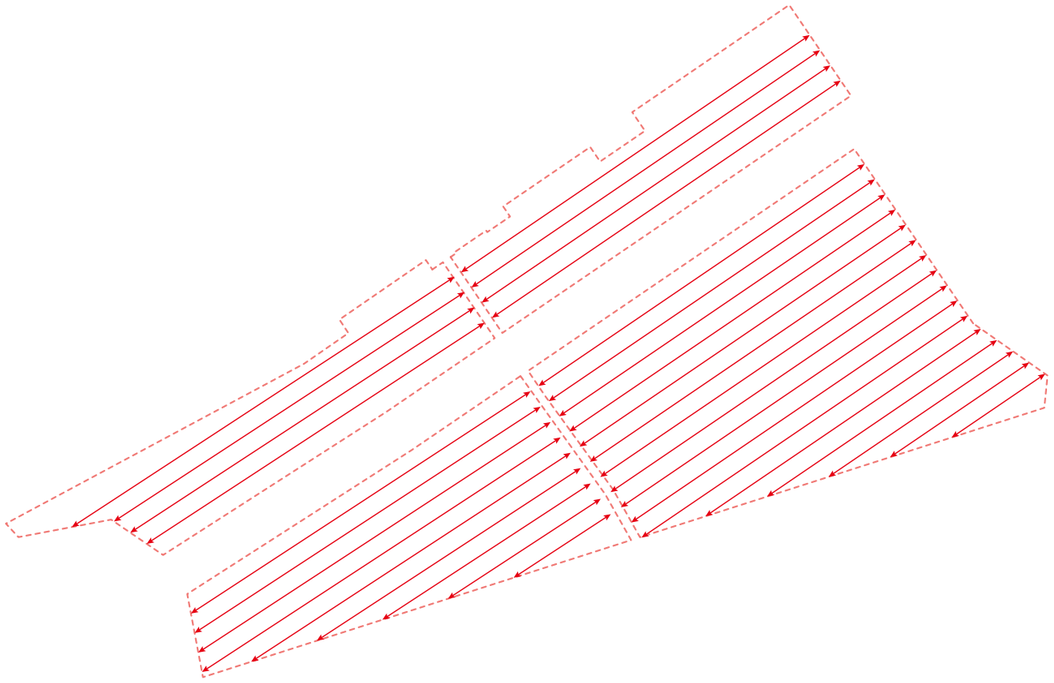
The velocity contrast shows that the intervention staircase and commercial spot decrease the area with velocity over 5.5m/s, this proves the effectiveness of the intervention in optimizing wind environment.

Circulation contrast

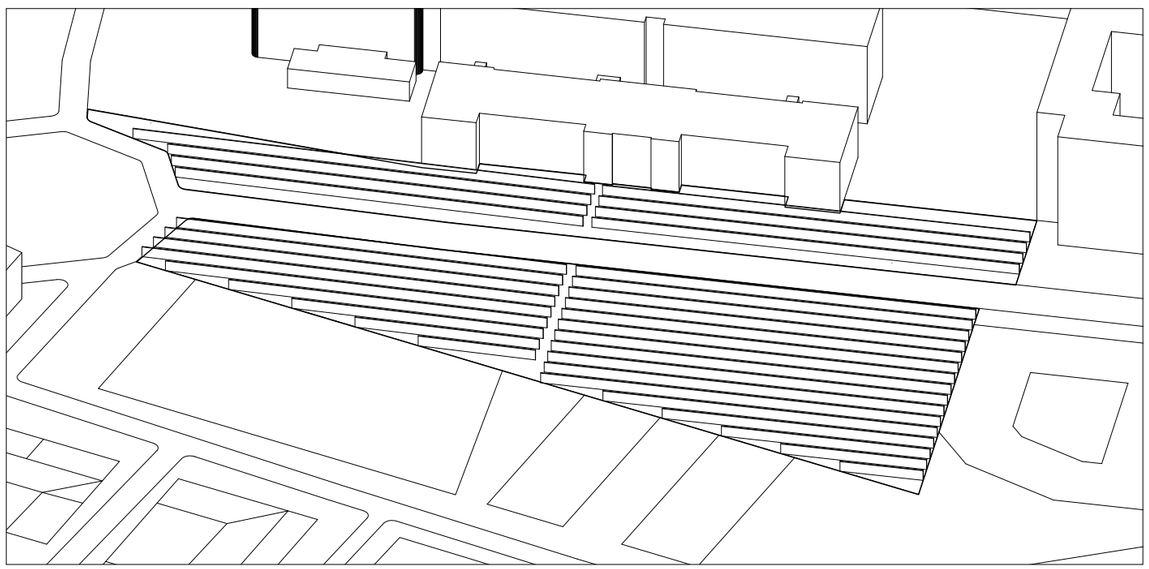
The circulation contrast demonstrates that the circulation formed by staircases and commercial spots is more effective in separating movements and avoiding unnecessary intersection.

Result

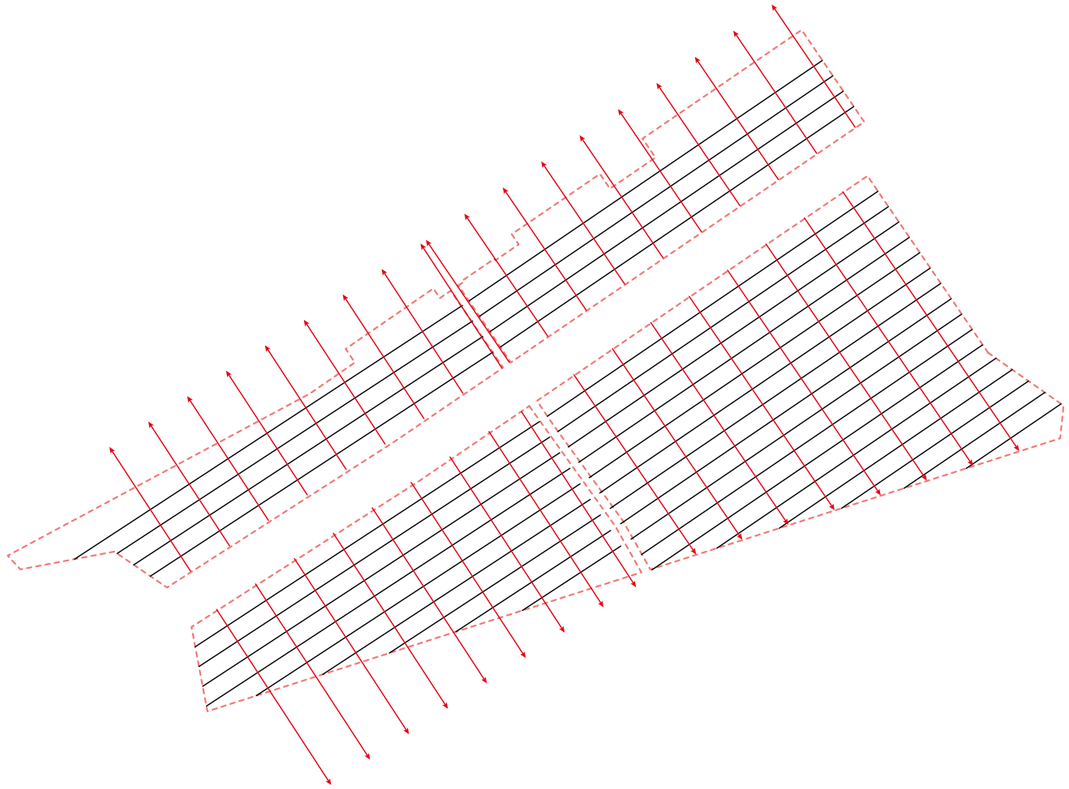
The axonometric drawing in the next page shows how the staircases and commercial spots are organized by wind situation. The space consists of 20 staircases and 11 commercial spots. The staircases are arranged at different height with commercial spots following the shape, offering pedestrians the option to pass through the area at various height or to stay at these commercial pavilions to shop or have a drink.



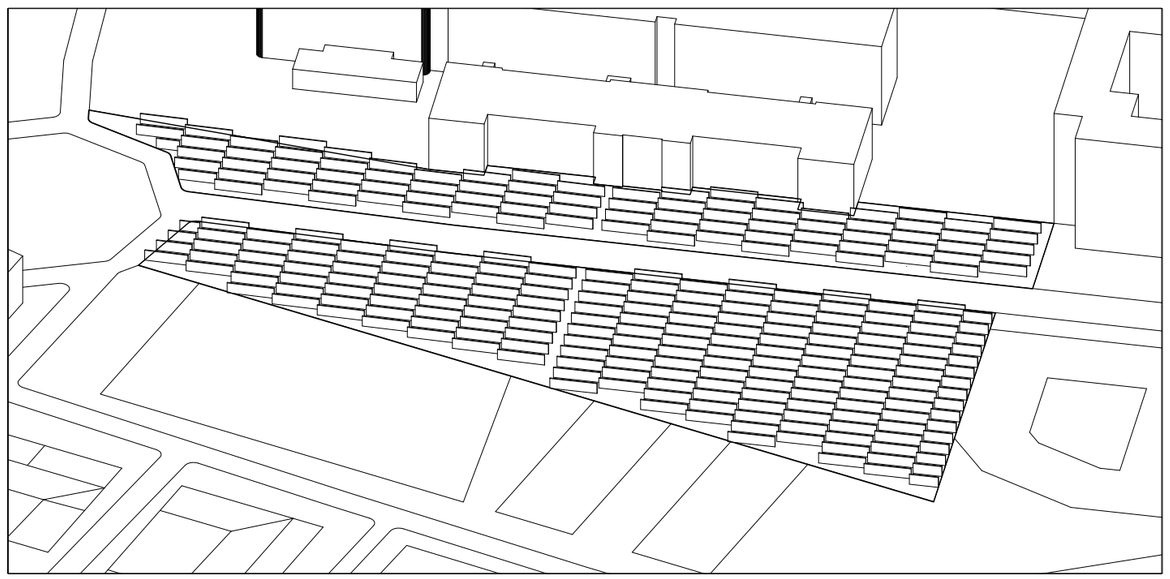
Step1: put the maze regularly in the site

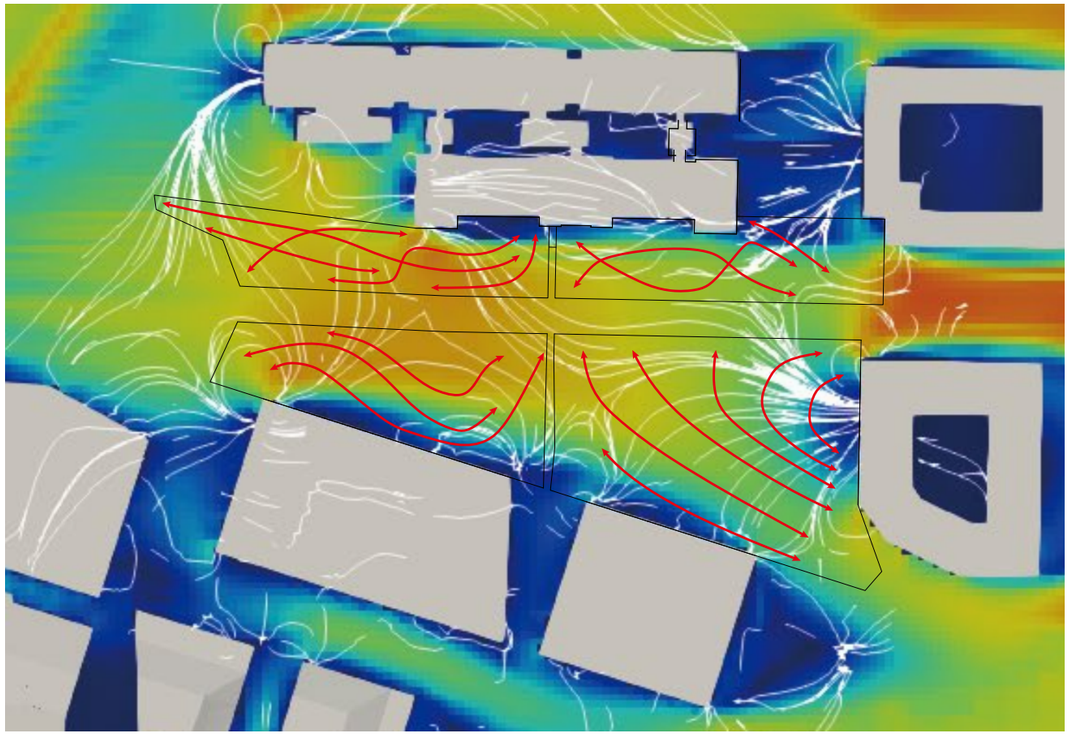


5.7 Intervention maze and benches

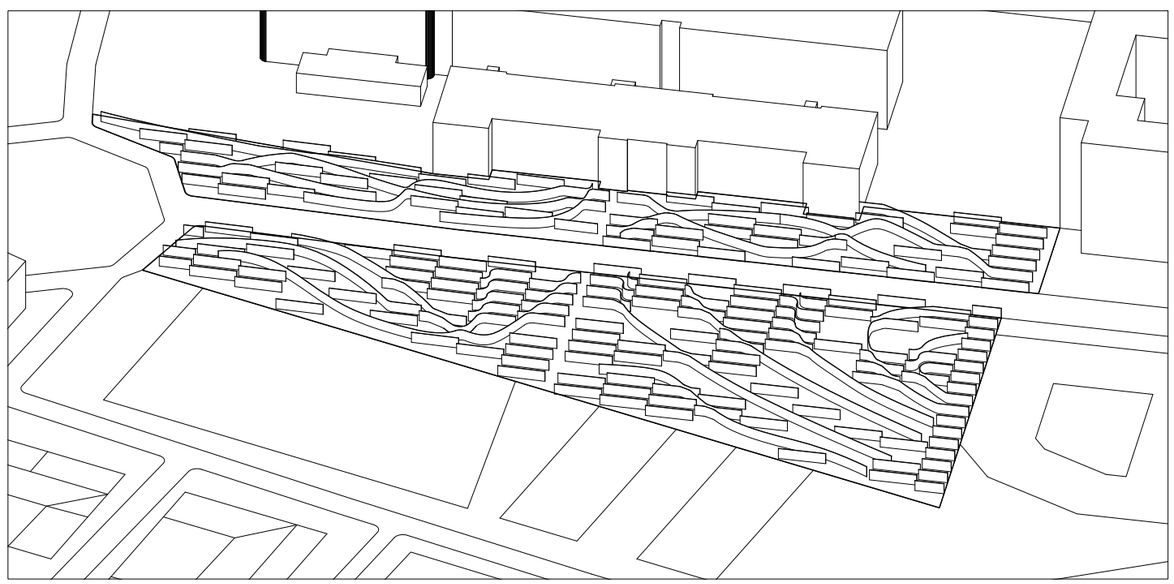


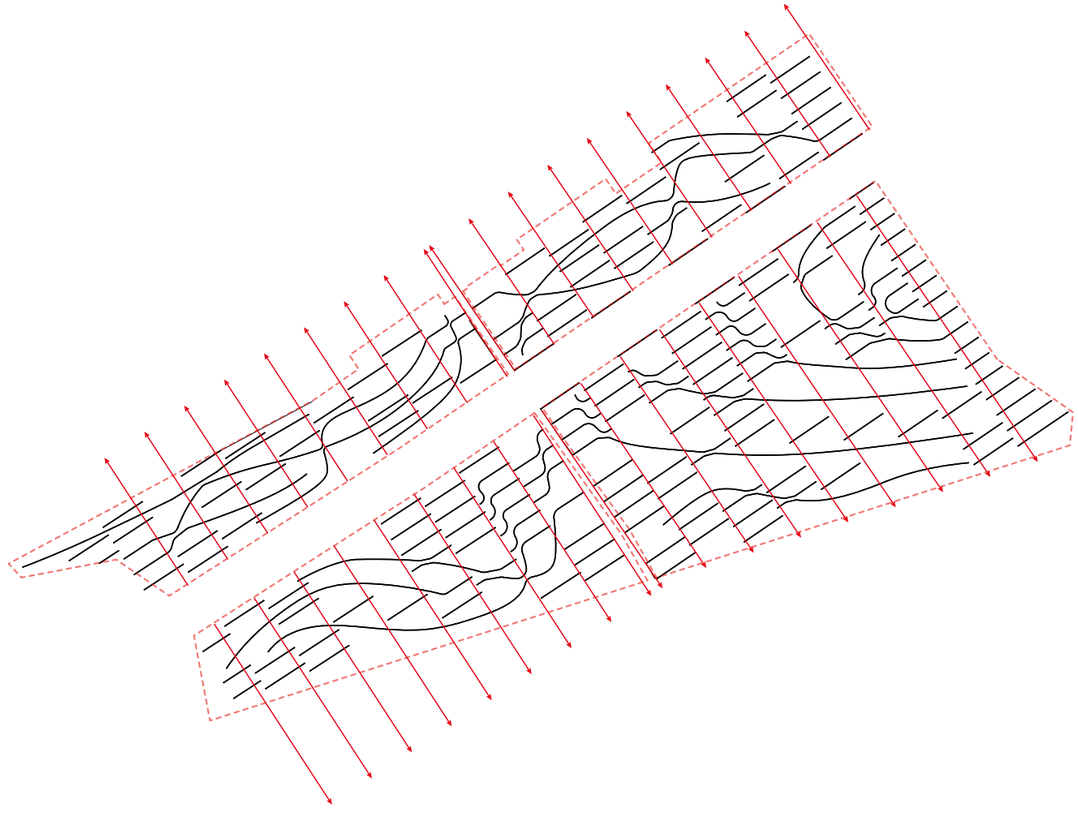
Step2: Divide the maze by 10m grid and offset 2m



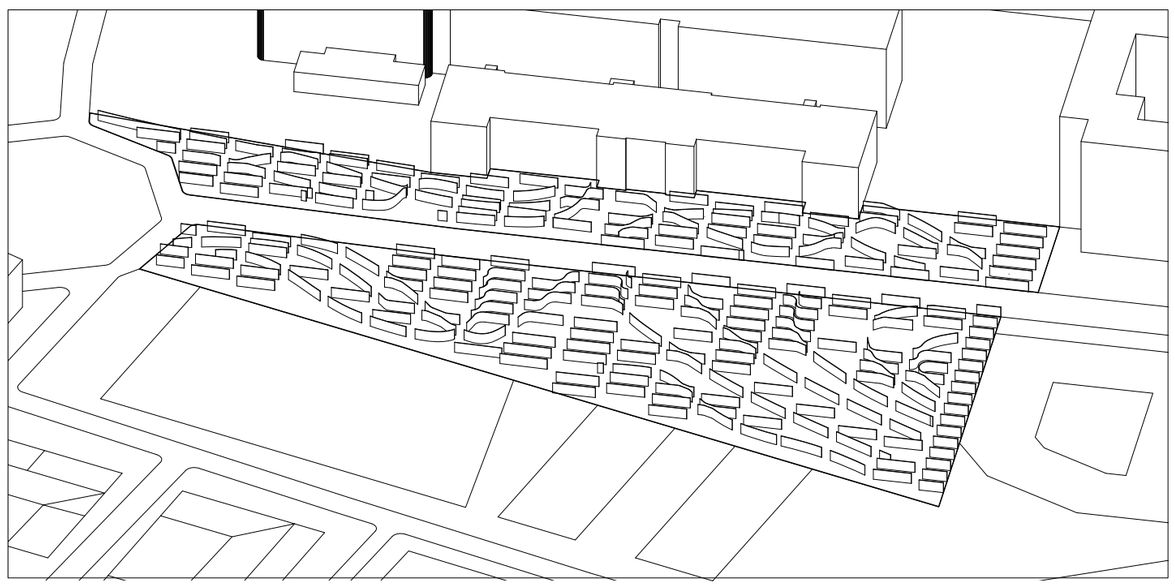


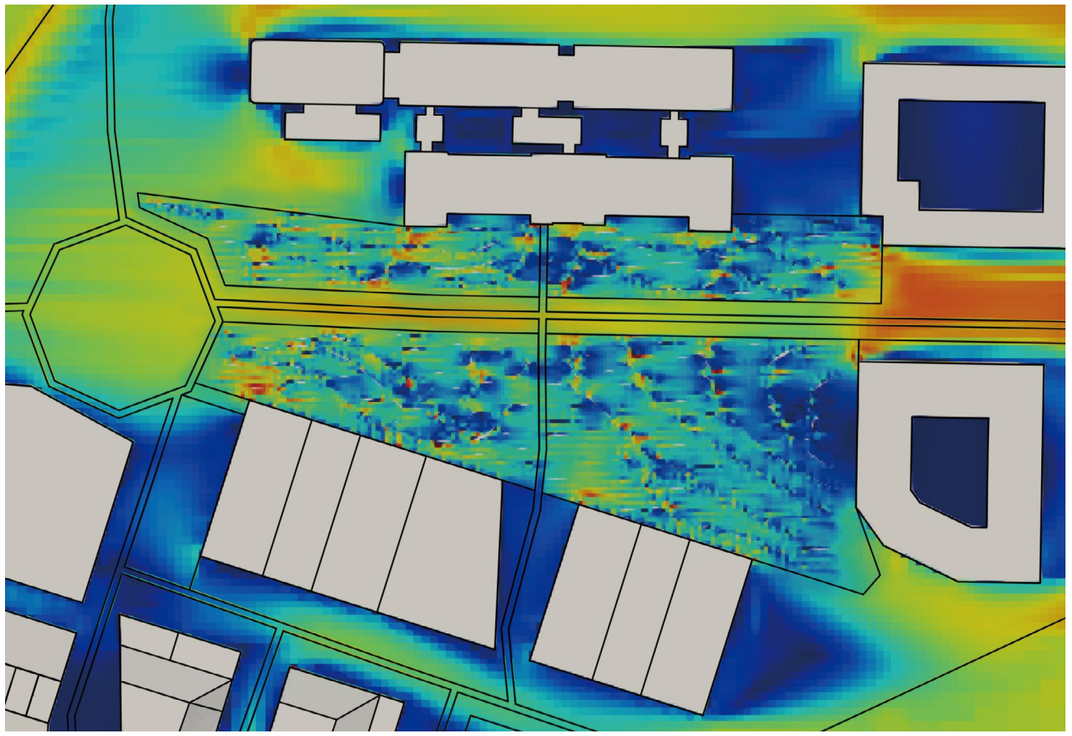
Step3: Twist the maze against the wind flow to lower the wind velocity



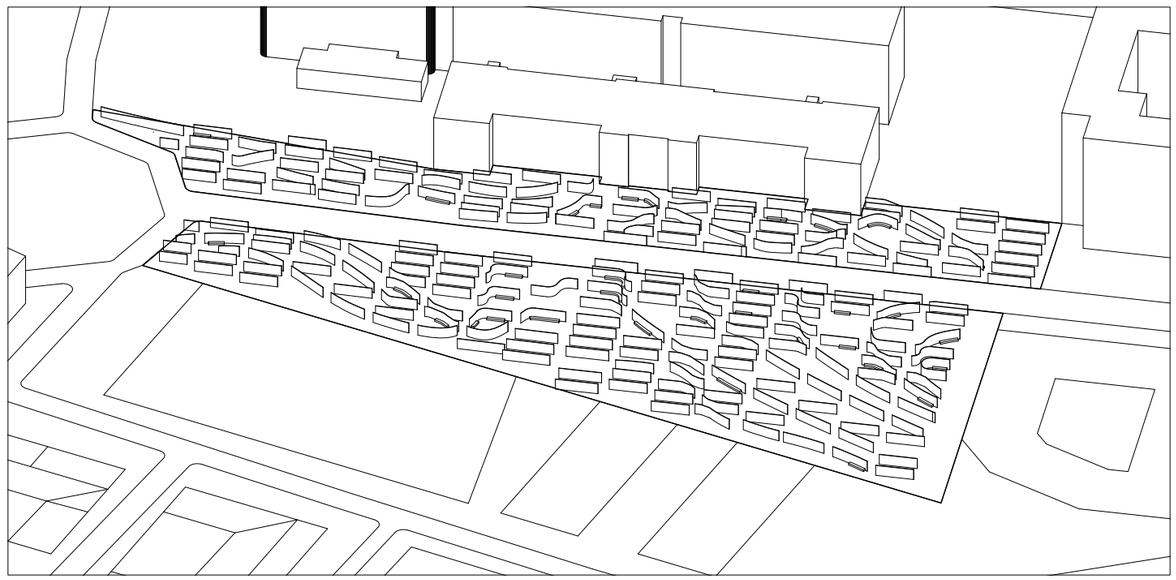


Step4: Set quick access from street to building for emergency situation

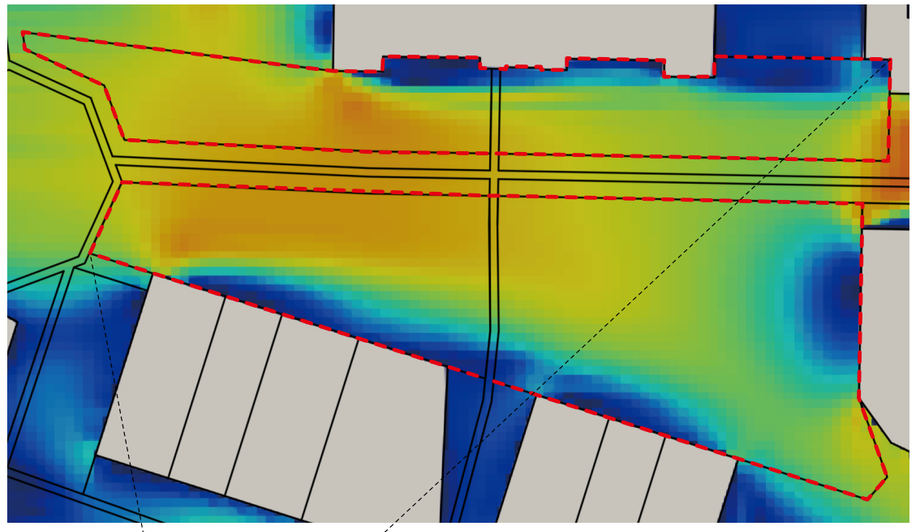




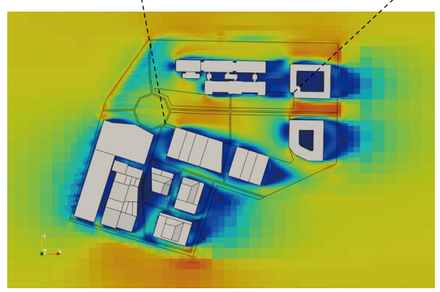
Step5: Put benches to low velocity areas



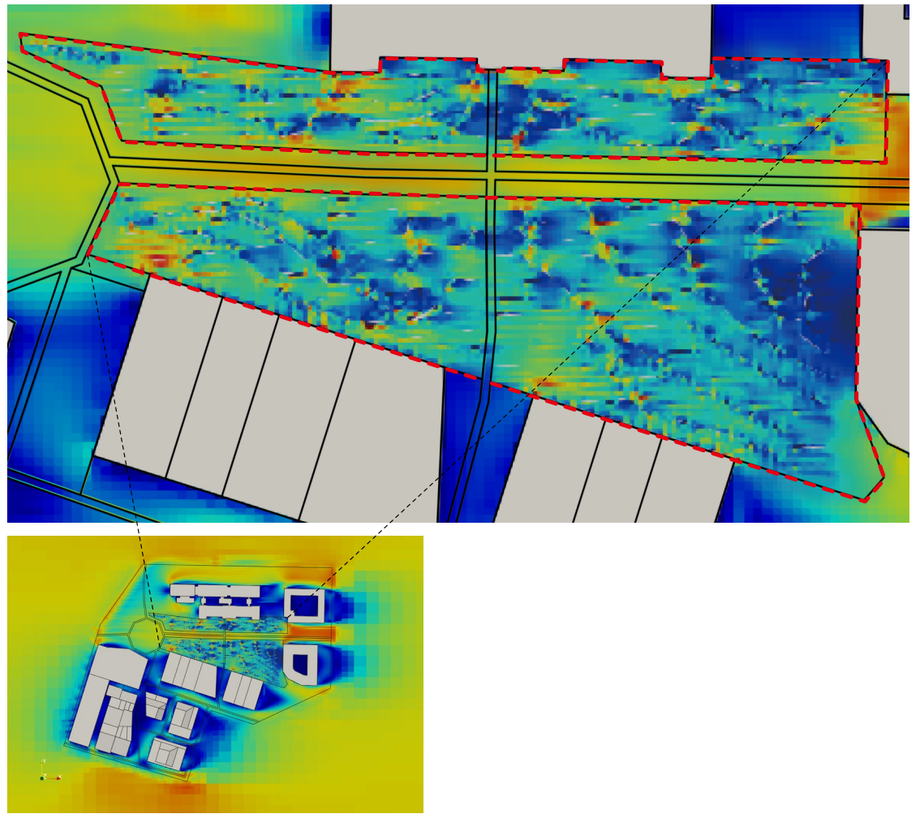
Wind velocity contrast



Velocity situation without intervention



Site boundary



Velocity situation with maze and bench

Velocity (m/s)

8.0e+00

7

6

5

4

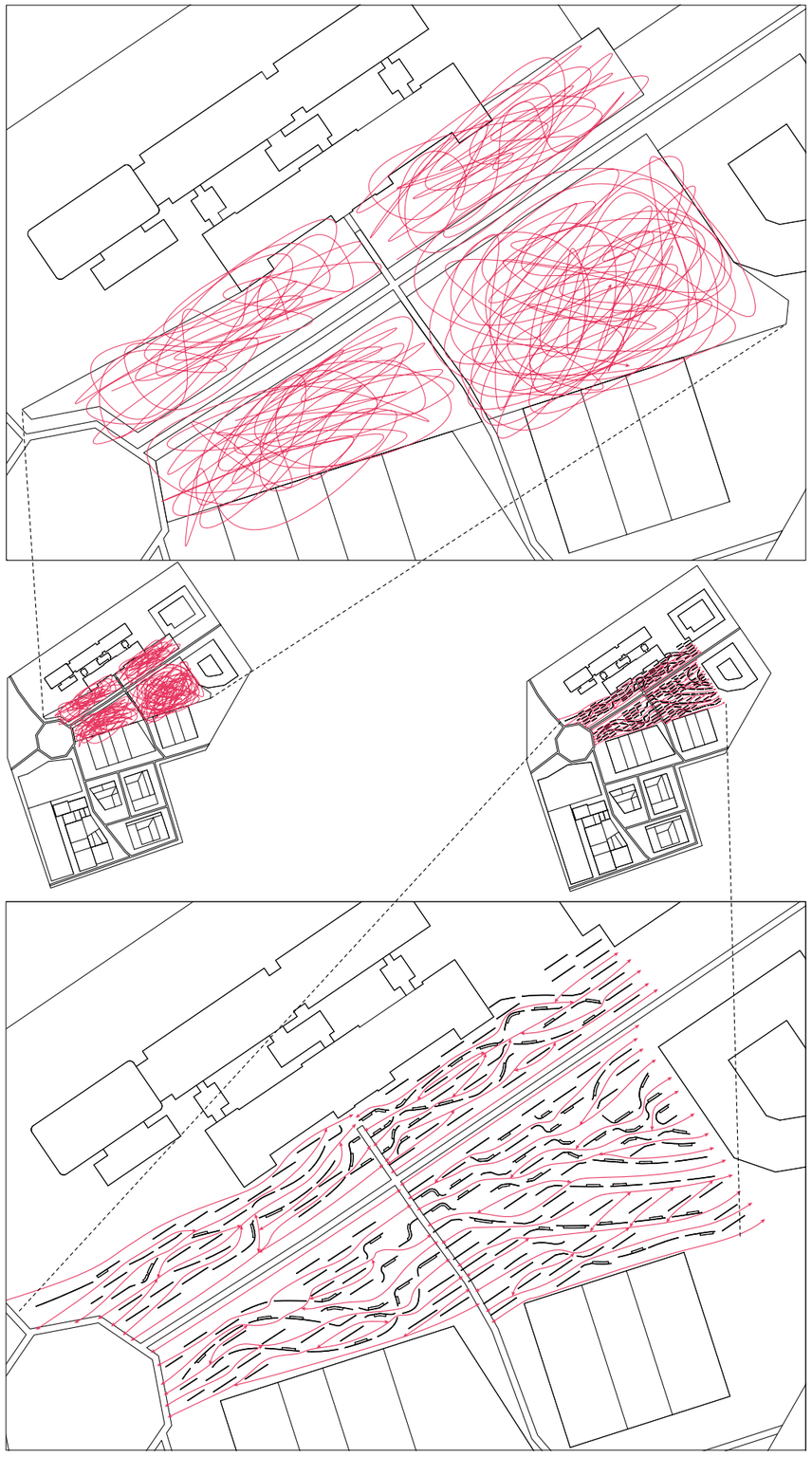
3

2

1

0.0e+00

Circulation contrast



circulation without intervention

circulation formed by maze and bench

Summary

Velocity contrast

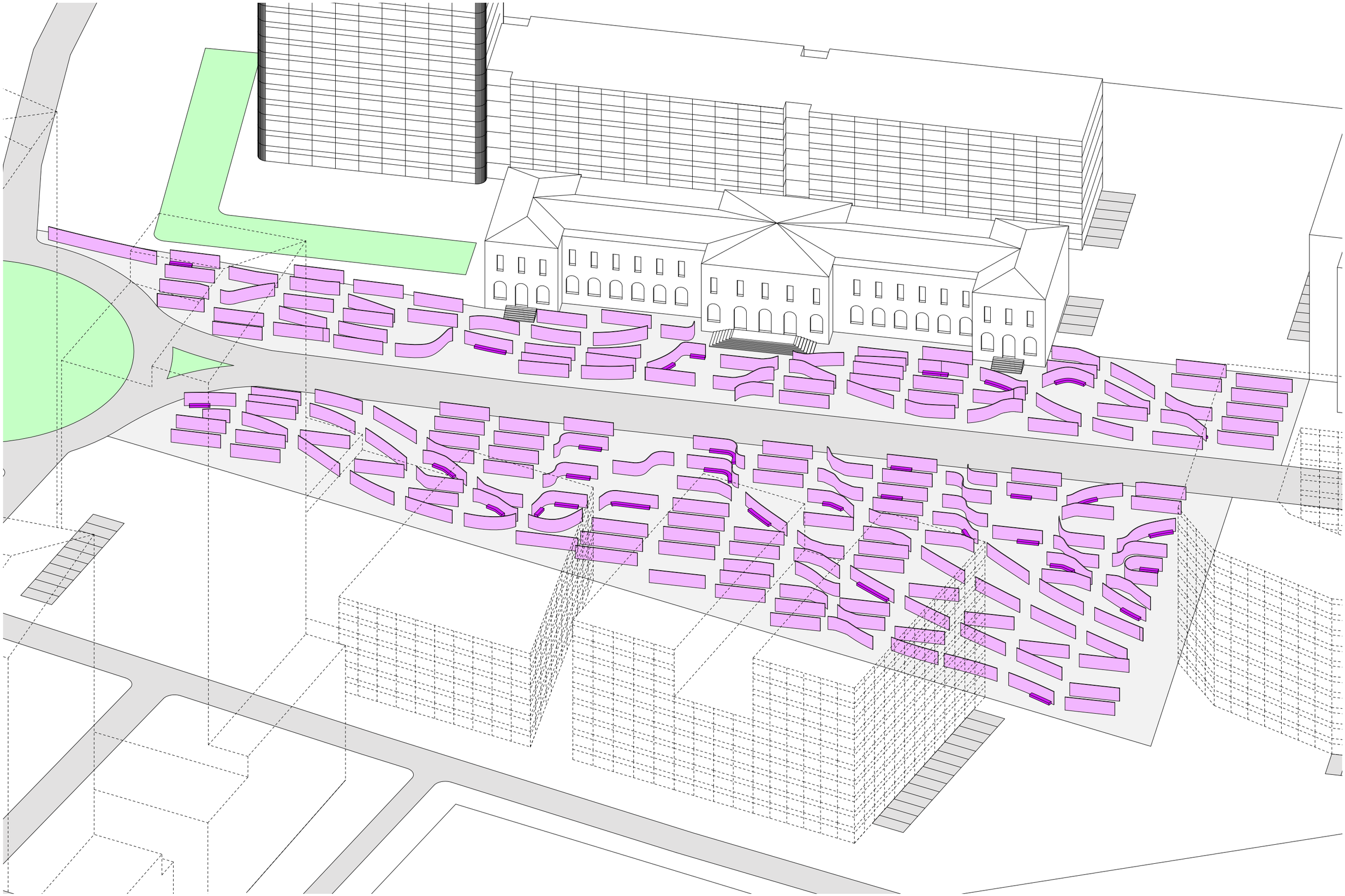
The wind velocity contrast between site without intervention and space formed by maze and bench shows that the high velocity area (over 5.5m/s) is reduced, so the pedestrian wind comfort is improved.

Circulation contrast

The circulation contrast between site without intervention and space regulated by maze and bench demonstrates that the circulation formed by the intervention is more efficient in separating pedestrians so people can easily keep social distance by naturally following the circulation.

Result

The Axonometric drawing shows the result of intervention maze and bench organized by wind situation. The mazes fill up the whole site and are twisted against wind flow to lower velocity. This creates various space, some are very narrow, just allowing one person to pass at a time and some are quite spacious, providing room for events.

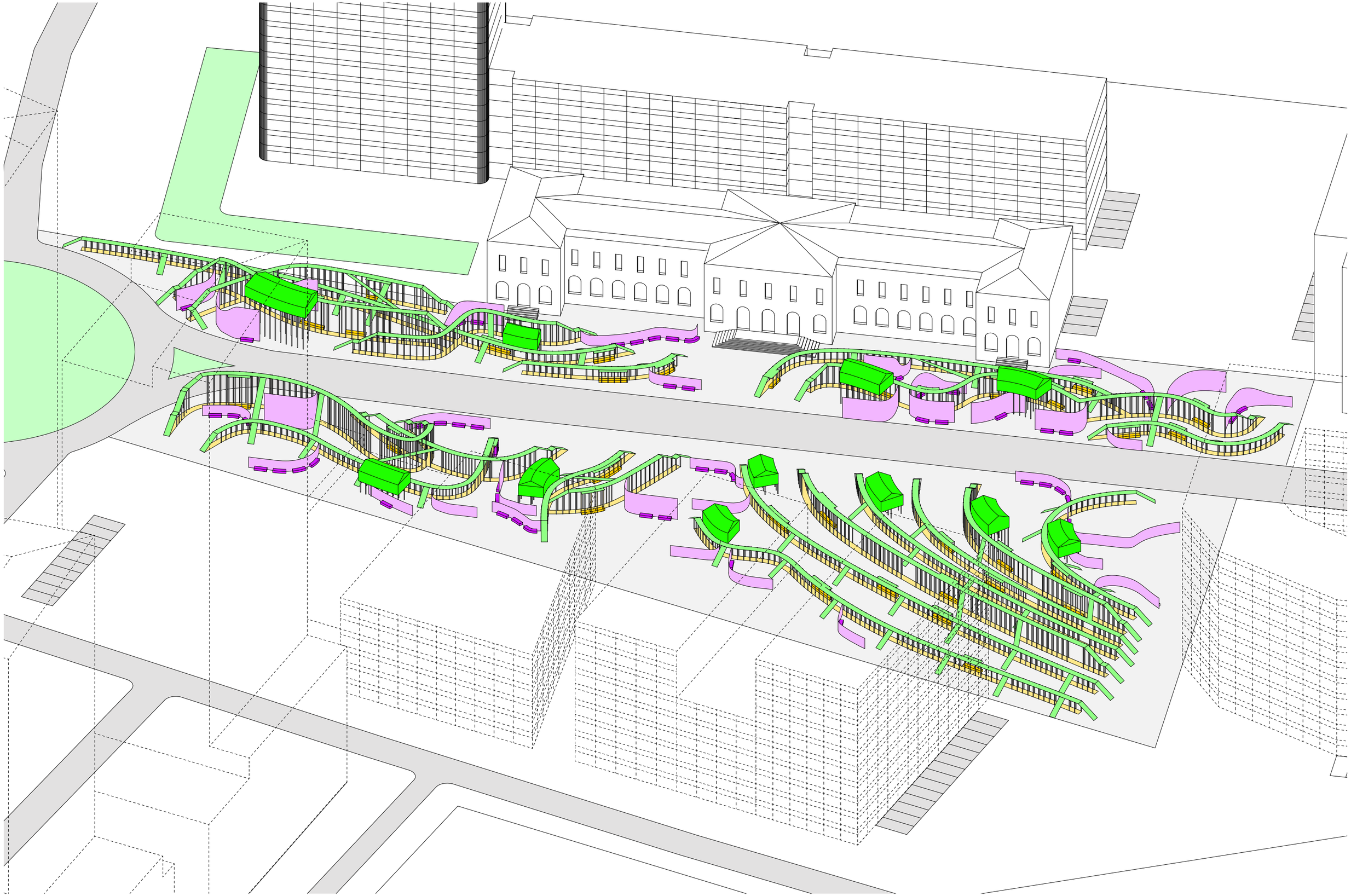


Intervention maze and benches

Intervention staircase and commercial spot

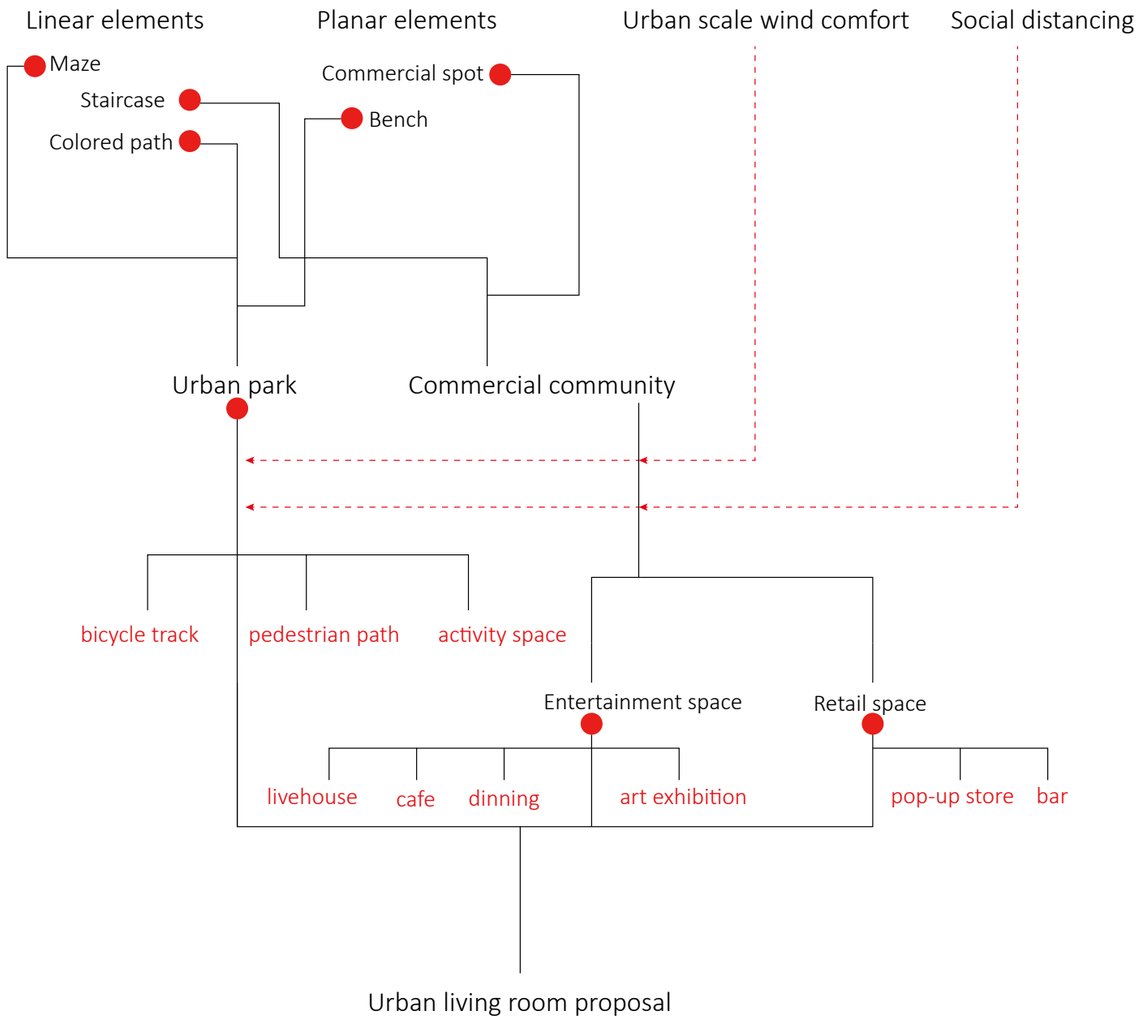
Intervention colored path and benches

After testing the effectiveness of the interventions in improving pedestrian wind comfort and creating circulation that separates pedestrians, I tried to combine them and form a prototype.



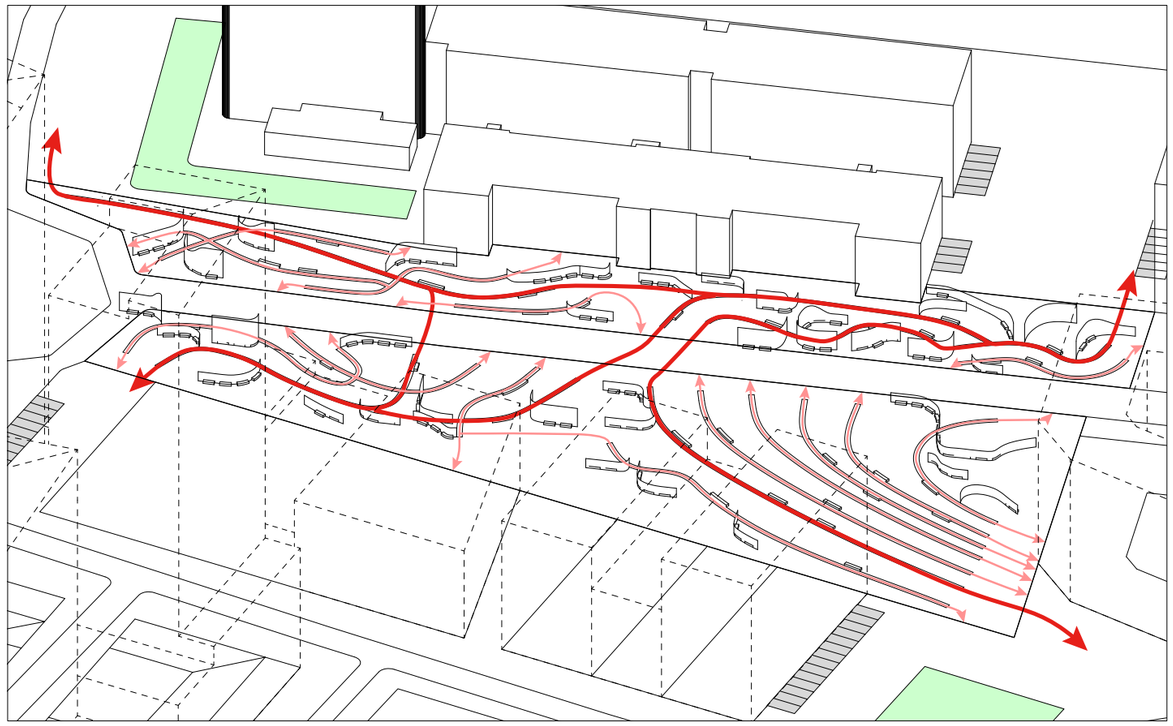
Elements of prototype

Circulation of prototype



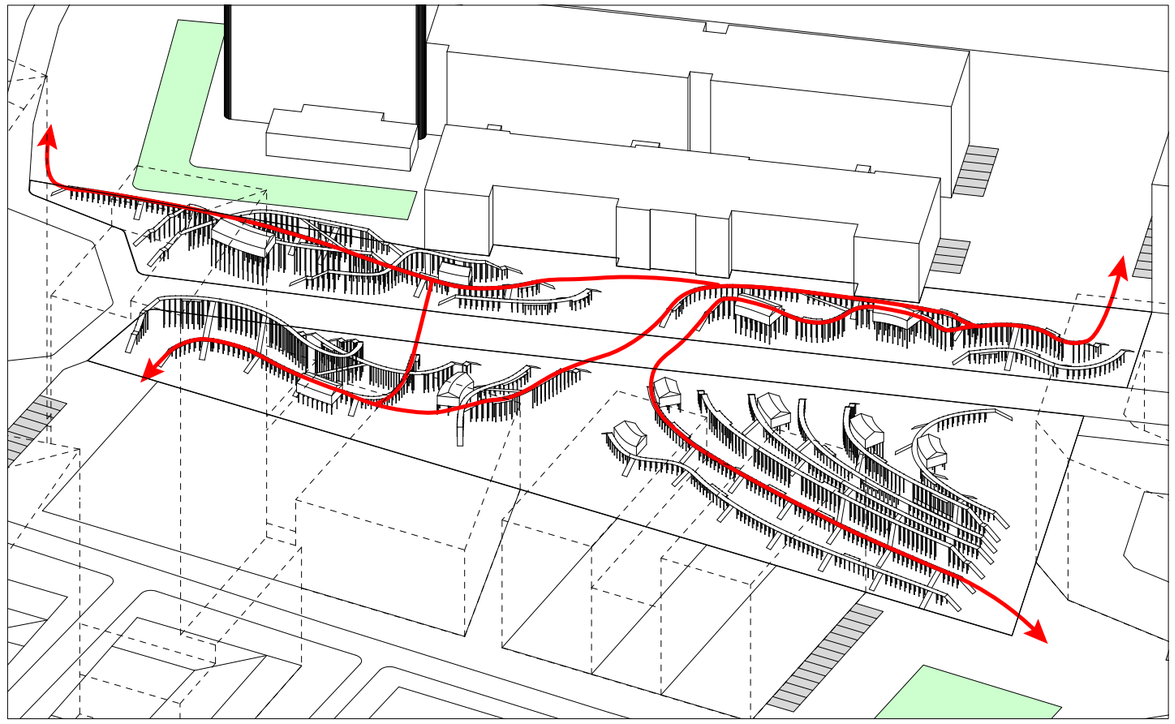
The prototype will be transformed to an urban public space proposal, called urban living room. The urban living room consists of three components: urban park, entertainment space and retail space. The urban park takes maze, colored path and bench from the prototype and is divided by the circulation of the prototype into bicycle track, pedestrian path and activity space. The entertainment space and retail space take staircase and commercial spot from the prototype and they are classified by circulation of the prototype.

Urban park



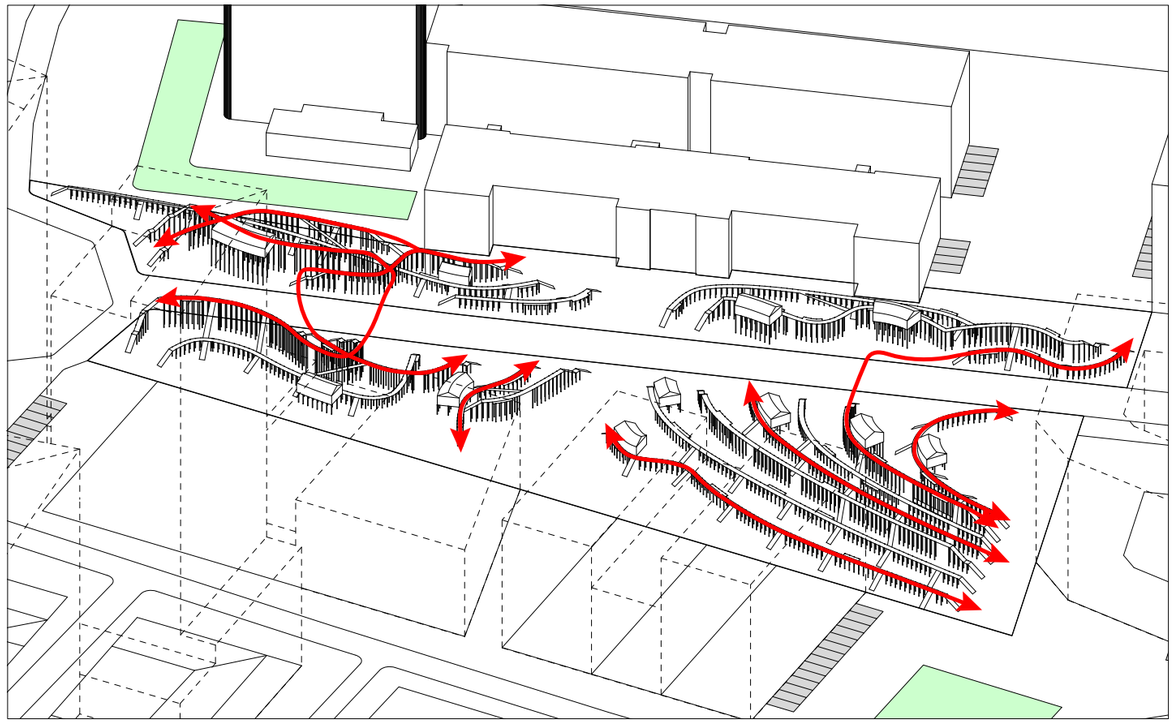
The new circulation is formed by re-organizing the circulation of maze, colored path and bench from the prototype. The red arrows are the bicycle tracks, the pink arrows are the pedestrian paths and the intermediate is space for various activities like picnic, open air movie, rock climbing and badminton. One pedestrian path is extended to the side entrance of Regionens hus and bicycles are extended to surrounding facilities like planned parking lot and greenery.

Entertainment space



The circulation of entertainment space is generated by re-organizing the circulation of staircase and commercial spot from the prototype. The general expectation of the entertainment circulation is to be continuous and travel through the whole site and work as the base for the retail circulation to attach.

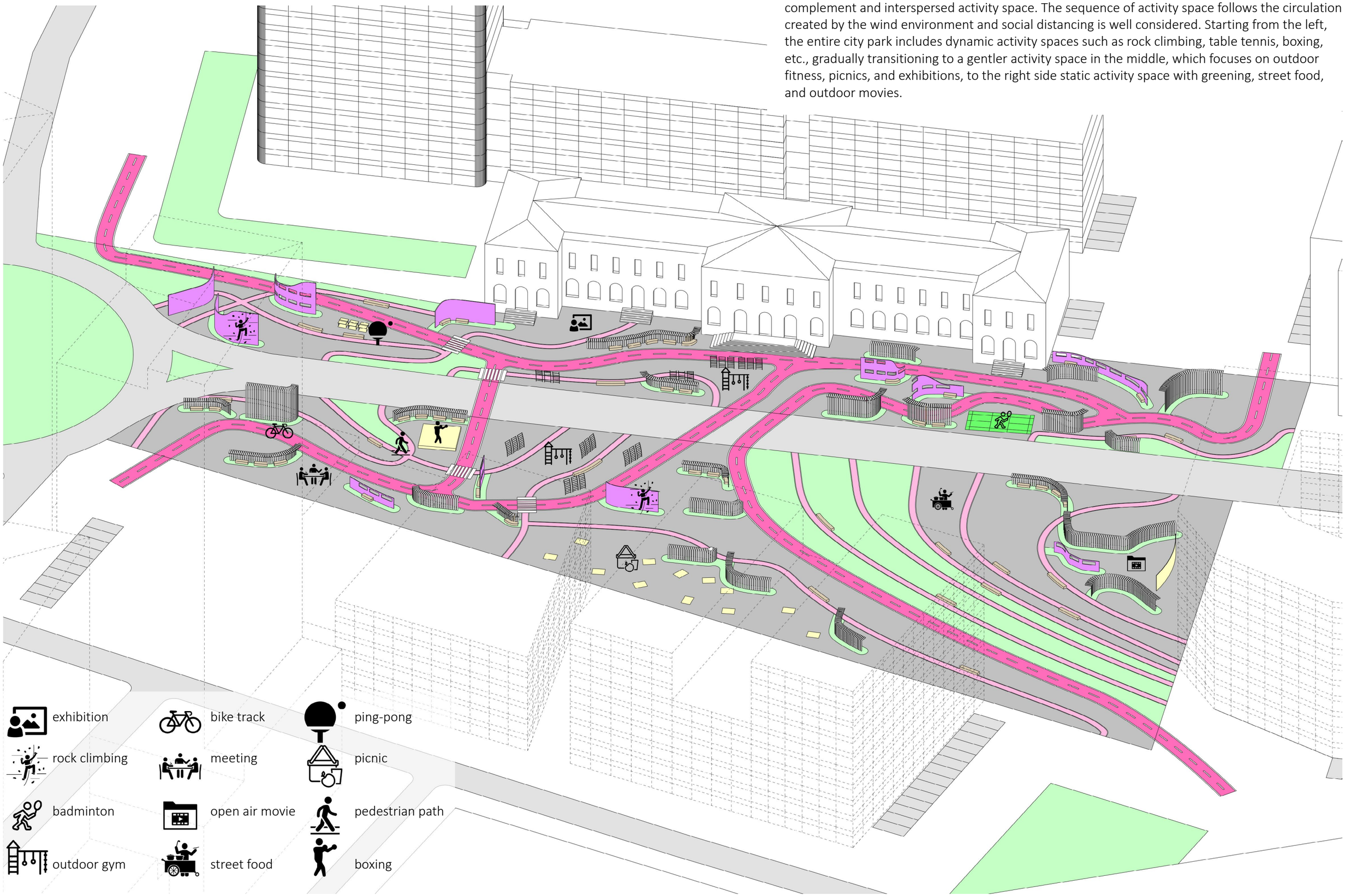
Retail space



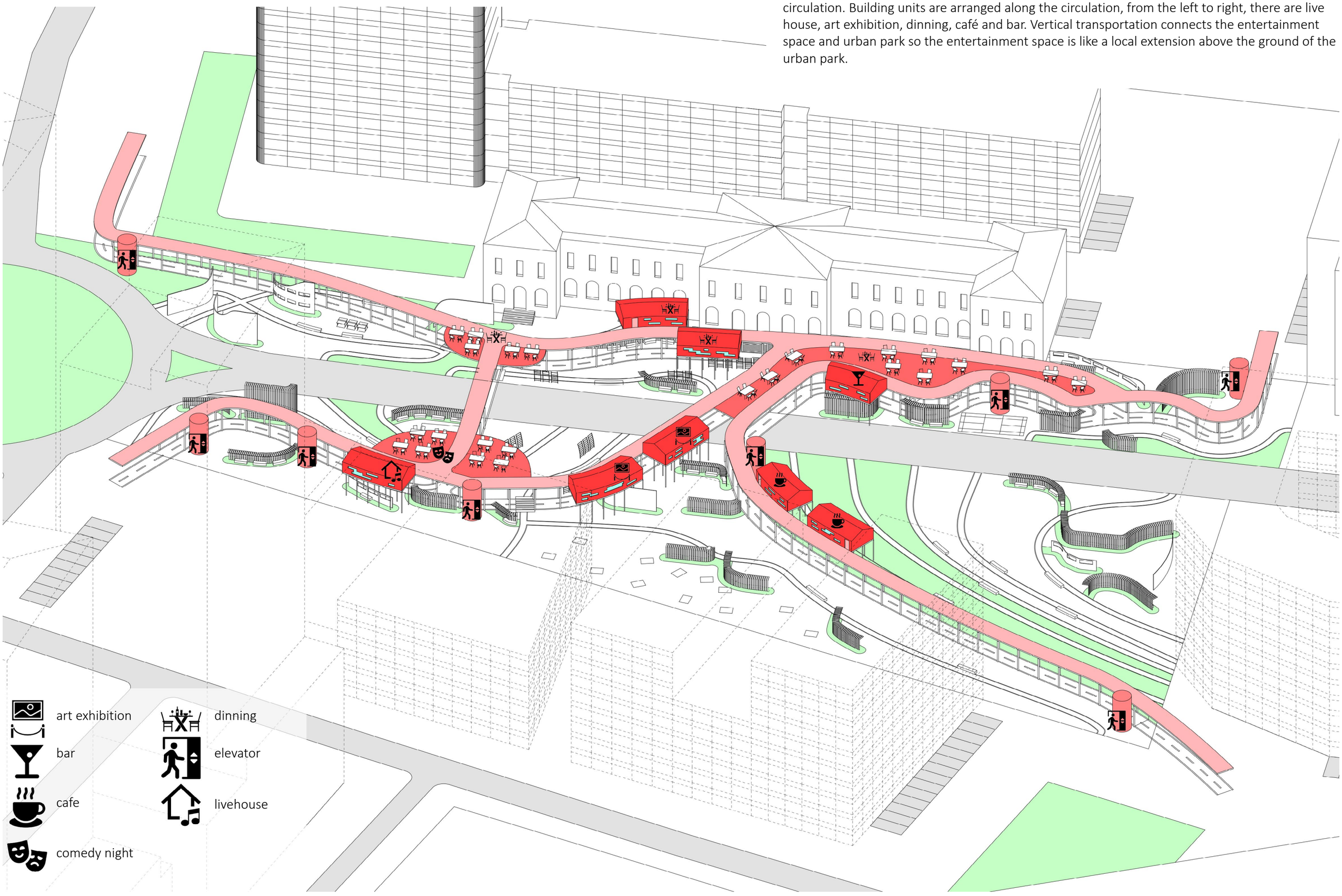
The circulation of retail space is also formed by re-organizing the circulation of staircase and commercial spot from the prototype. It is the complement to entertainment circulation and it works as an integrated system through connection with the entertainment circulation.

Proposal

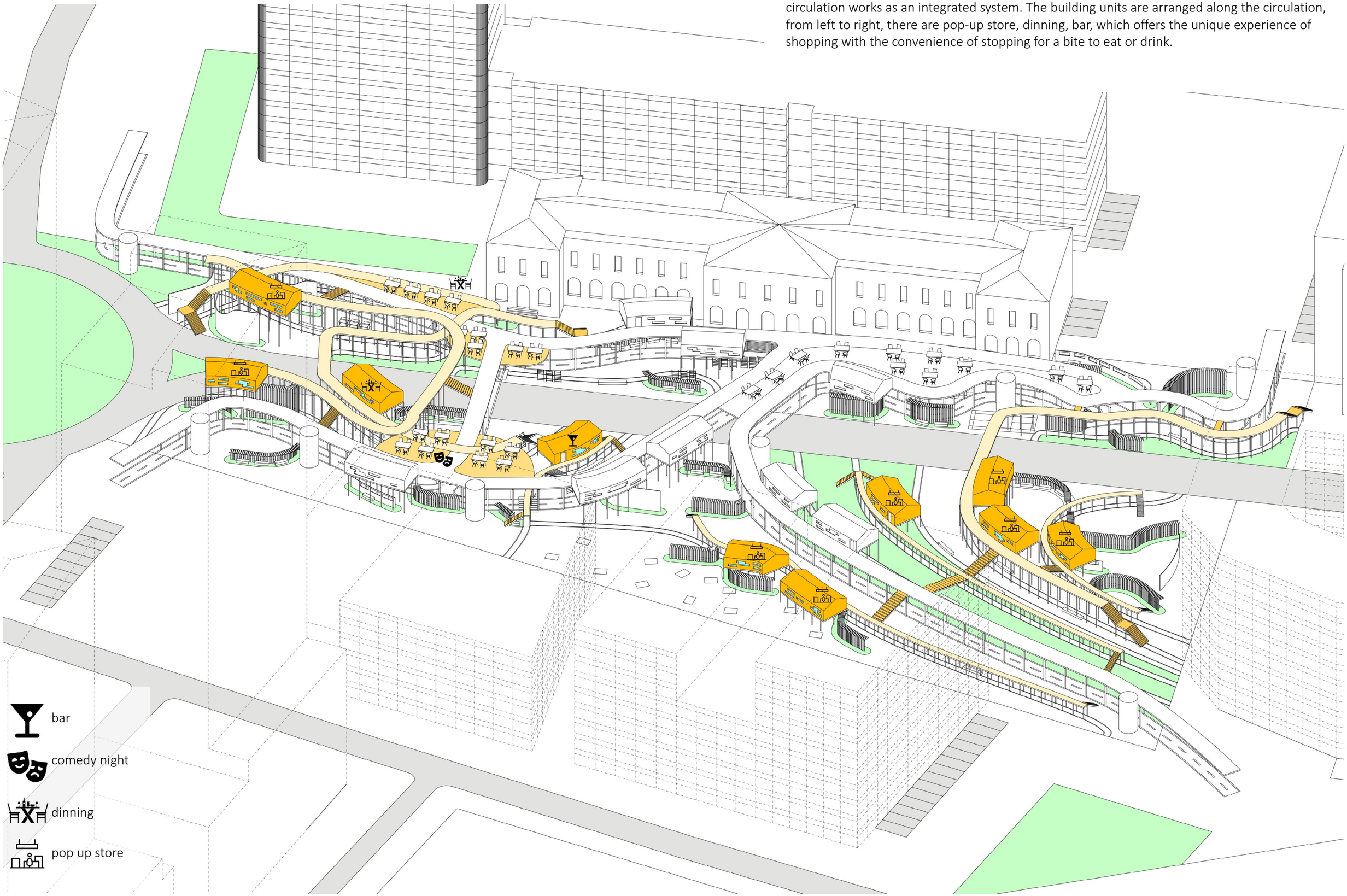
The urban park is on the ground floor. The space is structured by the bicycle tracks which travel through the site and extend to the surrounding facilities and pedestrian paths which work as the complement and interspersed activity space. The sequence of activity space follows the circulation created by the wind environment and social distancing is well considered. Starting from the left, the entire city park includes dynamic activity spaces such as rock climbing, table tennis, boxing, etc., gradually transitioning to a gentler activity space in the middle, which focuses on outdoor fitness, picnics, and exhibitions, to the right side static activity space with greening, street food, and outdoor movies.

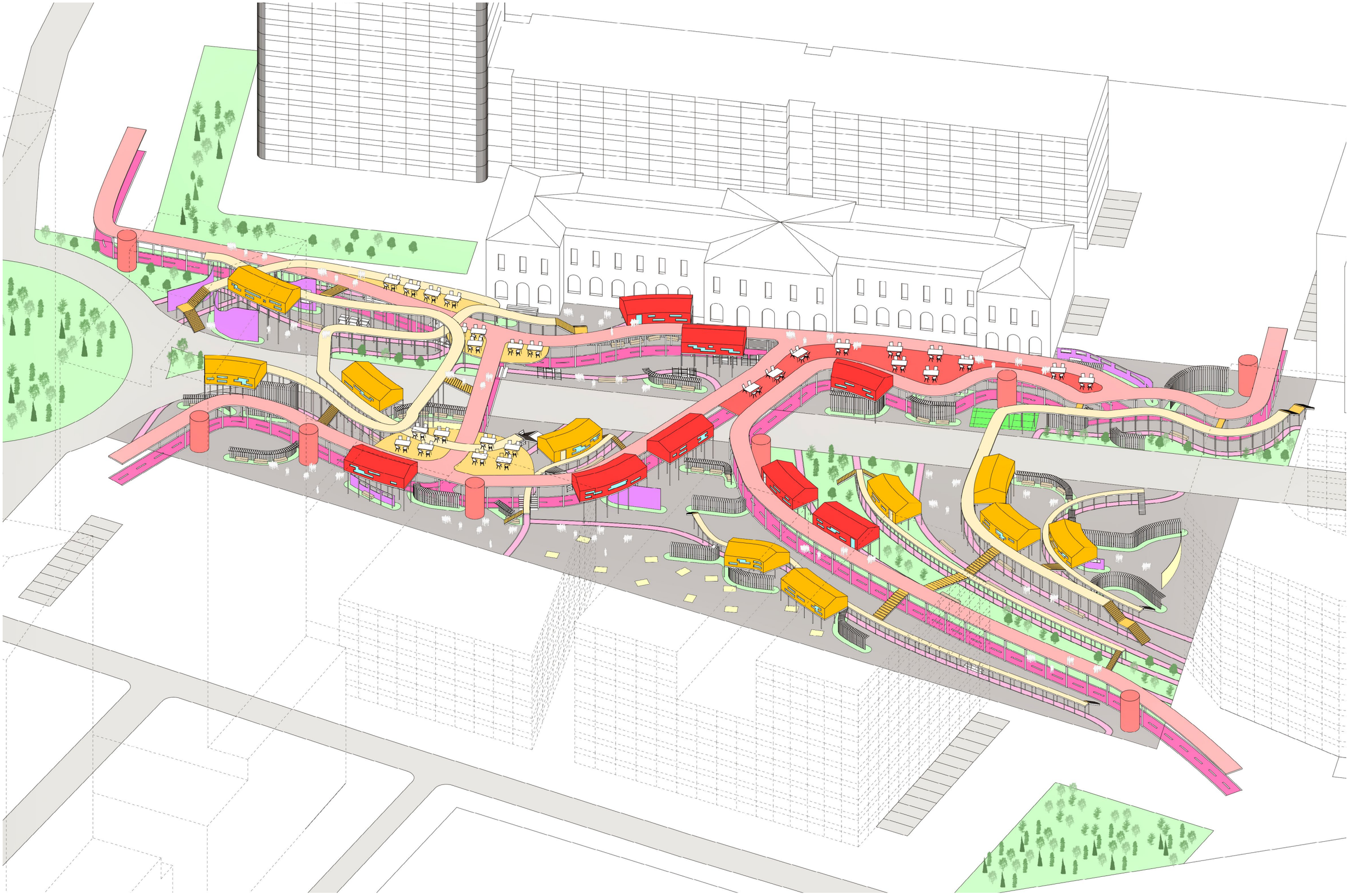


The entertainment space is at 4m height. The circulation of it basically follows the bicycle tracks on the ground floor with activity space such as outdoor dinning and drama at the junction of the circulation. Building units are arranged along the circulation, from the left to right, there are live house, art exhibition, dinning, café and bar. Vertical transportation connects the entertainment space and urban park so the entertainment space is like a local extension above the ground of the urban park.

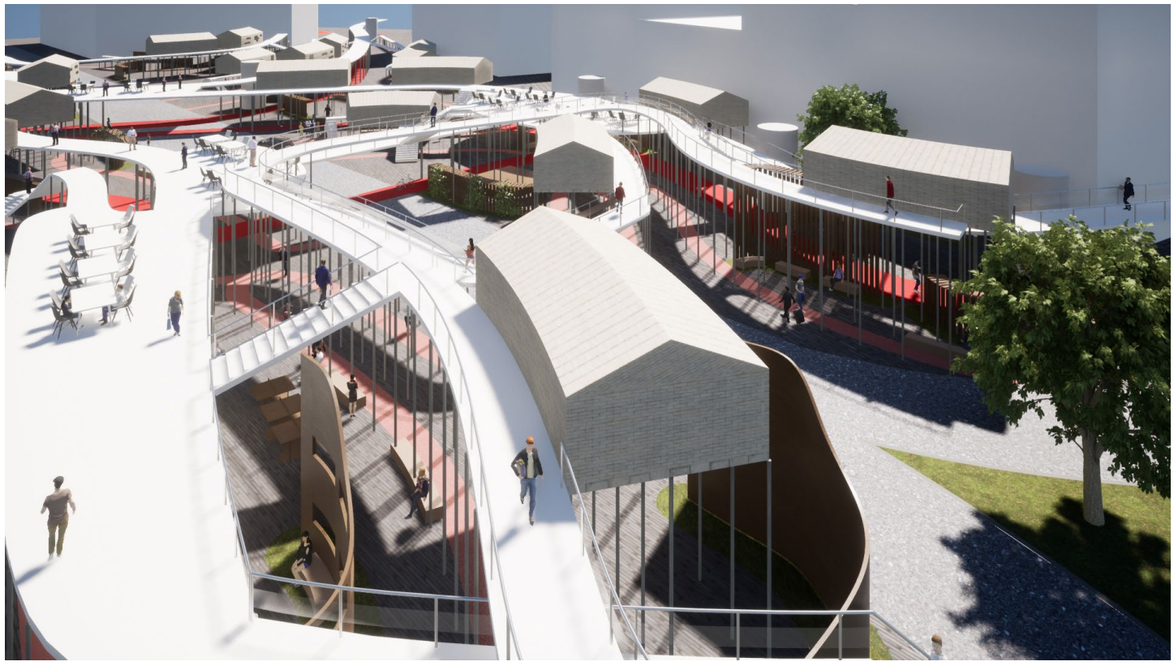


The retail space is at various heights. The circulation of it complements that of entertainment space. The space sequence is discontinuous and through connection with entertainment space the circulation works as an integrated system. The building units are arranged along the circulation, from left to right, there are pop-up store, dinning, bar, which offers the unique experience of shopping with the convenience of stopping for a bite to eat or drink.





This perspective shows the overview of the urban living room, consisting of urban park on the ground floor, entertainment and retail space intertwined at various height.



This local perspective starts from a corner of the retail space, and focuses on the connection between the retail space and the entertainment space, where we can also see the relation with the climbing walls in urban park.

This render shows the atmosphere in urban park including bicycle track, pedestrian path and activity space such as ping-pong and rock climbing.

This render shows the atmosphere in retail space. A group of people standing in front of the pop-up store. The distant entertainment space and the urban park are connected with the commercial space as an integrated system through a specific circulation.

Reflection

The master thesis revolves around urban public space in the post-epidemic era. The sudden pandemic has undoubtedly changed the original life track of everyone. In the more than one year since the initial outbreak of the virus, a lot of resources have been put in emergency medical treatment and vaccine development, and some results have been achieved. However, the worldwide epidemic situation shows that in the foreseeable future, we will have to coexist with the virus. It is true that many activities have been switched to remote mode, but a certain number of daily agendas still need to be carried out physically. So, what kind of public space do we need in the urban area under the pandemic situation. This thesis explores this issue from the perspective of urban-scale ventilation design.

Conventional ventilation design is on the building scale, and the purpose of enhancing or weakening the air movement in the indoor space or around the building is achieved through mechanical or natural ventilation design. In urban-scale ventilation design, pedestrian comfort is an important indicator. Through the assessment of pedestrian comfort, we can predict the behavior of wind flow in a specific area. Wind speed and other parameters can be calculated at pedestrian levels, and a comfort assessment can be made using specific criteria. This allows for improvements to be directly implemented into the design and assessed in cycles until a satisfactory wind comfort is achieved. A technical problem I encountered afterwards was that conventional wind simulation software, such as Butterfly, had too long running time to simulate the fine model. Here I want to thank Iboflow and its developer Andreas for his help in operating the software. Iboflow radically shortens the time to simulate the wind environment of a complex model.

Then I choose to use urban furniture (extended to be explained as every object that accommodates various activities of users and adds comfort and character to urban public space) as intervention to start the design. Experiment is conducted on a simplified virtual context to study the specific impact that intervention has on wind environment. The result of the experiment is the urban furniture which is re-shaped according to wind flow and the re-organized pedestrian circulation which helps people to keep social distance. This experiment made me know how to optimize the wind environment in a specific area from the perspective of pedestrian wind comfort.

From Vision 2035 Goteborg, Gullbersvass becomes the plot in the master thesis, which contains many potential opportunities and a strong identity. Gullbersvass is planned to be the center of Goteborg with high building and population density. The thesis uses the context after construction. The procedure from virtual context experiment is applied on the site and after that all the interventions are combined as a prototype. An urban living room proposal is transformed from the component and circulation of the prototype. The master thesis's target is to offer a proposal of urban public space from the urban scale ventilation design perspective in the post pandemic that could be applied in other social circumstances.

Nowadays, with the gradual increase in the rate of vaccine delivery worldwide, the figure of victory gradually appears in the distance. One possible development direction is that viruses will become normalized and coexist with humans, just like the flu. Our lives will eventually return to the original track. In the end, the thesis's final goal is to contribute to the construction of the living mode in this new normality.

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