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Theme: Architectural Enginering (LAB 07)
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Graduation project

Title: Winddriven archiventure in Scheveningen harbor
Theme: Wind and Smart and Bioclimatic design
Teachers: H.Plomp, A. van den Dobbelsteen
Preface

Before you lies the research thesis written in preparation for the P4 presentation, part of the graduation program of the architecture faculty of the Technical University of Delft. In the field of architectural engineering, an architectural design is made by researching and integrating technical fascinations. The technical research done during the graduation programme is written down in this research thesis, and forms the basis and constant checking point for the architectural design that will be further developed in the time to the P4 presentation.

This research will start by explaining the research framework, by discussing the background, questions and goals of the research. After which it will continue with a description of the design assignment. Next to that you will find an introduction to the technical fascination; wind, and the windclimate in the Netherlands and Scheveningen. After that the research will be ordered by the design.

With thanks to Jan Engels, Suzanne Groenewold, Huib Plomp and Andy van den Dobbelsteen.

Jettie Vernee,
March 2012, Delft
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1. Introduction - Research framework

Research background

Smart & Bioclimatic design approach - In architecture we then to design with the context. A closer look to build environment teaches us something else. Buildings all over the country and europe look the same, while the context certainly isn’t. Smart & bioclimatic design is a design approach in which local circumstances are used to optimizied the sustainable design of buildings and urban plans, that use less energy and surfe users better. The Local circumstances can be natural (climat, seasonal, geomorfolgy, etc.) or man made (landscape, history and culture etc.) Smart & Bioclimatic design has its roots in the research fields in smart design and bioclimatic design. The first one is an design approach that designs buildings that intelligently interact with there surroundings to make the buildings more sustainable. The second one was first defined by the architect Ken Yeak as “the passive low-energy design approach that makes use of the ambient energies of the climate of the locality to create conditions of comfort for the users of the building”. (article a. Dobbelsteen ea)

Local circumstances, Harbor of Scheveningen - The natural local circumstance that stand out in the Scheveningen harbor are the beach, the dunes, the mild seaclimite, the wind and the water. These local circumstances are a big part of the design location and the way we experience the place. The man-made local circumstances that stand out in the location are the harbor, that was made in 1904 wherefor the boats where just on the beach. With the Harbor that was made in tree parts, came also the buildings on the quays, the streets, radio scheveningen and later on the windmale from eneco.

Research topic, Wind - On of the most important natural local circumstances in the Harbor of Scheveningen is Wind. Not only is it very important to the way we experience the Harbor and the beach, everytime in a different way, but is also very important for the working of the Harbor and it surroundings. The dunes are formed by the wind, but undergo constant treath of the wind too. In the early years of the harbor the wind was necessary for the boats to sail and enter the harbor, but when wind was too strong they couldn’t. Nowaday the recreational sailing boats still face the same problems. On the otherside we generate power by use of a windmale on the location. A lot of local building traditions evolve wind in there practise. The use of wind can be devided in to fields. The passive-low energy use of windflows and the use of wind for the gain of energy. In more modest wind earas we mostly see the use of windflows for controlling the climate in and around buildings. (smartarchitecture.org) The field of using windflows in passive-low energy design, with research topics such as natural ventilation, heating and cooling and draft, this fields connect the most to the field of Smart & Bioclimatic Design.
Problem statement

Global scale

Global warming - Through the use of CO2 we amplify the process of global warming. Although scientists still argue if we can do something about it, bringing the CO2 production down is something we must do now, before the effects are irreversible.

Exhaust of natural sources - An other thing we cause by producing and building the way we do know, is exhausting natural sources. The fact is though that we need this sources to make the transition to a more sustainable way of living. Therefore we need to make this transition now we still have the resources to do so.

Building play a big part in the process of global warming, as well as exhausting the natural sources. Not only in the process of building, but also in the process of using. If we use more sustainable materials to build, and make the uses of our buildings take less CO2, we could make a contribution to the problems on the global scale.

Building Practice

Lost of local building traditions - With the industrial revolution the globalisation of the world, we got lost of a lot of local building traditions. Whereas these local building traditions make better use of local characteristics to create conditions of comfort for the users. And most of the time these traditions are a lot sustainable too.

Lost of design for location - With the lost of the local building traditions all over the world buildings started looking the same. This gives us more challenges than needed to create a comfortable indoor climate. Therefor we now use more CO2 to do so than necessary. We could save a lot of CO2, and create better conditions for users, by designing buildings specifically for the design location.

Designing with the Smart & Bioclimatic Design approach and deploying the local characteristics can help us make more sustainable buildings that serve users better.

Design location - Scheveningen Harbor

Wind bother vs. Wind use - Scheveningen Harbor is an area where high wind speeds are not an exception. This brings wind bother for a lot of people and activities, but the boats in the harbor has more than ones profit from the wind climate in Scheveningen. Without an good wind climate the Harbor becomes unusable of sailing boats and just like some activities. Every building that will be build in Scheveningen Harbor will influence the local wind climate, a thing that should be taken into account.

Natural vs. Man-made - In the harbor of Scheveningen, nature and man-made interventions are in contrast and sometimes meeting each other. The man-made interventions are hard and made to protect us, to give us shelter and to make the Harbor function well. The nature can be something we have to protect ourselves to, but can also be part of our protection. In Scheveningen a balance between nature and man-made interventions seems to be preferable, a building build in this location should take this into account.

In Scheveningen the relation between nature and man-made interventions is one of pro's and con's. Wind is one of the natural local characteristics that is very important for the experience and the climate in the harbor. By designing with the wind we could not only profit from it, but we can also avoid problems with the wind climate on the location.

Problem statement - Through the process of globalisation and internationalisation buildings have become non-sustainable and serve users non-optimal. Local building traditions got lost in which the use of local characteristics was a good way of improving buildings. In the harbor of scheveningen the wind climate is very demanding and can cause problems if we don't take it into account when designing.
Research Objectives

As earlier written, the technical research will be done in order to gather tools/aspects or design issues for the integral design. The finding of the research will be translated to the design assignment. Aim of the research will thereby be the gathering of knowledge about research topic earlier subtracted out of the background and the problem statements.

Global scale - Designing a building that is more sustainable by using less CO2 if it is in use. One of the ways we can achieve this is by designing a passive-low energetic building. Hereby the climate control is low-energetic. To make the building use less energy for climate control we could optimize natural ventilation.

Building Practise - Using the smart & bioclimatic design approach the designing a passive low-energetic buildings, can be done by designing a building optimized for the design location. Designing a building that deploys the local characteristics of the Scheveningen Harbor inteligently, in order to make the building more sustainable and surfe users better.

Scheveningen Harbor - Designing a building optimized for the location, one of the local characteristics that should be taken into account is wind or the windclimate. Designing a building that deploys the local windclimate in the harbor of Scheveningen optimal, in order to make the building more sustainable and create conditions of comfort for the users.

Research Objective - Gathering the knowledge that is needed to design a building that deploys the windclimate of the Scheveningen Harbor intelligently for the use of natural ventilation in order to make the building more sustainable (in a passive low-energetic way) and create conditions of comfort.
Research Questions

To be able to gather the knowledge that is needed to design a building that deploys the wind climate of the Scheveningen Harbor intelligently for the use of natural ventilation in order to make the building more sustainable (in a passive low-energetic way) and create conditions of comfort, several research questions can be formulated.

**Local characteristics**
- What are the site characteristics of Scheveningen that can play a role in passive low-energy design?
- How is the wind climate in Scheveningen Harbor?

**Build environment**
- How can buildings influence airstreams?
- How can buildings addictions influence airstreams?
- What effects can occur when wind is in the build environment?

**Sustainability**
- How can we save energy using wind or airstreams?
- How can we benefit from wind, when we design the indoor climate?
1. Introduction - Design assignment

Location

Choice of location - The location in the original assignment was Scheveningen harbor. By the use of the knowledge that we want to design a building that interacts with the wind in the environment a high wind location is chosen. A location at the dune line is preferable because of the solid windstreams from sea. The height of the dunes is ideal because we don't aim on making a tower, but want some height to be able to catch the higher wind speeds. Chosen is the location as marked on the map. Here the dunes can be extended, in cooperation with the buildings. Wind extremes (from high speed, to zero speed) can be formed and the clash between nature and man-made structure is very explicit.

consequences of location - By designing and building on this location the pedestrian, cycle and car ways to the beach are influenced, just like the parking spots and the harbor of northfolke. These will all be included in the design assignment. The ways to the beach, as well as the parking spot will be redesigned an integrated with the building and the extended dune. Starting point will be to implement windexperience in the ways to the beach. Second starting point will be the connection between the ways to the beach and the public functions of the building.
Function

**Choise of function** - The smart and bioclimatic design approach is focus on the use of local circumstances to make the building more sustainable and serve users better. In most of the hotels we see, that we want to make everybody feel at home, and thereby disconnect from the location, the aim will be to design a hotel that is connects users to the design location by using the local circumstance wind. Thereby the location has a very explicite clash between the soft nature and the hard man-made harbor side. In hotels we see the same kind of clash between the use of the building by business man and the use by tourist.

**consequences of function** - Designing an hotel that uses wind and natural ventilation to make the building more sustainable and make the users connect with the context, means a lot of different requirements. First there is the requirement of being accessible, for tourist and businesspeople. The mixed use, makes the building requirements varie a lot. Aim is to make the building usable for tourist, businesspeople, staff and short vistors.

Architectural Concept

**Choise of concept** - Aim is to design hotel that uses wind and natural ventilation to make the building more sustainable and make the users connect with the context. Because of this goal the chosen concept considers natural ventilation as airstreams trough the building, and let users experience this windstreams. Not only to show in what context the users is situated but also to experience constantly what the building does to surve the users. Protecting the users against the high wind enviroments. Not an general design, but the feeling of being comfortable and secure will make the user feel at home.

**consequences of concept** - consequences of choosing a concept that takes windxperience in the building as one of the main architectural goals, can mean that the norms for airspeed in the building will be exceded. Aim is to make a comfortable indoor climate and to make it still possible to experience the wind trough the building.

First layout of the design - the first layout of the design shows that in order to achieve more connection with the context, a relatively new hotel typology is worked out. Spreading the functions over the design locations, makes it possible to design this connection more psycific for each part of the hotel, and makes is possible to create a route between the functions shows the hard interfaces between the low windspeeds that are prescribed for places you stay for a amounth of time.
Engineering and Integration

**Goals for engineering** - The main goal is to create an comfortable indoor climate, and use wind and airstreams to make the building as sustainable as possible. Aim is to use natural ventilation and the use of air for heating and cooling as much as possible. Making the building as passive as possible will also include other natural sources and circumstances if needed. This will also mean that if necessary because to make the building even more sustainable the use of wind for energy gain is not excluded.

**Goals for integration** - the original assignment is to make technical driven architecture, which means a high level of integration between architecture and engineering. Aim is to create a building in which architecture and engineering strengthen each other. For this design this means designing a building in which architecture and indoor climate profits from the use of wind.
Hotels that are designed to connect to the context

**Design:** Graciastudio, Arq. Jorge Gracia  
**Year:** 2011  
**Location:** Valle de Guadalupe, Ensenada, Mexico

"Located in Valle de Guadalupe «Mexico’s Wine Country», Baja California, Endémico Resguardo Silvestre is a set of twenty independent rooms of twenty square meters each, operated by Grupo Habita, a Design Hotels member”. "One of the principal premises was not to interfere directly the land, as part of the philosophy of the project is to respect nature in every possible way”. "The approach of the design of the room comes from the concept of a “deluxe” camping house, covering the guest’s basic needs, being in contact with nature and the environment.” (archdaily.com)

**Design:** Circa Architecture  
**Year:** 2011  
**Location:** Saffire, Coles Bay, Tasmania, Australia

"The desire to create a unique experience and ultimately positive lasting memory of the resort was a key aspiration of the design. With this in mind, the architects shaped the main building as the end point of a continuing journey, in which views of the Hazards Ranges are shielded and revealed and finally presented inside the building as a panoramic overview of Great Oyster Bay”...

"The guests’ journey is a deliberately extended special sequence in which guests move from the monumental resort building, through the site, to the private space of the suites.” (www.worldarchitecturenews.com)

**Design:** Pir II AS  
**Year:** 2011  
**Location:** Stokkøya, Åfjord, Norway

"The clients, a young couple running a small sheep farm on the island of Stokkøya, wanted to do something more with the place they inherited, and perhaps be able to make a living out of it. They wanted to create a resort with a high architectural quality that was not exclusive, but a place where the uniqueness of the location could be experienced by everyone.” (www.worldarchitecturenews.com)
2. Wind - Introduction

Forces on air

Based on the book of J. Wieringa, we will first discuss how wind is formed and which forces are determine the main characteristics of the wind.

Wind can be described as the movement of air. This movement of air is primarily caused by pressure differences in the atmosphere, which thereby creates wind. These pressure differences arise mainly form horizontal temperature differences. Hot air is less dense than cool air and thereby forms low pressure fields, also called depressions. The pressure differences cause the “gradient force” to push the air in the direction of low pressure field. When we take \( P \) for pressure and \( \rho \) for the density we can calculate the acceleration by the gradient force;

\[
G = -\frac{1}{\rho} \frac{dP}{dx} \text{ m/s}^{-2}
\]

When the air is already in movement a couple of other forces start working on the air stream. First of all, there is the rotation of the earth. This rotation causes a shearforce on the wind. This shearforce we call the “Coriolisforce”, which can be calculated with the latitude and the traveling velocity of the air;

\[
C = 2 U \omega \sin \phi \text{ m/s}^{-2}
\]

This shearforce works (seen from the earth’s surface) on the northern hemisphere in the direction of the clock. On the southern hemisphere we see the shearforce working in the counter direction. Moving to the equator, we see the effects of the rotation fade and nearby the equator we don’t see the horizontal displacement any more.

One other forces working on the wind is the friction force, which works on the wind when it is moving over the service. How much friction the service has, is determined by the roughness (\( C_w \)) of the service. How much the roughness slows done the wind, can be calculated with;

\[
W = C_w U \text{ m/s}^{-2}
\]
Windspeed and winddirection

On moving air, or wind, the gradientforce, the coriolisforce and the friction force are always working. The extent to which they are working, determines the wind we perceive. If we state that the windspeeds constant, and therefore the sum of the forces zero, we can theoretically calculate the windspeed and the winddirection.

In the upper layers of the atmosphere the friction force can be neglected, because these layers of air are not moving over the service. This means that the gradientforce and the coriolis force must be in balance. The wind direction (U) is hereby perpendicular to the other two forces. Wind will flow parallel with the isobares (lines that connect points with the same pressure, air will thereby not be flowing from high pressure to low pressure. This wind direction is also called the geostrophic wind direction).

Closer to the ground we see friction force. This friction force, together with the coriolis force will balance with the gradient force. The wind direction (U) will still be perpendicular to the coriolis forces, which means that the direction will tilt towards the low pressure area. When the friction force is bigger, the tilting of the wind direction will be bigger. This means that the pressure differences between the high pressure field and the low pressure field will reduce. This reducing of pressure difference will hereby go faster if the friction on the service is bigger.

As a result of the friction forces of the service of the earth the pressure differences will be slowly resolving, and air is flowing from high pressure fields to low pressure fields. Hereby another force works on the airstreams, because they flow in circular paths there is an centrifugal force. Winds nearby low pressure fields are hereby more likely to be strong winds. The coriolis force and the centrifugal forces are then working in the same direction. Winds nearby high pressure fields are by the contradictory of the two forces more likely to be moderate.

The friction force from the air with the service of the earth will slow the wind down, make it tilts its direction, and make pressure fields desolve slowly.
Windprofiles

Most commonly used to describe the difference in wind in the upper layers of the atmosphere and the more lower layers are windprofiles. These profiles show the windspeeds at different heights.

The atmospheric layer of the earth consists of several layers. The most differences are seen in the planetary boundary layer, that is the lowest first kilometer. The planetary boundary layer can be divided into the service layer (the first 60 meters) and the Ekman layer (from 1km - 60 meters from the earth service).

Looking at windprofiles we first see the influence of the friction force become bigger, with the reduction of height. On the upper layers of the atmosphere the friction force can be neglected, and as described before the windspeed and direction will be almost equal to the geostrophic wind. When we enter the planetary boundary layer downwards we first see the wind tilt its position, and loose a little bit of the speed. In the service layer we mostly see the losing of speeds, and just a little bit of tilting.

Windprofiles are mostly looked at from the service of the earth till 60 meters above it. In these feel the windspeed direction is mostly a fixed factor. The sort of terrain which the airstream comes from, and thereby the friction forces, in combination with the heat distribution over the height will determine the windprofile in the service layer.

When we view the temperature distribution over the height in the service layer we can see three states; it can be stable, unstable and neutral. The service layer is stable when the earth service is cool, and the air above it warmer. The cold air on the ground, is very dense and almost won’t mix with air from higher layers. Hereby it’s hard for the windspeeds to transfer from the higher layers to the cold lower layers. The service layer is unstable when the earth service is warmer than the air above it. The warm air nearby the service has a low density, and will rise in the form of bubbles. This convection will also allow cold air from higher layers to sink and transfer the windspeed from these layers. The service layer is neutral when temperature differences are not really determining. This can be when the windspeeds are very high and will transfer anyway. When windspeeds are very high, and the terrain is rough, wind gusts will mixed the air (turbulence) and thereby transfer the windspeed to lower layers. An other situation in which the neutral state will occur is when the sky is very cloudy, and the radiation of the sun has no change to heat up the service of the earth, and there will almost no temperature difference in the service layer. When the service state is neutral the windprofile is determined by the fraction of the terrain.
3. Windclimate - Netherlands

Windclimate in the Netherlands

Looking at global wind patterns we see low pressure fields in the planetary boundary layer at places with a high service temperature. This means that around the equator we see a low pressure belt. Next to that we see a high pressure belt in the subtropes, with next to that a low pressure belt. The Netherlands are situated in the low pressure belt next to the subtropical high pressure belt. Because the air of the high pressure fields at the subtropes and the pole is essentially flowing from to the low pressure fields where the Netherlands are situated. The place where the to pressure fields meet we call a front, and this particular front we call the polar front. This front moves over Europe and can be placed at different latitudes. This frontline is determining for the weather because it can cause depressions (fields of low pressure) and determine the positions of high pressure fields. Which both bring a different weatherclimate with them.

J. Wieringa shows in his book that an analysis from wind data from measuring point over the country, shows that in the Netherlands the location with respect to the North Sea is determined for the winds speeds above the service layer. For the wind climate closer to the ground the roughness is playing a part too.

A yearly average is however not very representative to describe a wind climate from. In the Netherlands we can divide the year in 6 seasons of two months, defined by the location of the high pressure fields:

- January - February: Winds out of the North East
- March - April: Stormy weather above land
- May - June: Seawinds at the coast
- July - August: West circulation
- September - October: Winds out of the North East
- November - December: West circulation

West circulation is the situation in which the polar front is above Netherland, and depressions are moving above the north of the country. Because of the fact that depressions usually have the strongest winds at the south side, the west circulations cause a lot of wind and storms in the Netherlands. The west circulations determine the weather in the Netherlands 30% of the time.

Over the year, with the seasons the wind speeds are changing, we call this the annual going.
seawindclimate and landwindclimate

Over the year, with the seasons the windspeeds are chancing, we call this the annual going. This annual going is based on the stability of the service layer as earlier mentions, because these stability is based on temperature and radiation on the service this stability is affected by the seasons. On sea the service takes more time to head up, and thereby the stability of the service layer above sea is more slowly effected. This means that, while the friction force is less and we would thereby expect that windspeeds would be higher, that is not true for the hole year. When in the spring the temperature difference between the air and the sea is very small the windspeeds on land are not much less than the winds at sea. Thereby the annual going is much bigger at sea than at land.

This annual going of the sea is also causing an other phenomenon; seawinds. Seawinds occure very locally by the cost, at sunny springdays, when the temperature difference between the air in the service layer. Above the seawater the air is cool (just like the water), while above land the air is warmer, because of the radiation of the sun that headed up the service. The air above land rises leaving an low pressure field near the ground. Cold air from the sea, flow towards the low pressure field at land. At higher level the exact opposite phenomenon occurs.

Next to the annual going, we have the daily going, the changing of windspeeds over the day. This daily going occures, because of the changing stability of the service layer over the day. Mainly in the summer, during the day the service of the earth heats up, by the radiation of the sun. Hereby the service layer becomes unstable and windspeeds will transfer easier to the the lower layers. In the winter this daily going is thereby less noticable. This also counts for the winds at sea.

When we look at the windclimate in the Netherlands, we can divide it into tree several subclimates. the seeclimate, the costalclimate, the landclimate. Looking at the design location, it is located in the costalclimate areas. dat This means that it is a mixe of the seeclimate and the landclimate.

**Figure 4.9**
Jaarlijkse gang van de maandgemiddelde wind op vier stations.

**Figure 4.10**
Describing, researching and designing on the location in Scheveningen harbor, we base ourselves on the wind data from measuring station Hoek van Holland. This measuring station is geographically not the closest station, but has the most comparable situation, by being located on the line of the demarcation between sea and land.

The yearly windrose shows that a real dominant wind direction is absent, and there are much strong winds (>9 m/s). If we compare it with measuring station the Bild, we see that the winds are less dominant than further away from the sea. Thereby the wind speeds are clearly higher, than further on land, like expected and described before. When we compare the results with the measuring station Ijmuiden, which is on a pier in the sea, we see much also a lot similarities. Hoek van Holland shows a truly mixed picture from the two.

When we look at the monthly wind roses we see that several months do have there dominant wind direction. Looking at the winter months we see strong wind directions between west and southwest. When we look at the spring and early summer months we see this shifting towards north west and north east. The late summer and autumn months show a fragmented picture, without a clear dominant wind direction.

Looking at the wind speeds we see that the most high wind speeds come from the sea and the relative open fields of the dunes. Lower wind speeds are measured from where the city is located (east). This phenomenon can be explained as a combination of different terrain roughnesses and thereby friction forces and the natural differences from wind from sea and wind from land.

The wind climate of Scheveningen is thus a typical coastal climate, which is very close to the coast, and thereby picks up a lot of influences from the seewind climate. Combined with the locational typologically situation between the city and the sea, which are two very different wind profiles.
4. Routing - Wind and landscapes

Integrated in the design there is the public routes from the harbor area through the dunes to the beach, or if that is preferable to the pier. In order to design this route, not only the actual walkway is designed but also the landscape around it. In order to find out how the wind experience of the user will we will look at the interaction between the wind and the landscape.

**Roughness classes**

If we want to know how much friction force the service is giving on the airflow, we have to know how rough the service is. A rough service means a lot of friction force, where a smooth service can cause almost none friction force. If we look at every location on itself, it is hard to determine how rough the service is at that location. Therefore roughness classes are used to classify several types of terrain and make comparison possible. The roughness are as shown at the next page. To every roughness class there is a z-value assigned. When the service is smooth, the z-value is low and the friction force will be low. That the roughness of the service won’t slow down the wind so much, and the wind profile will show high windspeeds on low levels.

In the design location in Scheveningen harbor, there are two different roughness classes. On the seaside we have roughness class 1, which is linked to a wind profile with high windspeeds at low levels. On the other side we have the city of The Hague, which falls into roughness class 8. This roughness class with buildings higher than the 10 meter, which are usually in the core of a big city, with high and low-rise buildings. This roughness class is linked to a profile in which the windspeeds are much more slow down and wind at a lower level show low windspeeds.

### Classes of roughness

<table>
<thead>
<tr>
<th>Class</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Open sea, pond with free brush length of at least 1 km</td>
</tr>
<tr>
<td>2</td>
<td>Sand surface without obstacles or vegetation</td>
</tr>
</tbody>
</table>
| 3     | Flat land with shallow vegetation (grass) and isolated, random obstacles:  
  - air strips  
  - grassland without trees  
  - narrow fields |
| 4     | Farm land with average low (<0.5 m) crops  
  - vineyards, maize fields  
  - artificial obstacles with mutual distance less than 20 x their width |
| 5     | Trees and shrubs  
  - low hedges  
  - narrow rows of trees without leaves  
  - narrow fields |
| 6     | Trees and shrubs  
  - large farmsteads  
  - trees of forest  
  - dispersed shrubs  
  - young densely planted woods  
  - orchards  
  - bottom regularly and fully covered  
  - other large obstacles with mutual distance not larger than 20 x their height |
| 7     | Bottom regularly and fully covered  
  - regular forests  
  - low rise buildings in villages  
  - suburbs  
  - sand dunes of a large city with alternating high-rise and low-rise buildings  
  - heavy woods with many irregular open spaces  
  - h = 10 m |

**Wind profiles - Scheveningen harbor**

Jong T.M. (2008)
Turbulentie

In normal situatation airflows flow in smooth laminar paths, which means that layers or air are orderly stacked. In other words, if an airstream is smooth and the adjacent airstreams are moving in the same direction, we call it a laminar airflow.

When an obstacle or service is in the way of an airstream the orderly stacked smooth laminar airflow will be disturbed. If an obstacle causes slow, gentle alternations, the laminar flow will stay in tact. The airflow will be able to compress a little and thereby contains its form. When an obstacle or service causes more abrupt and less subtle alternations, the laminar airflow will become turbulent. Turbulent airstreams separate suddenly from adjacent airstreams and move in circular, less predictable directions. The circular motion is caused by the low pressure field, behind the obstacles.

Obstacles can have all kinds of dimensions, and there for the turbulent airflows have them too. The circular motions, also called turbulent eddies, are there in all kinds of measurements too. If we look at landscapes we the roughness of the service determine how big the eddies will be and there by how turbulent the air will be. As a result of the eddies an turbulent airflows will be experienced as gusty winds, while laminar windstreams will be experienced as smooth air flows.

Dunes

In Scheveningen harbor we are between two very different windclimate. The windclimate of the sea and that of the city. Wind from different sites of the location have a different history and therefore there own characteristics. Between these two different windclimates we see the dunes.

Dunes are formed by the wind. Sandparticles from the beach are moved till the face an obstacle (mostly plants or an already existing dune). There the wind is slowed down, and no longer able to move the sand particles. Sandparticles can be move in different ways, determine on there size and mass. First of all very small parts (almost dust) get picked up by the wind and are moved without touching the ground, over long distances. Slightly bigger sandparticles will be picked up, but will bounce back to the ground.
over long distances. Slightly bigger sand particles will be picked up, but will bounce back to the ground. This creates a movement of bounces. The biggest sand particles are not leaving the ground but are dragged over the service, sometimes by the direct force of the wind, but mostly by other smaller particles touching it.

The way wind flows occur at a certain location is thereby a controlling force in the creation and shaping of dunes. Because of the almost constantly presence of the wind and the changing of wind directions and velocity, dunes are always changing and moving.

In order to prevent dunes from moving we make obstacles. In most dune situation we plant marram, as showed on the side page. The sand gets stuck between the structure of the marram and is secured against the wind.

Besides the influence from the wind on the shaping of the dunes, the shape of the dunes has also a big influence on the wind. On the follow pages we see pictures from an article that describes the research of wind can’t be done in 2D only, because it is too complex for that. Looking at the pictures we see that the dunes create a wind climate that is very unstable. Wind becomes a little bit turbulent and thereby creates different wind fields. Next to that we see that the changing wind direction can create very different wind flows too.

For the location of scheveningen count that a part of the existing dune is completely covered green, which means that won’t be moving very fast. An other part is newer and not completely covered, this part is more likely to move. When we want to design and create a extra dune landscape with a route and several objects, we should take into account that we will create an unstable situation which will further develop over time. This development will be difficult to predict, because of the double influence from the dunes and wind flows.
Fig. 6. Pressure plot of simulated wind flow (m/s) near the bed (a) and near the shore (b) and at different planes of the 2D models (c), and at different planes of the 3D models (d). The arrows in (a) indicate the direction of the wind. The pressure is shown in colors as indicated in the color bar. The pressure is shown in colors as indicated in the color bar.

Fig. 8. Speed and pressure (Pa) fields of the proposed three-dimensional wind model with buried sources superimposed on the wind surface flow direction (a). The color bar indicates the pressure (Pa) and wind speed (m/s). The location of the wind source is indicated by the location of the arrows. The length of the arrows is proportional to the wind speed (m/s).

Liu. B. et al. (2011)
First layout of the routing - With the shape of the dune and the compositions of the buildings, the airstreams will be influenced into several different windclimates. A laminar, a turbulent and an windlow windclimate.
5. Composition - Wind and buildings

Designing a hotel that uses wind and natural ventilation, not only to make the building more sustainable and serve users better, but also to connect the building with the context, a different hotel typology is introduced. Any building would require a research to the effect of obstacles (or buildings) on airflows, and how different building forms would change these effects. Designing a hotel that consist out of several buildings does also require a research to the effects on the wind of a compositions of obstacles.

Obstical form

As a result of the laminar and turbulent airflows, the form of the obstacles determine the reactoin of the wind flow. Round, or rounded obstacles will cause slow and gentle alterations, the laminar flow will stay in takt. This is possible because of the fact that the windflows are able to stick very close to the obstical, and sudden low pressure fields are avoided. Square obstacles will cause abrupt alterations and thereby make laminar airflows turbulent. This is a result of the fact that the wind isn't able to make such abrupt alternations and won't stick to the service of the obstacle. This makes the apparence of sudden high and low pressure fields possible. In orde to fill up these lowpressure fields, the wind will flow in circular motion to wards these pressure fields, and will thereby become turbulent. This not only meas that squar obstacles make airflows less predictable but also that they cause more pressure differences than round obstacles. This phenomenon is descripted for horizontal airflows, but in vertical direction the same phenomenon can be described.

Bernuli vs. Venturi.

The buildingform will not only make the wind stay laminar or become turbulent, but can also speed up or slow down the windspeed. The bernulli and venturi discribe the way buildings can contribute to that. The bernulli effect is the decrease in pressure when an airflow is speeded up in order to cover a greater distance that adjuncted airflows. When an object is asymatric, airflows will flow faster on one site than on the other. This bernulli effect enables airplane wings to create lift. The venturi effect is mostly known form childrenen playing with stones in rivers. When we make the area for water to flow trough smaller, the water will flow faster. This same phenomenon is seen for wind trough a small opening, and causes an acceleration if an airflow is flowing trough an opening. This phenomenon is caused becaus more wind or water has to pass in the same time trough a smaller area.
Building additions

As a result of the fact that when an obstical stands in the way of an airstream the airstream will change its direction and move around it. With this phenomenon we can navigate airstreams around the building. Often we in order to do so, we not only use the building form but also building additions. This can be either to speed up wind to gain energy out of buildings, to protect users from windbother or to regulate the indoor climate. The other pages show an couple of examples. Research done at TNO shows that even the connection between facade plates can determine the reaction from airstreams on the facade. Every obstical will influence the wind, and make it alternated. Herefore every detail of on buildings schould be designed with the wind in mind. With highrise buildings, that catch much wind, facade plates sometimes let lose and cause demage on buildings and people.

Influence feelds

When an obstical stands in the way of an airstream, as said above, the airstream will change its direction and move around it. After the obstical is past the movement of the side airstreams are normative and the airstream will go back to the direction and speed of the site winds. This returning to the origonal state will take a lengh of 15 times the building hight, in the direction of the wind. Firstly this shows that the building hight is influencing the windflows. The higer the building is, the harder it is fore the wind to pass it. This has to do with the low pressure feeld that is bigger when the building is higher.

Secondly this means that by different winddirections the area that is influenced by the obstical is different. For a location like our design location in Scheveneningen Harbor this, where a clear winddirection is missing, the influence of the building on windflows must be analys for more than one winddirections. In Scheveneningen Harbor, we see that some of the influence feelds contain parts of the harbor and the design location. The wind in the harbor, must be analys in this area to avoid problems for boats that come in and out of the harbor.

The next pages show the influence feelds and the building hight analyses done fore the design location.
Influence fields on the locations for all the wind directions.
Influence area - 15 x building height.
Clear is that when we analyse the wind on a building, knowing where the wind has been before (the history), can tell us a lot about the wind that is working on the building. Is it laminar or turbulent? How is the distribution of windspeeds over the height of the building (windprofile)?

Looking to the influence one building can have on windflows and the influence fields analyses that are done. We can conclude that the when we want to design a composition of buildings, the other buildings will influence the wind that will work around the analysed building.

First of all there is the component form. Earlier we stated that when a windflow passes a round or rounded object, that is will stay laminar because it is able to stick to the building. As a result of the fact that there will be some change in the windflow, there will be some influence at the building stream on wards, but it will be not so dramatic and the windflow will still be laminar. When we look at a components that have a square form we will see that they will force to wind to deviate a lot more. This means that the buildings around it will encounter a lot more influence from it. There by the airflow will change to a turbulent airflow, wich will change it’s characteristics drastically.

Second of all the arrangement of the components plays a big role. If we look at the influence fields we see that a building has a certain influence field, determine from the winddirection. As a result of this we can firstly conclude that the arrangement of the components and the influence from this arrangement is influenced by the winddirection at a certain moment. Analyising this, will thus include several winddirection at the location of Scheveningen Harbor. Secondly we can conclude that influence the building has is also determined by the way the two are arranged.

Next to the influence fields, we should take the influence circles for the building height into account, if we want to determine if a building is in an influence field.

Designing an composition in the Harbor of Scheveningen we will have to work with different scenerios, for different windspeeds and direction. This a result of the absence of a clear dominant wind direction, and the very different windclimates the location is situated between.
Composition on location.

First design sketches - building composition
6. Interieur - Wind in buildings

Well we could say that a building is primarily a shelter against wind and rain, we need air in our building. If we thereby define wind as the movement, we could say that most of our buildings do have wind in them. Because the airspeeds are very low, we don’t usually talk about wind, but air movement or ventilation and heatflows.

Natural Ventilation

Ventilation is the changing of the air in a room, and is done in order to control air quality and air temperatures in the building. Ventilation in order to control air quality is called basic ventilation, and is state in regulations. Ventilation in order to control air temperature is called summerventilation and is not regulated. We can devide to mechanical driven ventilation, and natural driven ventilation. This research will focus on the possibilities from natural ventilation because it past the best in the design approach.

With natural ventilation the airflowing to the rooms, in order to change it, is driven by natural forces. This are the same forces that drive airstreams outside the building, pressure differences, by obstacles of temperature differences. Although this resources are free and sustainable, they are difficult to control. The design challenge for designing natural ventilated buildings is thereby mostly about controlling air movement.

We can divide natural ventilation in two different kinds. The kind that is defined by the pressure differences that occure as a result of wind. Wich we call winddriven natural ventilation. The second kind is defined by the pressure differences that occure as a result of temperature differences, and is called stock ventilation.

Winddriven natural ventilation

The way wind interacts with the building is determined by the shape of the building and it surroundings. This shapes define low and high pressure fields around buildings. On the windward site of a building, wind gets stuck and the pressure will rise. On the leenward site of a building, there will be a lowpressure field. This enables an airflow trough the building from the windward site to the the leeward site of the building. Ventilation is by wind can therefore be controlled by the form and position of the the building.

To create the speed of changing the air, we can create bigger pressure differences. By the use of the venturi and bernulli effects we can shape the building or building additions in a way in wich they speed up windflows and
create bigger pressure differences. This principle is often used by placing wings on the roof of a building. The wind has to speed up in order to pass a bigger distance than the adjuntent airflow, and hereby lowers his density and pressure.

An important issue we have to take into accound when designing a building that wind is not controllable because of its natural resources. We can influence its flowing paths, but we can’t control its original direction and windspeed. This means that the sability of the system can be a problem if we use natural ventilation driven by wind. Thereby buildings can create turbulent eddies, which enables the creation of guts. This guts can make the windspeeds very instable. This means that we have to look for certain points in the design that are constantly high and low pressure fields, and may use ventilation openings that are designed to control airflow speeds.

**Stack ventilation**

Buoyance forces are the driving forces behind stack ventilations and arise when there are temperature differences between inside and outside or between different spaces. In the atmospheric boundary layer we see this forces be driving behind stable or instable service layers. In buildings we see the same temperature distributions over spaces, that determine airflow.

Using this stratification we can distinguish to different kinds of stack ventilation, mixed ventilation and displacement ventilation. Mixed ventilation can be compared with an instable serves layer. When a opening is made in at the top of a space, and cool air is comming in, the incomming air will decent in a circular movement. This turbulent movement will make the air mix and creates an uniform interior temperature distribution. The same effect we see when warm air enters the room at a low level. The warm air will rise in circular movement and mix the air. In the article: “the fluid mechanics of natural ventilation” by P.F. Linden, calculations are described that can be used to calculate the speed, temperature, and volume of the flux. Linden, P.F.(1999)

Displacement ventilation more comparable with a stable service layer, and is caracteristised by high temperature differences over the hight of the space. By displacement ventilation we use two different openings. The first one enables cool air to come in, at a low level in the room. The second one enables hot air to escape at a high level of the space. This means that high pressure differences occure in the space.

The level where the pressure level is exactly as high as the pressure level outside the room we call the neutral level. In side pressure at lower levels is lower, and creates a suksing wich is used to suck cool air in the space. The inside pressure at higer level is higher and creates a pushing wich is used to
puch hot air out of the space. For designing this means that the upper openings should be above neutral level and the lower openings should be beneath neutral level. In the artical: "the fluid mechanics of natural ventilation" by P.F. Linden, calculations are described that can be used to calculate the speed, temperature, and volume of the flux.

Displacement ventilation is characterised by big temperature differences of the space. These temperature differences can take on a lot of different patterns and are determined, among other things, mostly by the sources of buoyancy, or heating or cooling sources. In practice they vary in number and kind. We can have a single heat or cooling source, and a very clean interface, of a couple of heating and cooling sources, which complicates the interface and the temperature distribution.

**Wind and stack ventilation**

If we combine the systems of wind and stack ventilation, it can become reinforcing or opposing, determined by the placing of the openings and the windspeed and direction. If we look at displacement ventilation, we have warm air in the space, being replaced by cooled air from outside. If the lower (cool) openings are on the windward site, and the upper openings are on the leeward site the wind will be reinforcing. The article: "the fluid mechanics of natural ventilation" by P.F. Linden says the following: "The effect of the wind on the stack-driven flow is threefold: The interface is raised, there is an reduction in the temperature step across the interface and an increased airflow rate through the space." This means that the interface between the high and low temperature is higher in the space, the temperature differences is smaller and the airstream faster.

When the low opening is on the leeward site and the high opening on the windward site of the building, the wind will oppose the stack ventilation. The opposite effects will occur. The interface will sink, to a point where the ventilation starts being mixed ventilation. Where the cold outside air and the hot air mix in the space. This will also decrease the airflow rate, or slow down the airstream. The temperature difference over the space will be mixed and become more uniform.
Buildings that use Natural Ventilation

**National Assembly for Whales - Rigard Stirk Harbour + Partners**

**Design:** Rigard Stirk Harbour + Partners  
**Year:** 2005  
**Location:** Cardiff, Wales

**Architectural Expression** - The architectural expression of the building is determined by the ventilation opening from that not only shows where the debating hall is. On the outside of the building, we mostly see the windcatcher on the roof. The rest of the architectural experience is focused on the connection with the river and the waterfront.

**Wind** - The windcatcher on the roof of the building is made so that the opening always points to the low pressure field of the windcatcher. Thereby air gets drawn from inside to the outside of the building. The glass roof warms up the air from the big hall, thereby the hot air gets through the glass and thereby ventilates the big hall.

**Integration AE** - The integration of architecture and engineering is based on the right form to ventilate the building. The rest of the building has a more office-like outline and is less integrated. The public spaces show the sustainable goals of the people inside the building, and therefore the measurements taken are very easy to recognize.

www.rsh-p.com

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**Breeze engine - Zoka Zola Architecture + Urban Design**

**Design:** Zoka Zola Architecture  
**Year:** 2011  
**Location:** Southern China

**Architectural Expression** - The architectural expression is clearly linked to the technical wind research. The building is composed of three layers: the outdoor layer, where the community activities take place; the "closed" room layer, that is shown as a box; and the roof layer, that captures the wind. The use of bamboo shows the ecological concept of the building.

**Wind** - In the forests where the building is located, the hot air gets stuck between the trees. By bringing the wind in from above the trees, the roof brings in the cool air in and around the building. Hereby the building is naturally cooled and ventilated. The roof is two-sided and every room can be reached from each side. This is because at the day time, the wind is landward, and at night time the wind is turned seawards.

The building is CO2 neutral, with the help of PV cells that are placed on the large roofspace. This is with help of the subtropical climate.

**Integration AE** - The integration between architecture and engineering is very high. In the building you can see that the wind has been leading in the design process. Every building part is design at airstreams and how they flow.

www.zokazola.com
7. Windexperience

Designing a hotel that uses the wind not only to make it more sustainable, but also to connect it to the context, windexperience is an important part of the design. This part of the research focuses on the way we experience wind.

Windcomfort and danger

In the Netherlands, norms are determined for how people experience wind, by certain windspeeds and activities. Windspeeds up to 5 m/s are considered safe. For the percentage in time the windspeed exceeds certain windspeeds, the review of the windclimate for certain activities is determined. A windclimate is considered good as the majority of people doesn’t experience any windbother. A moderate windclimate is described as a situation in which now and then people experience windbother. A windclimate is considered bad if the majority of people do experience windbother.

For sitting, the windclimate is good when the wind doesn’t exceed 5.0 m/s more than 2.5% of the time, moderate 2.5% - 5.0% and bad for an exceeding of more than 5.0% of the time.

For slow walking, the windclimate is good when the wind doesn’t exceed 5.0 m/s more than 5.0% of the time, moderate 5.0% - 10.0% and bad for an exceeding of more than 10.0% of the time.

For walking, the windclimate is good when the wind doesn’t exceed 5.0 m/s more than 10% of the time, moderate 10% - 20% and bad for an exceeding of more than 20% of the time.

For the review of a windclimate in order to determine if there is a risk for winddanger, we look at the percentage of time the wind exceeds a windspeed of 15.0 m/s, not more than 0.05% of the time. The risk is considered limited if it exceeds 15.0 m/s 0.05 - 0.3% of the time, and high when it exceeds this number for more than 0.3% of the time.
Tabel 1 — Eisen voor de beoordeling van het lokale windklimaat voor windhinder

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<thead>
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<th>Overschrijdingskans</th>
<th>Kwaliteitsklasse</th>
<th>Activiteiten</th>
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<tr>
<td></td>
<td>I: Doenlopen</td>
<td>II: Sjouwen</td>
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<td></td>
<td>III: Langdurig zitten</td>
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<tr>
<td>&lt; 2,5</td>
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<td>Goed</td>
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<td>&gt; 20</td>
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Tabel 2 — Eisen voor de beoordeling van het lokale windklimaat voor windgeraas

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<thead>
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<th>Overschrijdingskans</th>
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NEN 8100:

- Sitting
- Slow walking
- Walking
- Winddanger
Wind is not visual from itself, because air isn’t. Only clouds are visual, but they are in higher layers of the atmosphere and say nothing about the wind in the service layer.

To be able to understand how we experience wind, we can look at the way we review it and order it. If we look at the international beaufort scale on land, we see a variety of senses used to review wind. We see visual aspect, where a medium shows the movement of the wind, like smoke or the movement of dust and papers. Feeling, were the temperature of the wind, and the movement of air are sensible with the face. Hearing, where the winds makes noise by vibrating cables. And the forces of the wind, which forms an obstacle to move against.

Clear is that when we want to visualise the wind, we need a medium to do so. This can be done in a very direct way, with the movement of object of parts of objects. On the location, this is one of the ways we currently experience the wind. The movement of the sand particles, the movement of the marram, and the waves. An other way to visualize the marking of the air, by putting particles in the air, and creating clouds. A third way is a less direct way, and uses the sensors to measure the movement of the winds, and after that visualise. This can for example done with lightning facades.

The same can be said for the hearing of the wind. If we experience the wind, this is because the wind brings a medium (object) in vibration. This vibration can be taken over by the air and create a sound. This way of experiencing wind is also already a part of the wind experience on the location. For example is we stand near to the windmill, the kabels of the boats in the harbor or just the way the wind flows pass your ear. We can also produce this sounds in a less direct way, the same way we can visualise wind.

Feeling and temperature

When we talking about feeling the wind, we are talking about several things; windspeed, air temperature and wind forces. Talking about air forces, we can notice especially by strong winds. Strong winds can blow us from our bycicle, give speed to sailing boats, or be an obstacle to walk.

Looking at temperature we must distinguish outside situations and inside situations. With outside situations the windspeed can play an important role in the way we experience temperature. By strong winds the temperature we experience can be several degrees lower than the actual air temperature. This is because the wind, let our body give more heat to the air, by contacting it to new cold air sooner than normal.
With indoor temperatures, we see this happening with draft situations, at very specific points from or bodies.

Diverse studies, like franger, to how we review temperatures, and if we find a climate comfortable show that a couple of things are determining for the way we judge temperatures. First of all there is our own energy balance determining on what we are doing, we want the space to be hot or cold in order to make our body at the right temperature. When we are sporting we want to be able to give off heat to the air, if we are resting we don’t want to lose heat to the air. Hereby, clothes are a factor, because they can slow down the transition from heat to the air, determine on how well your closing is isolating.

Next to that there is an acceptance difference for different places, a psychological factor. Outside we expecting not optimal and changing temperatures, indoor that is something we do not expect and thereby don’t want. If we are able to influence the situation ourselves, by opening a window, we are willing to except a lot more temperature fluctuations.
Buildings that make wind visual

Design: One Design Inc  
Year: 2011  
Location: Beijing, China

“The Cloud Room designed by Shanghai-based architect Bing Bu sits on the roof terrace of the National Art Museum of China, a historical landmark from the 1960’s in Beijing”...

“The outside white polycarbonate panels follow a computer generated cloud-like profile. Each piece revolves according to the wind, casting moving shadows and reflections onto a second layer of translucent polycarbonate. Standing inside, people can think of this cloud room as an apparatus of urban observation or meditation – the translucent interior screen gives a mix of vague pixel urban image intertwined with wind and sun.”

www.archdaily.com

Design: Ned Kahn  
Year: 2000  
Location: Gateway village, Charlotte, North Carolina

“Kahn, who has developed an international following for his artworks that incorporate the use of natural elements such as wind and light will collaborate with UAP and BAC’s design team to create a 5000 Sq m kinetic façade for the new Domestic Terminal short-term car park”...

“Viewed from the exterior, Kahn’s proven concept for one side of the car park will appear to ripple and move due to the wind passing behind 250,000 aluminium panels. Inside the car park, intricate patterns of light and shadow will be projected onto the walls and floor as sunlight passes through the kinetic façade. In addition to revealing the ever-changing patterns of the wind, the artwork has many environmental benefits by being designed to also provide ventilation and shade for the interior of the car park.”

www.archdaily.com

Design: nArchitects  
Year: 2006  
Location: Lacoste, France

“Windshape was conceived as two eight-meter-high pavilions that dynamically changed with the Provençale wind. A vine-like structural network of white plastic pipes, joined together and stretched apart by aluminum collars, emerged from the limestone walls and terraces of Lacoste’s hillside.”...

“By varying the degree of tension in the string, nARCHITECTS built Windshape to respond to the wind in several ways, from rhythmic oscillations to fast ripples across its surfaces. During heavy winds, Windshape moved dramatically, and made a hissing sound akin to dozens of jumpropes. The pavilions took on a multitude of temporary forms over the course of the summer, as they billowed in and out, and momentarily came to rest. In this way, the local winds and the Mistral gave shape to constantly mutating structures”...

www.archdaily.com
Designing a hotel that uses the wind not only to make it more sustainable, but also to connect it to the context, researching the generic characteristics of wind, the local wind climate, wind experience and influencing the wind is important. In this research we haven't put that research and tried to put design consequences next to it.

Wind is a natural phenomenon and can be described as the movement of air. This movement of air is primarily caused by pressure differences in the atmosphere, which thereby creates wind. These pressure differences arise mainly from temperature differences. When the air is in movement the rotation of the earth and the friction forces of the service start having influence on the wind, and the tree determine the wind direction and speed. The distribution of the windspeed over the service layer is determined by the temperature distribution through this layer, and is shown in wind profiles.

The windclimate in the Netherlands is determined by the location by the sea. The annual and the daily going are determined by this location and show differences throughout the land. For the design location of Scheveningen we see a big influence of the sea windclimate and thereby we have an flattened annual and daily going, and the wind direction is not so dominate.

Windflows are influenced by the roughness of the terrain and landscape, which can make a wind slow down and make it turbulent. The design location of Scheveningen has winds from to very different inflow terrains, the sea and the city. The flow from the sea is laminar, from the city we see a turbulent windflow. The dunes on the location itself, determine the wind, but are also influenced by the wind. This makes it difficult to simplify the situation.

Buildings, obstacles and compositions can influence airflows by forcing it to go around it. Airflows can hereby speed up or become more turbulent, determining on the height, form or composition. The influence fields are determined by the wind direction and are stretched over an area from 15 times the building height.

Natural ventilation is the movement of air in order to cool, and remove unwanted particulates from the air. Wind driven natural ventilation is depending on the wind direction and the form of the building, to form high and low pressure fields around the building. Stack ventilation is depending on temperature differences in the space to form pressure fields. A combination of the two can be positive or negative depending on the wind direction.

Conclusions

Wind experience is mostly viewed by how much the wind bothers us. Norms are stated in order to review a wind climate this way. But is we want design with the more positive experiences of the wind, we can use all our senses. In order to use or view or hearing senses we must use a medium, because the wind itself is invisible and doesn't make much sounds.

Designing a wind driven architecture in the harbor is Scheveningen we can use the general knowledges about windflows, landscapes and buildings to take the first steps in designing an desired wind climate. Using the knowledges about the different types of ventilation we can design first schemes for ventilation, and airstreams through the building. Designing with how we can experience wind in mind makes it possible to design a hotel that connects people more to the context and gives a special user experience.
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