Breezeway Wind Analysis

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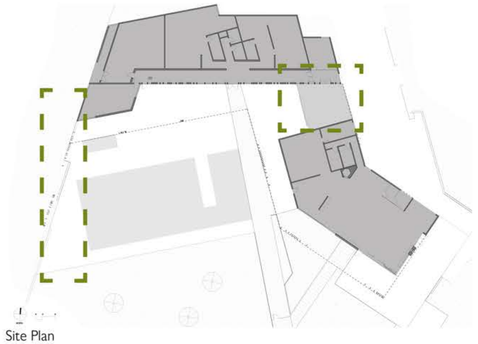
Portland State UNIVERSITY · THA ARCHITECTURE · WALKER|MACY · Black Butte Ranch

Building Perspectives



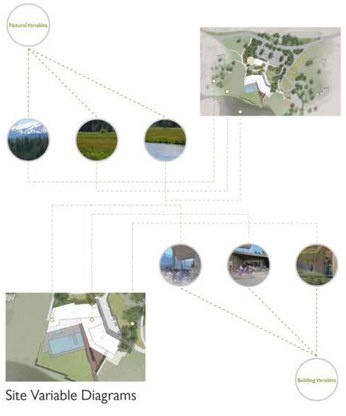
Site Plan

Introduction

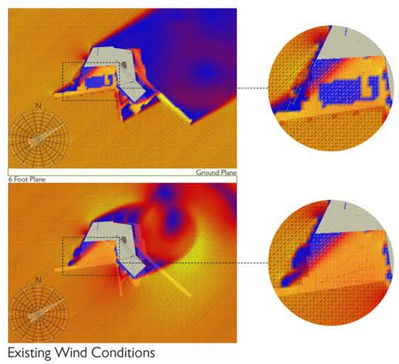
The project is focused on the wind strategies for the Black Butte Ranch site in central Oregon. The foundation is at the edge of a lake in the high desert with the central Oregon mountain ranges to the west. These mountains help to maintain a consistent wind direction for the majority of the year. Wind rose studies have given THA the basic idea of direction, west to east in the winter and slightly southwest to northeast in the summer. The Black Butte Ranch is rebuilding the main pool house along with a restaurant and new pool. The wind has been a main focus of their initial design, as the client preferred one of the original schemes allowing for a breezeway to cool the entire courtyard with the summer winds. The area of concern is the entrance to the pool area and the main entrance to the building in the winter as the wind only slightly shifts angles of flow seasonally. The location allows for a framed view of the mountains and this needs to stay intact. The pitch of the roof is meant to maintain the ranch look and feel of the rest of the complex. This allows for the wind to glide well above it and not create too great of turbulence on the leeward side, along the awnings perimeter. The project is in schematic design still, which allows for any research to be considered and possibly applied. The biggest design challenges will be directing or disrupting the wind in a way that is architecturally appealing, within the budget, and does not obscure views of the mountain range. The areas of focus are the entrance and breezeway, the spa area (directly exposed to the winter wind), and the surrounding pool fence that will serve as the main wind break.

The initial schedule began with the first meeting where we decided that we would follow our previous research, and continue with the use of Vasari and the low speed wind tunnel. Initially the team wanted to know about the speeds in the breezeway and main entrance. After our first few minutes of looking at the plan, we saw the end of the breezeway, which was the main entrance door, wasn't going to work based on what we learned from previous research and experience working with the entrance to the medical facility in a high wind prone area. This research had demonstrated in the wind tunnel how doors and windows become vacuums for the wind creating increased velocity and air pressure at the entrance of the building.

The wind screen fencing consists of angled 4 x 12's that are being used architecturally as well as disturbing the wind. The goal was to find the optimal angle without compromising the entire view of the mountains.

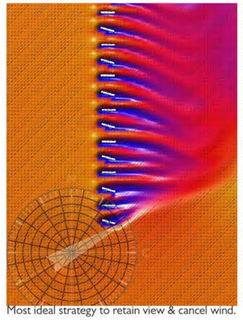


Site Variable Diagrams



Existing Wind Conditions

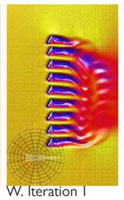
The following images are 4x12 wood plank wind analysis models using Autodesk Vasari. These images describe the wind conditions during the summer and winters months. The summer wind direction points towards the northeast and the winter months point toward the east. The following are a series of eight iterations of the fence line that border the swimming pool, each of which gradually shift angles to disrupt wind-flow through the swimming area, in return altering the wind conditions in the breezeway.



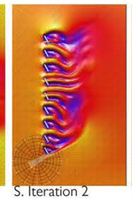
Most ideal strategy to retain view & cancel wind.

Most ideal strategy to cancel wind only.

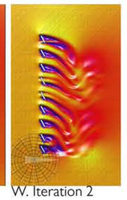
S. Iteration 1



W. Iteration 1



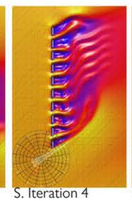
S. Iteration 2



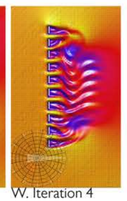
W. Iteration 2

S. Iteration 3

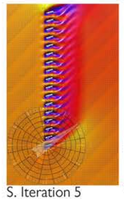
W. Iteration 3



S. Iteration 4

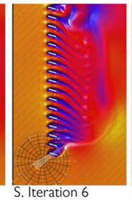


W. Iteration 4

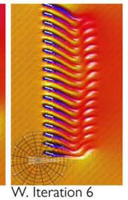


S. Iteration 5

W. Iteration 5



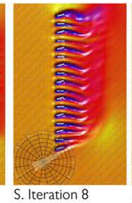
S. Iteration 6



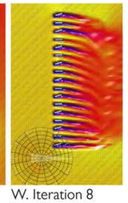
W. Iteration 6

S. Iteration 7

W. Iteration 7



S. Iteration 8

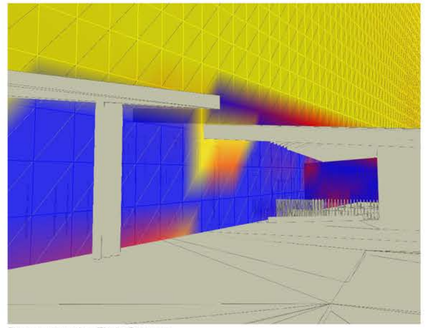


W. Iteration 8

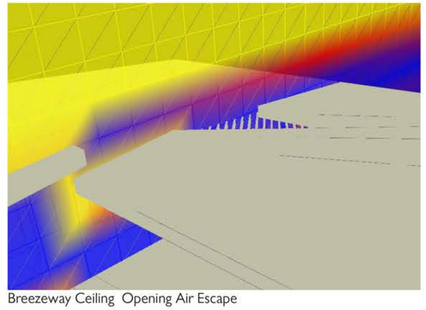
Results

We tested a variety of ways to counteract the influences of the wind on the entrance of the breezeway. One of the options was creating iterations of windscreens. One screen will act as a fence for the pool area (located on the west side of the breezeway) as well as a wind break. The other screen will act as an interface between the pool area and the main entrance of the building. These strategies will most likely be completed with the incorporation of glass partitions. Working with the Revit model in Vasari we found out the effects that the courtyard would experience from a high wind situation which we defined as (6+meters/ second). Original research was showing the wind excelling through the entrance at an uncomfortable rate that would be felt from the users of the pool house. 3.4-5.4 m/sec is the rate at which the wind is beginning to disturb the user. Disturbance would consist of blown hair or enough wind to extend a light flag. This can be tolerated during the summer when the temperature is higher and the occupants are in need of air flow to promote cooling. More importantly airflow needs to be controlled for the cold winters when the wind promotes the uncomfortable environment. The way the wind entered the site was displayed by energy build up at the wind screen and swoop low into the immediate environment on the leeward side. These segments were called out and tested in Vasari to isolate the effect with stronger individual visualizations. A number of iterations were applied and compared. The results showed a variance between the degrees that the boards are set created a disturbance that diffused the wind on the leeward side. The closer the 4 x 12's degree to the breezeway ran perpendicular to the wind, the better they would block the wind. This we considered common sense, so the goal to achieve optimal view

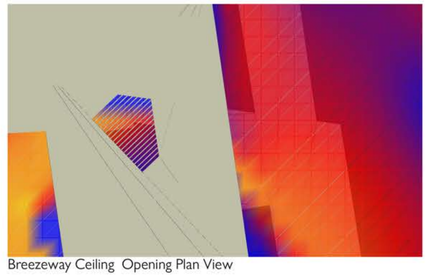
The results have shown that the effect the wind has on the pool area can be diffused through the integration of a concrete protective fencing for the pool codes as well as a wind screen comprised of 4 x 12 wood planks. The angle to which these planks are inlayed has the largest implication on how effective they will be at creating a disturbance in the wind flow, allowing for a habitable space even during a high wind scenario without totally compromising the view and aesthetic appeal of the space. The optimal configuration resulted in the variation of the planks on a sporadic degree shift from the adjacent planks. The closer the two planks parallel each other the greater the wind speed between as a result. With a twist in one of the planks the wind is disturbed enough to create a diffused result on the leeward side. The complete 90 degree twist of a plank to perpendicular was avoided as it prohibited the view. The breezeway included the integration of a four foot high fencing comprised of smaller planks mimicking the exterior fencing. These are able to follow the same rule applied on the exterior fence to help diffuse the wind velocity as it passes through the breezeway and entrance. The incorporation of an opening in the roof of the breezeway has proven to be a positive addition to the design. The opening allows for the wind to be drawn upwards as it enters the breezeway lessening the air pressure felt by the inhabitant. With the main entrance doors needing to be opened out into the breezeway, the incorporation of both the fence with its low wall foundation and the roof opening above the entrance are beneficial in maintaining a habitable space in the breezeway.



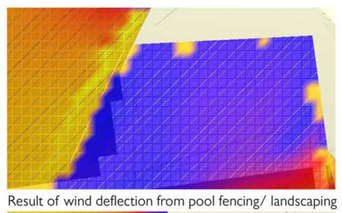
Breezeway Air Flow Pattern



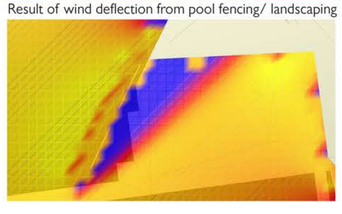
Breezeway Ceiling Opening Air Escape

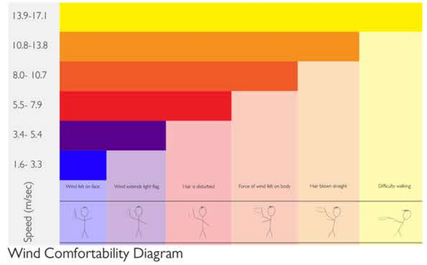


Breezeway Ceiling Opening Plan View



Result of wind deflection from pool fencing/ landscaping





Wind Comfortability Diagram

Development

Parameters: Code · Client · Program · Landscape · Seasons

Variables: Climate · Year · Day · Landscape · Budget

Research

Design Solutions: Wind · Fencing · Landscape

Analysis

Tools: Programs (Revit · Vasari · Rhino · Sketchup) · Case Studies