MASTER THESIS
MASTER-/DIPLOMARBEIT

Ice Lodge
Eis Lodge

Non-Footprint Architecture at the Mount Everest Basecamp
Nachhaltige Architektur am Mount Everest Basecamp

ausgeführt zum Zwecke der Erlangung des akademischen Grades
eines Diplom-Ingenieurs / Diplom-Ingenieurin
unter der Leitung von

Manfred Berthold
Prof Arch DI Dr

E253 - Institut für Architektur und Entwerfen

eingereicht an der Technischen Universität Wien
Fakultät für Architektur und Raumplanung

Teresa Pohl
Matr. Nr. 01527483

A 1040 Wien
Karlsgasse 13/1

Wien, am ____________________
Datum

____
Unterschrift

Kurzfassung

Diese Masterarbeit fokussiert sich auf das Kreieren einer nachhaltigen, funktionalen, non-Footprint Lodge aus Eis und Bambus, am Mount Everest Basecamp. Nach Erhalt des KUWI-Stipendiums der TU Wien, für kurzfristiges wissenschaftliches Arbeiten im Ausland, reiste ich nach Nepal, für 2 Monate, und trekkte zum Basecamp. Die Trekkingtour verschaffte mir Einblicke in die Herausforderung des Logistik- und Abfallmanagements am Mount Everest Basecamp und machte mir klar, dass dieses Projekt einen Blick über den Tellerrand hinaus erfordert. Die Dokumentation der Lodges entlang des Treks und die Durchführung von Interviews mit Lodgenbesitzern, sowie Bergsteigern, trugen dazu bei, die besonderen Anforderungen für dieses Projekt zu ermitteln. Das Hauptziel bestand darin, ein innovatives, non-Footprint Material zu verwenden, um die Umgebung nicht zu beeinträchtigen. Nach der Analyse des Khumbu-Gletschers und des Klimas am Basecamp stand die Entscheidung fest, eine Lodge aus Eis zu bauen. Eis-Experimente und Kräfteberechnungen während der Formfindungsphase zeigten, dass Eis nur sehr wenig Zugkraft aufnehmen kann. Eine Reihe von Kettenmodellen, mit Anwendung der Kettenlinie, bildeten die Basis für die endgültige Form der Eisschalen, die ausschließlich auf Druckkräften beruhen. Hydraulische Drucktests mit verschiedenen Eiszusammensetzungen zeigten die Druckfestigkeit der Eismaterialien. Je mehr Holzfasern und pflanzlichen Bindemittel dem Wasser beigemischt wurden, desto höher war die Druckkraft, die sie aushalten konnten. Das Ergebnis dieser Arbeit ist ein ressourcenschonendes, innovatives Konzept, das die Entwicklung neuer nachhaltiger Materialien anregen soll, welche sich an die Umwelt- und Klimasituationen anpassen.

Abstract

This master thesis focuses on the implementation of a sustainable, functional, non-footprint Lodge, constructed out of ice and bamboo at the Mount Everest Basecamp. After receiving the KUWI-Scholarship, for scientific research abroad, from TU Vienna, I traveled to Nepal, for 2 months, and hiked up to the Basecamp. After experiencing the Trekking Tour and getting an insight into the logistics and waste management challenges at Mount Everest Basecamp, it became clear that this project requires thinking outside the box. Documenting the Lodges alongside the Trek and conducting interviews with Lodge owners and mountaineers helped to distinguish the demands for this proposition. Using an innovative non-footprint material, to not affect the environment, was the main objective. After analyzing Khumbu Glacier and the climate at the Basecamp the decision to construct a Lodge out of Ice was bound. Ice Experiments, and calculations during the form-finding process, showed that the material can only endure a very low amount of tensile force. A series of chain models, using the catenary curve, formed the base for the final ice shells with solely compressive forces. Hydraulic pressure tests on different ice concoctions exhibited the strength of the materials. The more wooden grain and ecological binding agents were mixed into the water, the higher the amount of compressive force it could deal with. The result of this work is a sustainable, innovative concept aiming to inspire developing new ecological materials aligning to its environmental and climatical situation.

„When you are in the mountains, you find out who you really are.“[1]

- Nirmal Purja

Fig. 1: View from Dingboche

TABLE OF CONTENTS

1. INTRODUCTION

1. Introduction

Mountain. There is no mountain more famous than Mount Everest. It is the highest mountain on earth, with 8848m, and also known as the roof of the world. The Basecamp, situated at 5364m, is a destination for Trekkers, as well as the starting point for mountaineers who want to climb the summit. Building at these heights brings some challenges, such as extreme climate, high demands on sustainability, lack of infrastructure, logistics, and building materials.

Ice. In addition to the constant shrinking of resources, the enormous soil sealing and construction of areas is creating a serious problem. New sustainable building materials that do not burden the building ground must be developed and used. The application of ecological materials such as bamboo, which have been used for centuries, also represent a solution. Temporary sustainable constructions, as is possible with ice, could be an approach to preserve our planet.

Non-Footprint. In times of climate change and constantly intensifying globalization, building sustainable accommodations for mountaineers and Trekkers, all over the World, is of particular importance. It is our responsibility to keep the nature and mountains as unaffected as possible, to preserve it for next generations. This project is picking up the idea of Non-Footprint Architecture, not affecting its environmanet and nature.

Fig. 2: Himalaya at 5000m

2. SITUATION ANALYSIS

Fig. 3: Map of Asia

2.1 Everest Basecamp Trek

The Mount Everest Basecamp Trek is located in the Himalaya region, with its peak at the Mount Everest Basecamp at 5364m, and the viewpoint Kalapathar at 5545m. The Trek conquers circa 2600m altitude difference, throughout its 130km length, and takes around 12 days. The best time and main seasons to do the Trek are March-May and September-November. My Trekking Tour started on the 28th of April at 6 am, with a flight from Kathmandu (1400m) to Lukla (2860m). After meeting with Sujan, my Porter, our group, and a rich breakfast, the 4h hike to Phakding (2640m) began. The hiking trail, through the Dudhkosi-Valley, led us past colorful prayer wheels and numerous suspension bridges. We spent our first night in Phakding and started the morning with a cup of masala tea. Reaching Namche Bazar (3440m) the next day, took around 6h, while passing the tourist checkpoint to enter the Sagarmatha National Park. Due to the acclimatization process, we stayed two nights in Namche Bazar. We used the 2nd day to hike up to the Sherpa Museum and learn about the National Park and the Sherpa culture. On the 4th day, a 6h hike led us to Phortse (3680m), where we spend one night. Continuing the next day with a 7h hike, we arrived at Dingboche (4260m) and spent two nights for acclimatization. During the 2nd day in Dingboche, we hiked up to 5000m and enjoyed the breathtaking view. On our last night, before reaching the Basecamp, we stayed in Lobuche (4930m) after hiking for 5h. The following day was the most exhausting and longest one of the Trek. We hiked 3h to Gorakshep (5140m), had a lunch break, and then continued another 3h to the Basecamp (5364m). The trail offers a beautiful view of Mount Everest and Mount Nuptse. The Basecamp was packed with tents from excited mountaineers, ready for pushing to the summit. I had the chance to interview some of them and exchange ideas for a Lodge at the site. After taking a look at the famous Khumbu-Icefalls we hiked back to Lobuche, for 5h. During the night in Lobuche we could process all the new impressions from the Basecamp. The next morning we headed to Pheriche (4243m) and reached it in 4h. On day 9 the hike from Pheriche back to Namche Bazar took us 6h. The last stage, hiking from Namche Bazar back to Lukla, had a duration of 8h. At 10 am the next morning, on the 9th of May, I left Lukla and flew back to Kathmandu. In total, the Trekking Tour took 11 days with an average of 6h hiking per day and countless amazing new experiences.

Mount Everest Basecamp Trek Route Map

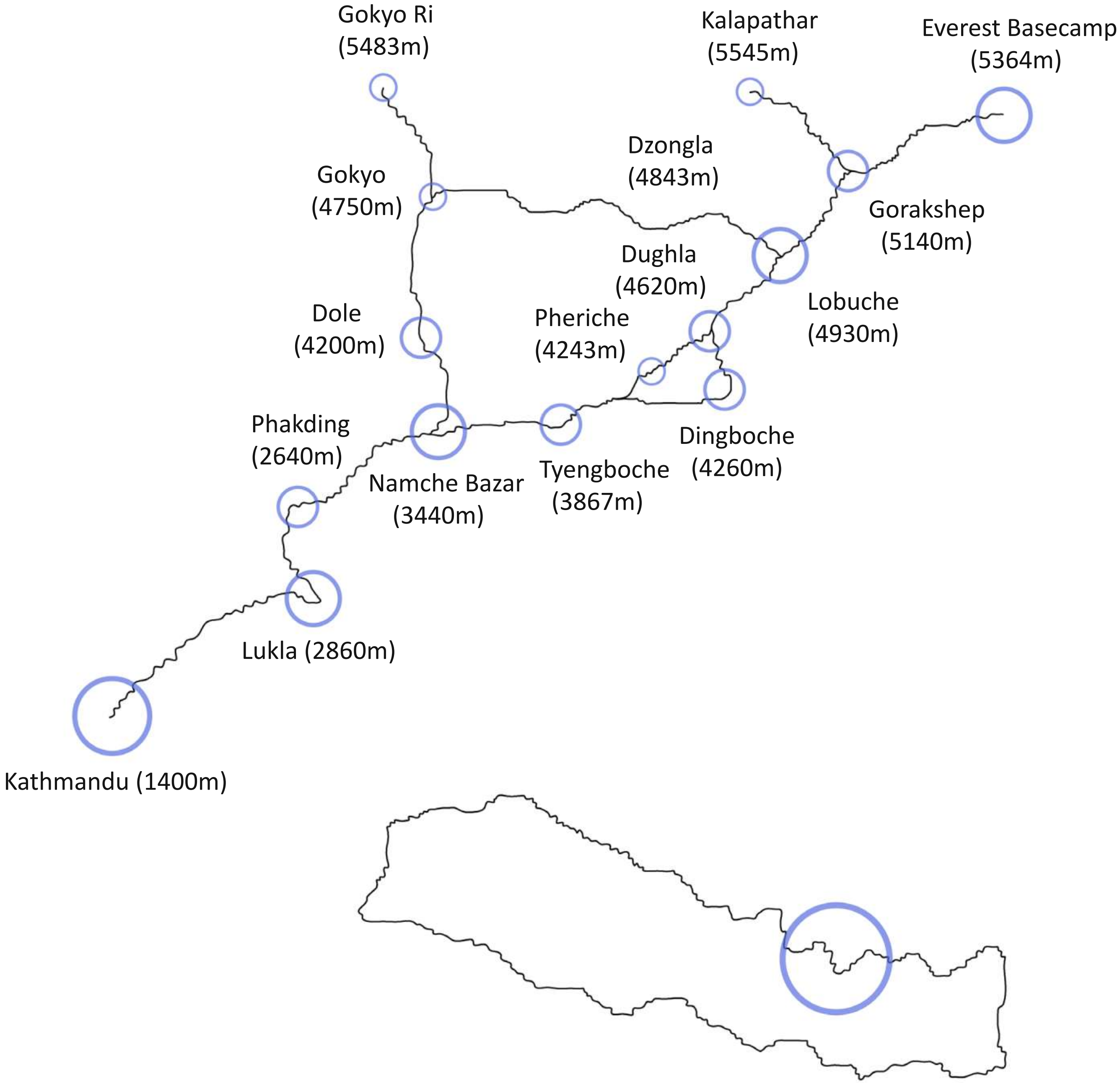


Fig. 4: Mount Everest Basecamp Trek Route Map

Lukla 2860m

Lukla is located at 2860m above sea level and is the start for Trekkers to Mount Everest Basecamp. Most of the Trekkers are flying from the Domestic Airport in Kathmandu to the Tenzing-Hillary Airport in Lukla. It is known as one of the most dangerous Airports in the world. The airstrip, for starting and landing, is only 530m long, build on a slope, and ends at a canyon while pointing to a tall mountain.[2] In May 1953 Tenzing Norgay Sherpa and Edmund Hillary accomplished the first ascent to Mount Everest.[3] In 1964 the airstrip was built by local Sherpas with the supervision of Edmund Hillary.[4] In 2001 the gravel airstrip got asphalted and an airport tower was built.[7] Lukla offers numerous Lodges, as well as shops with hiking and mountaineering gear. Some Locals are waiting for Arrivals in front of the airport and offer their service as Porters.

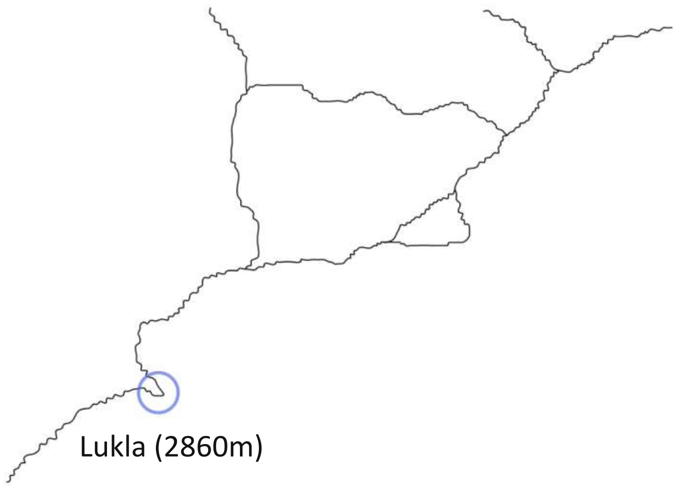


Fig. 5: Route Map Lukla

Fig. 6: Boarding for the flight with Tara Air

Fig. 7: Tenzing-Hillary Airport

Fig. 8: Airplanes at Tenzing-Hillary Airport

Fig. 9: Lukla

Phakding 2640m

Phakding is one of the first stops along the Trek after Lukla. The small village offers plenty of lodges. At this relatively low altitude, the lodges provide luxurious rooms and infrastructure, like sufficient hot water, wifi, and phone charging stations. The building structure is more massive, and windows and doors are more dense than at lodges at higher altitudes. Construction workers handbuild everything without the aid of machines, diggers, or cranes. They adjust stones and wooden pieces step by step and create handcrafted constructions.

Fig. 10: Route Map Phakding

Fig. 11: Hotel Sherpa in Phakding

Fig. 12: Construction Site Phakding

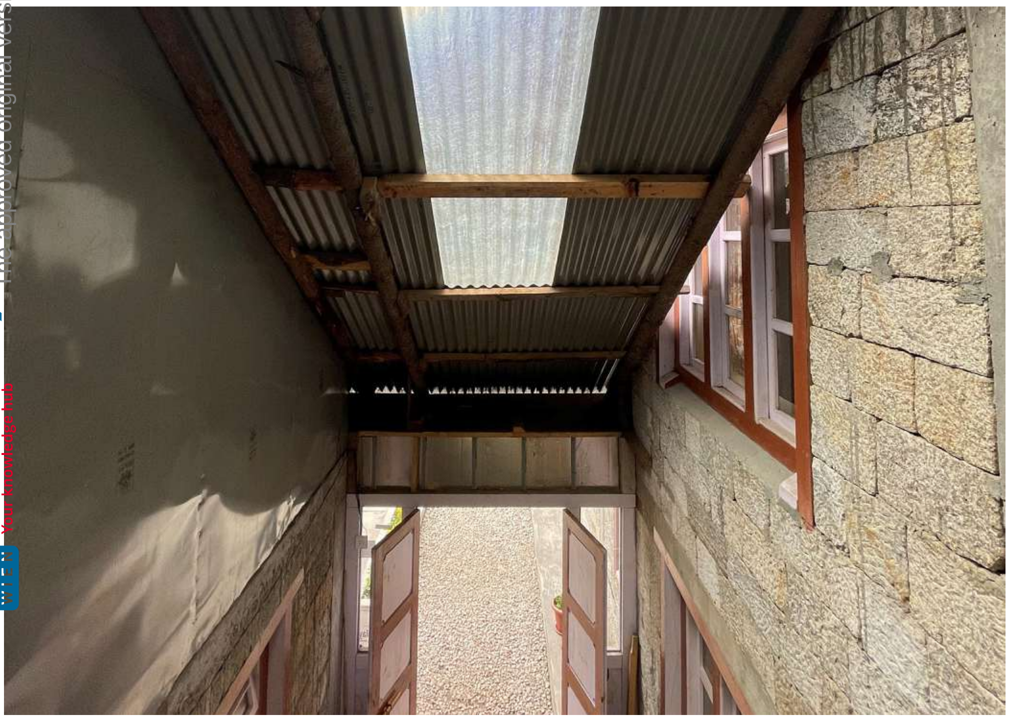


Fig. 13: Roof construction

Fig. 14: Room in Hotel Sherpa

Fig. 15: Construction of a ground floor

Fig. 16: Construction site near Phakding

Fig. 17: Rack for building the ceiling

Fig. 18: Construction worker

Namche Bazar 3440m

Namche Bazar is the principal town within the Khumbu region, located in a caldera with a terraced urban structure. The settlement is full of life and home to numerous shops and lodges. The town also offers a school, monastery, government body, hospital, sherpa museum, a helipad, some restaurants, cafes, and bars. Namche got famous with the highest bakery and tattoo studio in the world.

Fig. 19: Route Map Namche Bazar


Fig. 20: View to Namche Bazar


Fig. 21: Kitchen in the Lodge

Fig. 22: Wooden waste containers

Fig. 23: Central oven in the dining room

Fig. 24: Figure Ground Plan Namche Bazar

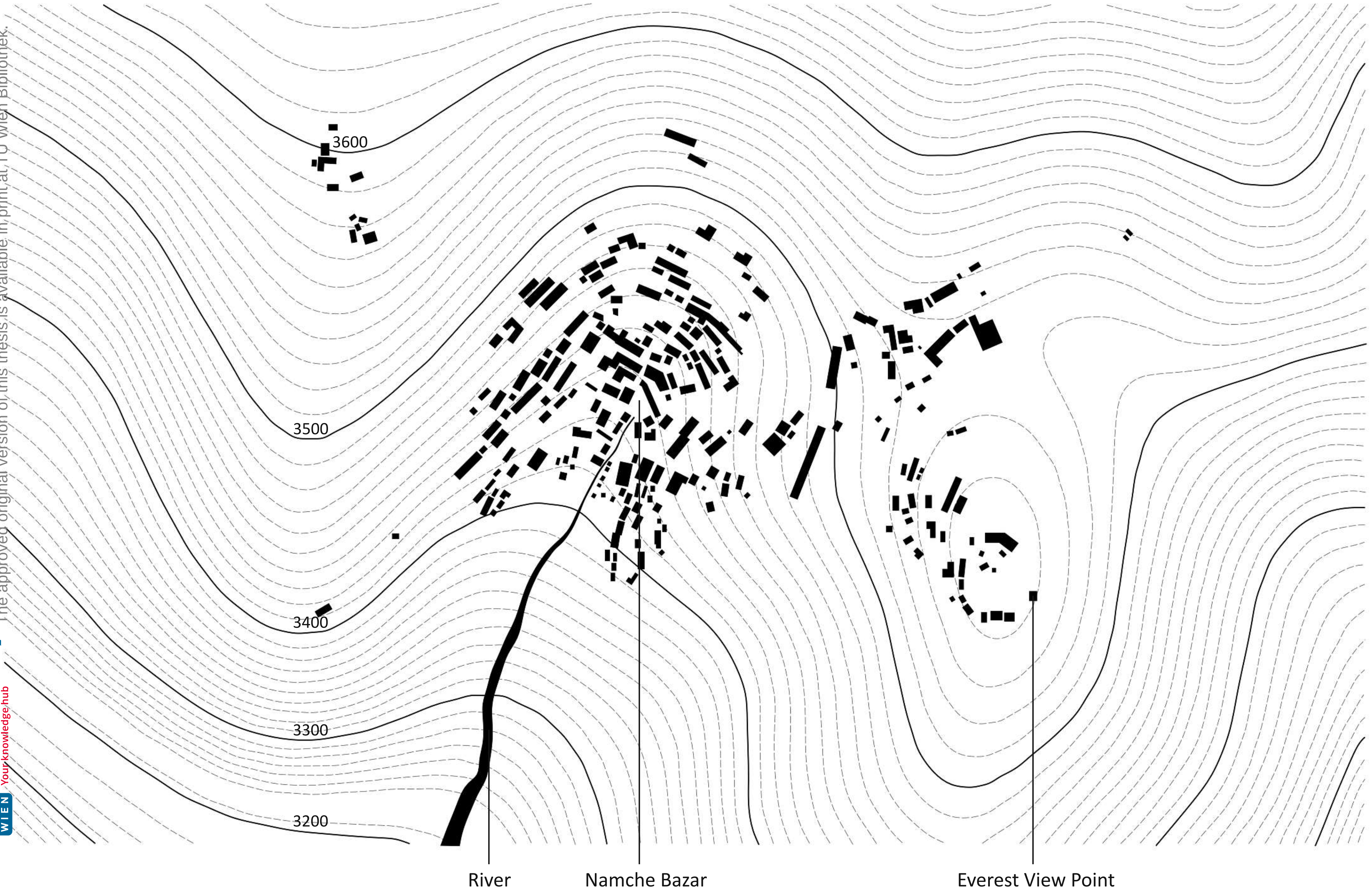
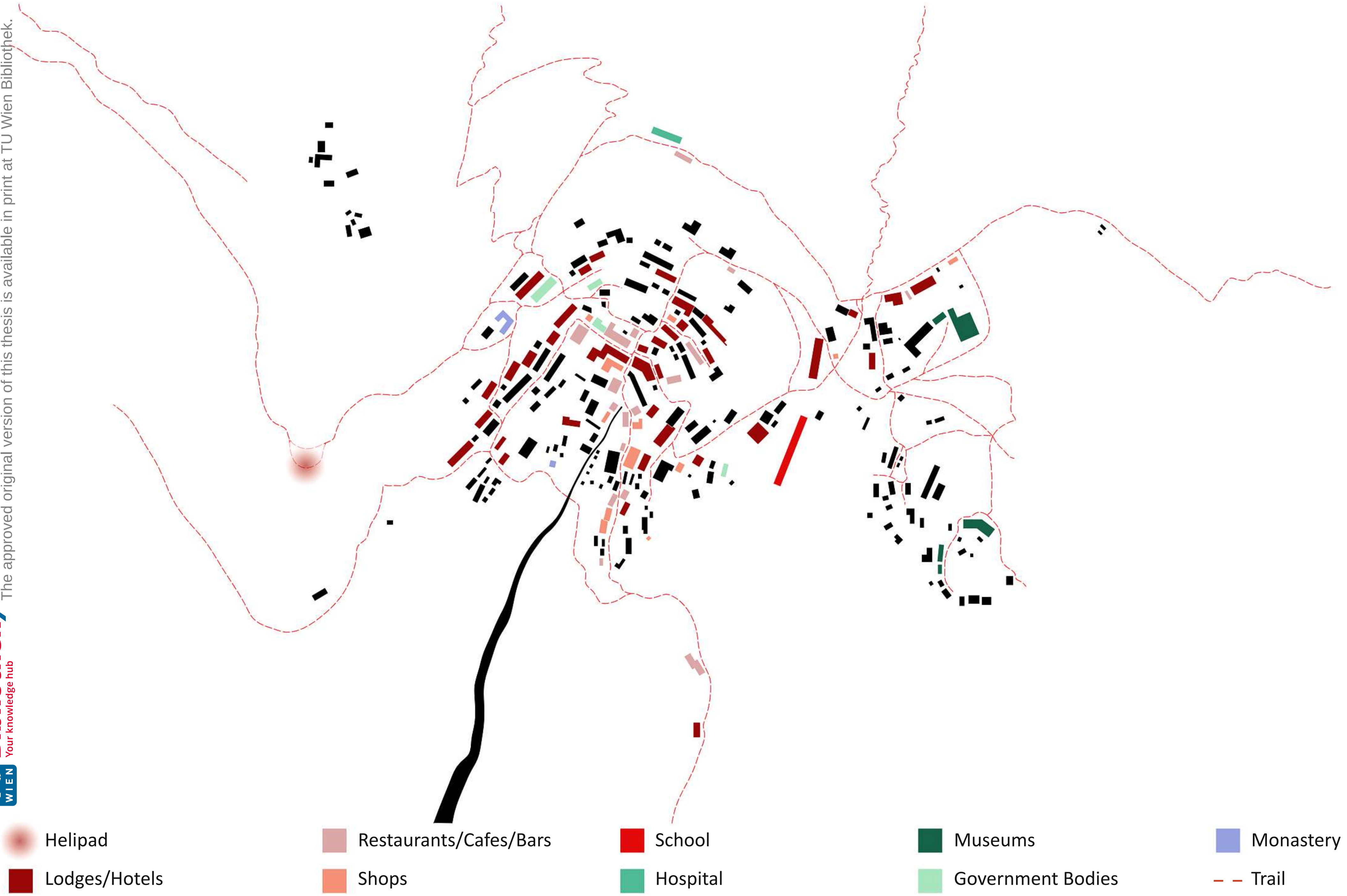


Fig. 25: Site Plan Nache Bazar



Dingboche 4260m

Dingboche is one of the bigger villages along the Trek. Climbers on their way to Mount Everest Basecamp or Island Peak usually stay more than one night to acclimatize. Dingboche even offers a little coffee shop with books and a beamer for showing movies. A memorial remembering all climbers who lost their lives on Everest got assembled between Dingboche and Lobuche.

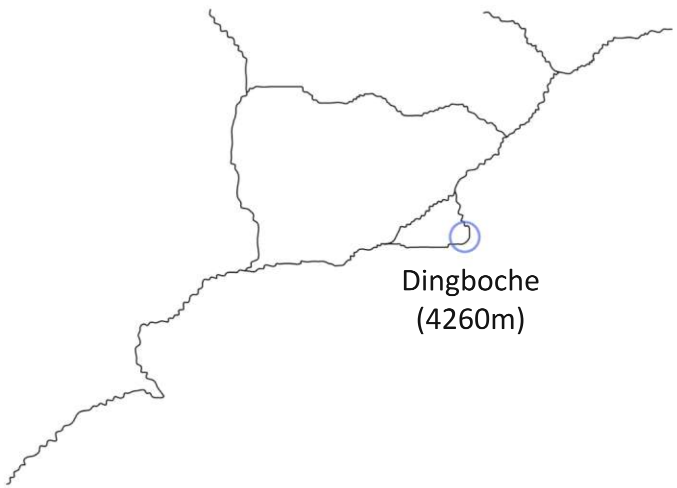


Fig. 26: Route Map Dingboch

Fig. 27: View to Dingboche

Fig. 28: Roof construction

Fig. 29: Water tank

Fig. 30: Dining room

Lobuche 4930m

Lobuche is one of the last locations before walking on the Basecamp, therefore it gets crowded especially during the main seasons. Due to the increase of tourists throughout the last decade, Lobuche grew rapidly. From there climbers can also reach the Lobuche peak of over 6000m.

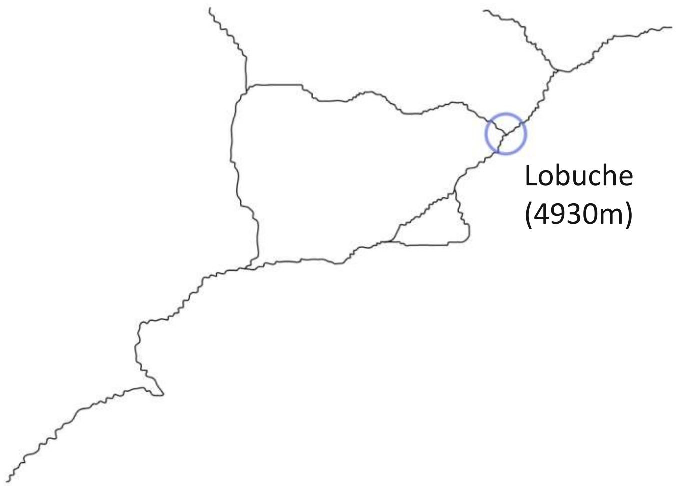


Fig. 31: Route Map Lobuche


Fig. 32: Lodge Lobuche


Fig. 33: Infrastructure Lobuche


Fig. 34: Toilet box

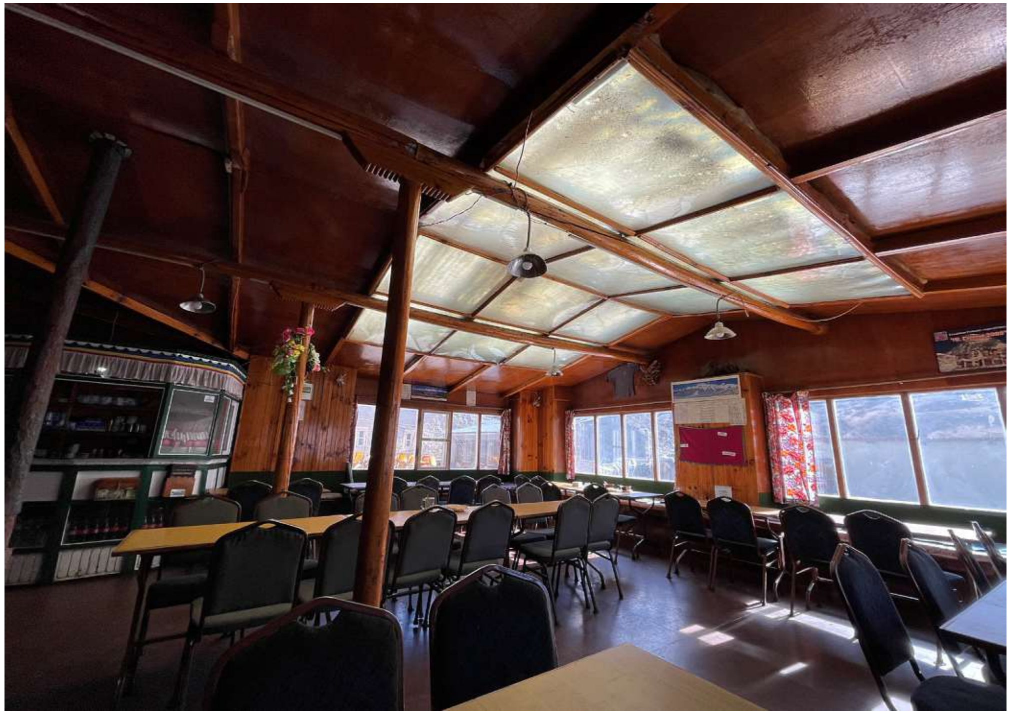


Fig. 35: Dining room

Gorakshep 5140m

Gorakshep is the last small town before reaching Basecamp. Settlements at such extreme altitudes have to manage some challenges. Every single item has to be carried or flown up to the location. Especially waste and recycling are difficult to manage. Numerous gas bottles get stocked outside along the terrain, waiting to get carried down the valley. Building services are kept simple, like squat toilets with no flush, with power outages at times.

Fig. 36: Route Map Gorakshep


Fig. 37: Infrastructure Gorakshep


Fig. 38: Kitchen


Fig. 39: Storage of gas bottles


Fig. 40: Squat toilet

Everest Basecamp 5364m

During the main seasons, Everest Basecamp gets packed with tents and camps. Climbers with the intention of reaching the Everest summit will stay several weeks at the Basecamp, acclimatizing to the altitude. The Khumbu Glacier, and especially the Ice-Fall leading to Camp I, is constantly in motion, moving and shifting. The so-called ‚Ice-Fall Doctors', mostly Sherpas with incredible climbing skills, set up ladders and ropes, so the climb to the peak can be conquered.

Fig. 41: Route Map Everest Basecamp


Fig. 42: Khumbu Glacier


Fig. 43: View to Everest Basecamp


Fig. 44: Photo stone


Fig. 45: Campsite

2.2 Sherpa Community

The Sherpas are well known to most people because of climbing literature. But instead of highlighting the Sherpas' extensive cultural heritage, their legendary reputation focuses on a single vocation. A few families departed eastern Tibet and settled as the Sherpas in the Himalayan mountains about 400 years ago. Their name, „Sher-pa," which means „east-people," reflects their origins. This small group of families brought with them the rich traditions, ideas, and literature of Tibetan Buddhism. Some examples of flat landforms where the Sherpas built their dwellings and engaged in agriculture are the old hanging plateau of Phortse, the ice-carved valleys of Khunde and Khumjung, and the bowl-shaped formation where Namche is situated. Although the vast majority of Sherpas live in one of the major towns of Khumjung, Khunde, Thamechok, Namche, Pangboche, or Phortse, they frequently spend time in huts in the high meadows during certain seasons. The Sherpas can only raise one crop from their fields of strewn rocks here each year due to the tough climate. To survive in this harsh environment, the Sherpas continuously engage in alternate livelihoods, such as trading over the Himalayas to the north or moving to find work. Since their beginnings as severe altitude porters on British attempts to conquer the main peaks of Sikkim in 1907, Sherpas have taken part in every notable Himalavan climbing trip. Mountaineers are still impressed by the Sherpas' friendliness, fidelity, and trustworthiness. Communities need to work together to survive in these mountain towns. The gathering of wood for heating and leaf litter, the moving of the yak herds, the celebration of cultural ceremonies, and other activities were all historically governed by community norms and standards. To oversee agricultural and grazing, forest usage, and cultural life, these posts are still chosen among community members. Scrolls with prayers written on them are magnified at every rotation of the water or hand wheel on prayer flags atop tin roofs. The Tengboche Reincarnate Lama gives the following explanation of the Sherpa way of life: „Our religion is meant to develop our thoughts. Religion is highly essential in our society because it safeguards our character. Our Buddhist practices seek to create spiritual energy for the good of all living things."[8]

Fig. 46: Women in Namche Bazar


Rs.10

2.3 Conservation of the Khumbu Valley

In the forest, the slope and height produce various ecological zones. The climate, humidity, and moisture vary from lower to higher elevations, leading the Himalaya to rise sharply and produce zones at the base of the mountains with distinctive plants and animals at different altitudes. Due to the normal temperatures, levels of precipitation and moisture, and duration of the growth season, these zones contain varied woods or vegetation at various elevations. Sagarmatha National Park was founded in 1975 to protect Mount Sagarmatha and the Khumbu Valley, two distinctive and internationally significant cultural and environmental features of the area. From the valley floor at 2500m to the snowy tops of the majority of the world‘s highest mountains at over 8500m, the park preserves high mountain habitats and wildlife. This exhibit aims to honor the depth and adaptability of the local Sherpa people‘s culture and the stunning Khumbu region in which they have resided for more than 400 years. Changes, both good and bad, are explained using a combination of research, rey eat photography, local mythology, and anecdotes about Mount Everest. The Khumbu Valley was special and unique to the earliest Sherpas since it was designated as a „beyul“ by Guru Rinpoche, the father of Buddhism, as a place to seek refuge in times of difficulty.[9]

Fig. 47: Hiking through Khumbu Valley

Sagarmatha National Park conservation efforts have aided in maintaining the trees, even though there are still numerous difficulties. Since Sagarmatha National Park was established, a wide range of organizations have supported conservation efforts in Khumbu. These include the Sagarmatha Pollution Control Project, the Himalayan Trust, the World Wildlife Fund, and the Ministry of Nepal Department of National Parks and Wildlife Conservation (DNPWC). The national park's and conservation activities' successes include preservation of the forest's current resources planting seeds and fostering fresh forest development Locals' appreciation of SP's advantages in terms of forest conservation preservation of the environment and that no glass bottles allowed in the park control over lodge construction on public property. The following issues need to be resolved in the upcoming years:

- Creating a management strategy that takes into account the demands of the community and the commercial sector.
- Including a variety of economic and social factors in the duties of park management.
- Developing a council for assembling scientific and cultural data as a starting point for monitoring park resources.
- Managing the number of hikers and mountaineers in collaboration with the Department of Tourism and the Civil Aviation Authority.[10]

Fig. 48: Cairn

2.4 User Profile

The variety of Lodge users alongside the Mount Everest Basecamp Trek includes local Nepali living in the Khumbu Valley, professional mountaineers climbing to the summit, trekkers completing the Basecamp Trek, hikers walking parts of the Basecamp Trek, tourists coming by helicopters for a sightseeing flight and scientists researching the Nationalpark and Glacier.

Fig. 49: Illustration User Profile

2.5 Interview

16.06.2022

The conversation with Ang was not recorded and therefore analogously reconstructed.

Teresa:
What do you think are the main problems in Lodges?

Ang:
Lodges usually have heating problems and rely on solar energy. In general, they depend a lot on the climate and the different seasons. Also, often there's no electricity due to heavy snowfall or storms.

Teresa:
How could the social aspect of Lodges and the Mount Everest Basecamp get improved?

Ang:
The porters can't effort the tourist prices, they have to save money. For them, climbing to the Basecamp is work and not a holiday. Maybe a universal Lodge could lead to more social equality and connect people.

Teresa:
Do you think there's a need for making the Lodges more luxurious?

Ang:
Locals, as well as tourists, want to keep it traditional, to live and experience authenticity. The demand at the Basecamp is high and it's very crowded during the peak seasons. So there's a limited possibility and not too much request for luxury.

Teresa:
What are your thoughts about a Lodge at the Basecamp?

Ang:
The Government won't permit building a permanent Lodge at the Basecamp. The moving Khumbu Glacier makes it hard to construct something permanent. A seasonal temporary structure could be suitable.

Teresa:
How do professional mountaineers, who are summiting Everest, use Lodges?

Ang:
In general, Climbers, Porters and Locals are using the Lodges. Climbers, who want to summit Everest, are flying directly to the Basecamp, stay there for 2-3 weeks, and then climb to the peak.

Teresa:
How do you think Lodges could be more sustainable?

Ang:
Instead of gas and kerosene, we should use eco-friendly electricity. Using more sustainable materials could be an approach. Also, very important is waste management. Together with the Nepali Government, we have this project called ‚Mountain Cleaning' where we collected 33 tons of trash from the mountains. I think after enhancing the logistics, also waste management will be improved.

Teresa:
Do you think the climbing permit for Everest should be higher/lower?

Ang:
The climbing permit for Everest costs 11000$. Right now the Government is thinking about changing it to 15000$. The permit for the other 8000m mountains is only 1800$. In my opinion, the current permit amount is reasonable. Decreasing it would be a bad solution, it's better to limit the number of climbers per season.

Teresa:
How do you think the Trekking Industry at the Mount Everest Basecamp will develop in the future?

Ang:
The number of climbers is increasing every year, as well as the demand for Porters, Lodges, etc. A higher number of tourists is good for Nepal because Tourism is the main income here. That way, we can invest in new roads, Lodges, and Sustainability.

Fig. 50: Ang Babu Sherpa

Ang Babu Sherpa
Managing Director
Climber

Ang is the Managing Director at Peak Promotion, a company focusing on Trekking, Mountaineering, Filming, and Tour Organizing, located in Kathmandu. Every year he spends around 2 months at the Mount Everest Basecamp to handle numerous expeditions. Ang summited Ama Dablam Mountain, 6814m in height.

2.6 Khumbu Glacier

The Khumbu Glacier is situated between Mount Everest and the Lhotse-Nuptse range in the Khumbu area of northeastern Nepal. It is the tallest glacier in the world, rising from an end elevation of 4900m to its starting elevation of 7600m.[11] The Khumbu Icefall may suddenly turn into a lethal trap for climbers. For instance, when one of the enormous ice towers, falls, or when new crevasses appear or old ones abruptly alter. Avalanches also pose a concern from Everest's west flank and down the sides of Mount Nuptse. 16 Nepalese climbers died in an ice avalanche on the Khumbu Icefall in April 2014. The Khumbu Glacier is continually moving, descending 600 meters towards the base camp, on average one meter every day, with an irregular flow.[12]

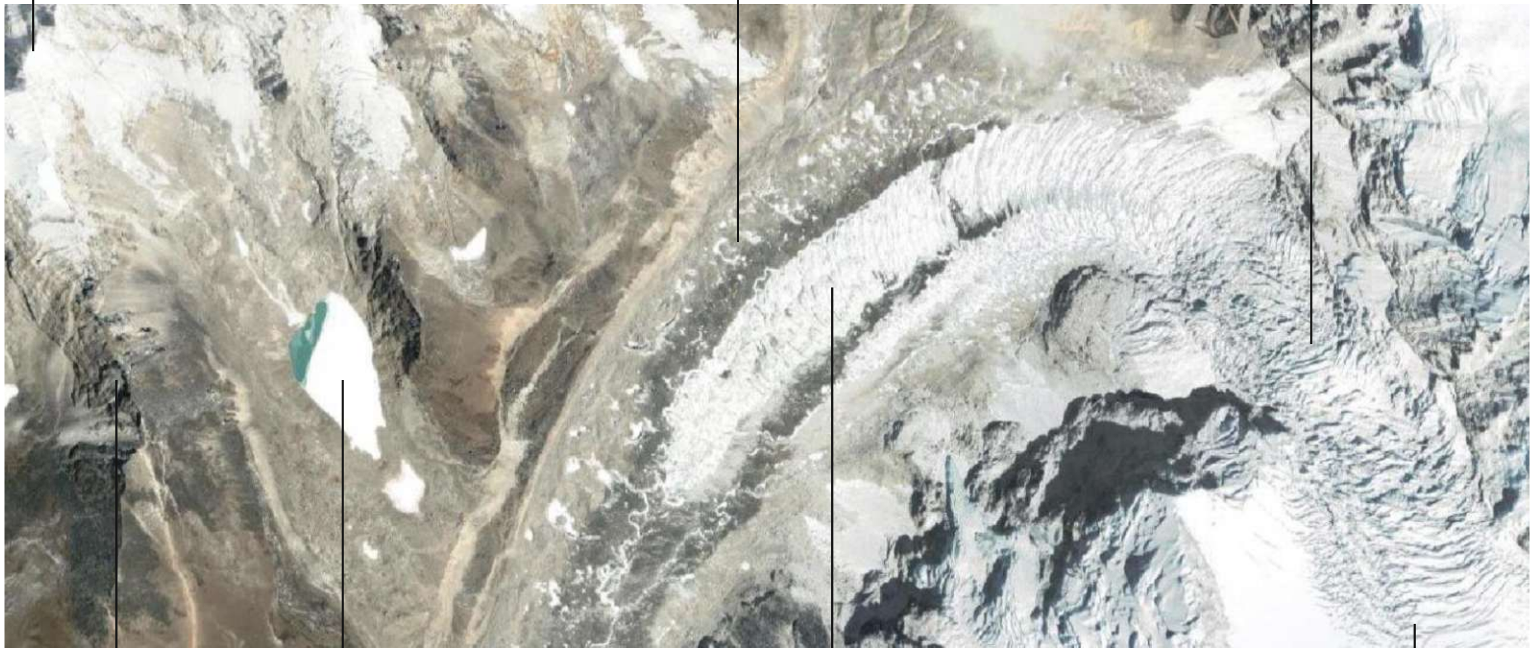


Fig. 51: Satellite Picture Khumbu Glacier

2.7 Climate at the Mount Everest Basecamp

Because the Himalayas prevent cold air from traveling south from central Asia, Nepal has milder tropical weather. The monsoon brings the majority of the yearly precipitation to the Himalayas. Condensation clouds, however, cool and move upward all year round. High-altitude regions have dryer atmospheric conditions because cold air will have less moisture in it. Fewer inches of rainfall in the high mountains because the icy air does not hold much moisture.[13] Throughout the night, the temperatures at the Basecamp are below zero, except during the months June-September. Also, throughout the days measurements show temperatures below the freezing point, excluding the summer months. The precipitation is peaking in the monsoon months June-September. Meanwhile, the wind speed is at a low during these months.[14]

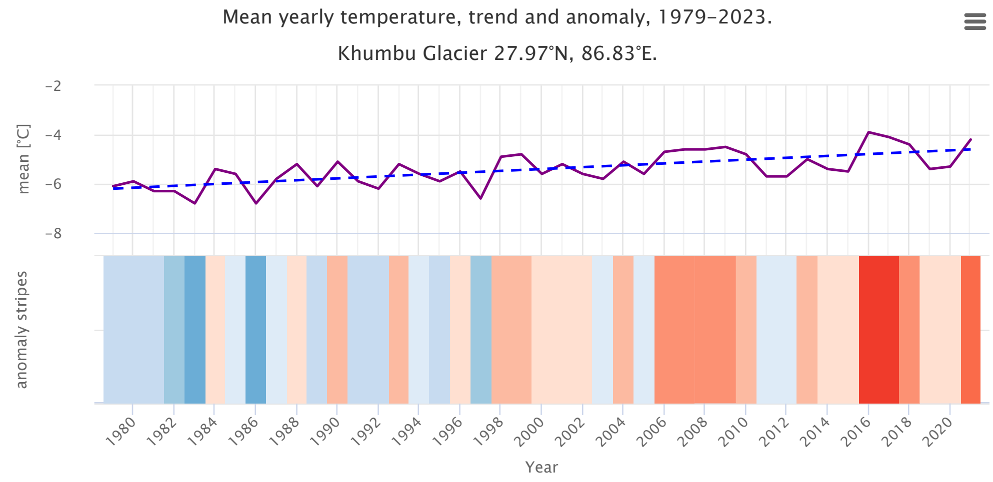


Fig. 52: Mean yearly temperature

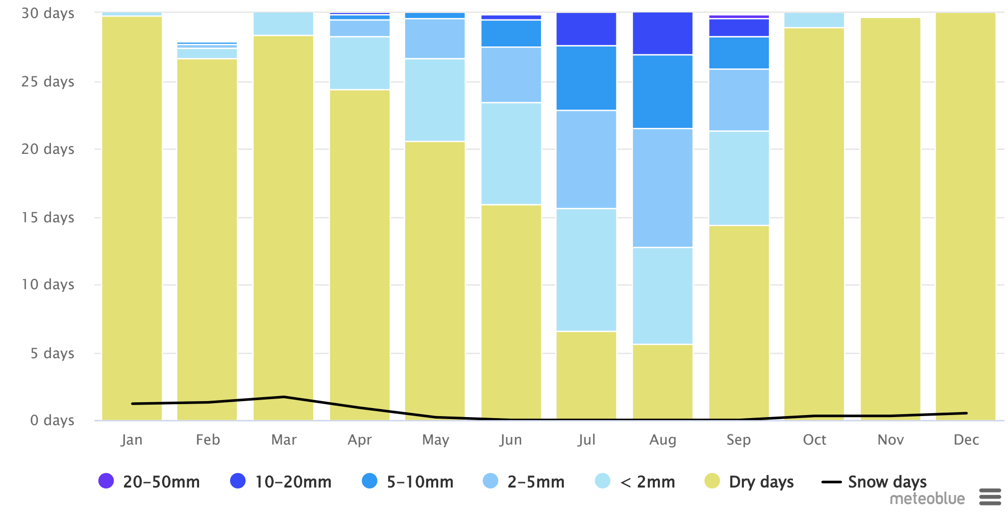


Fig. 55: Precipitation and snow days

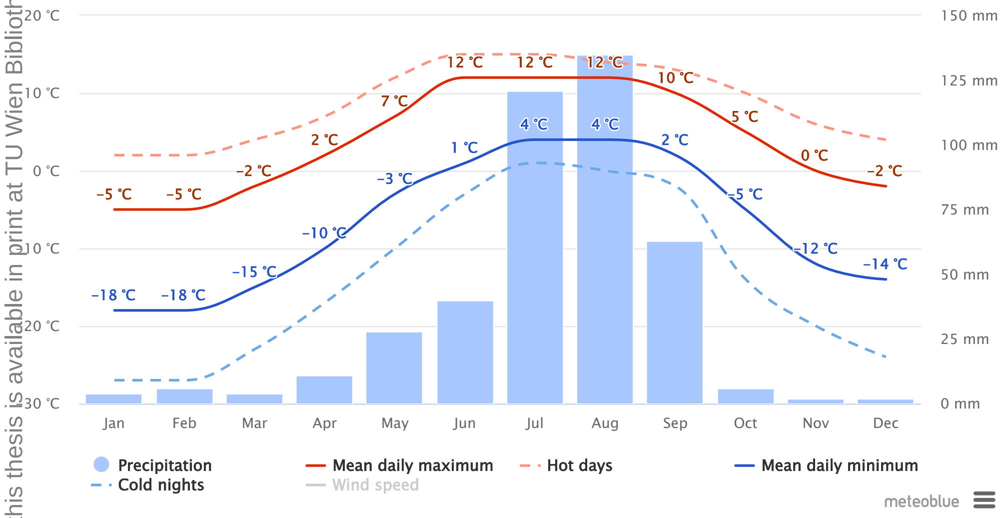


Fig. 53: Temperatures and Precipitation

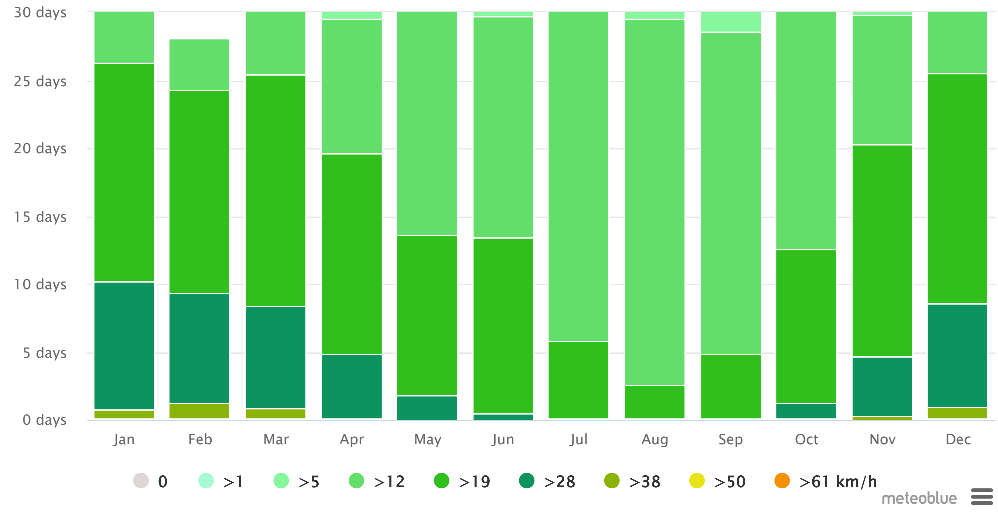
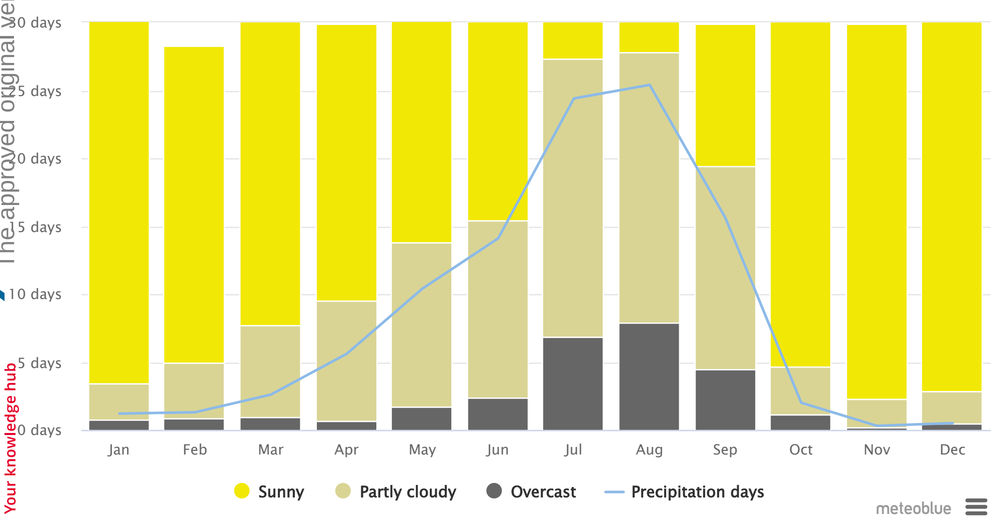


Fig. 54: Wind Speed



56: Sunny, cloudy and precipitation days

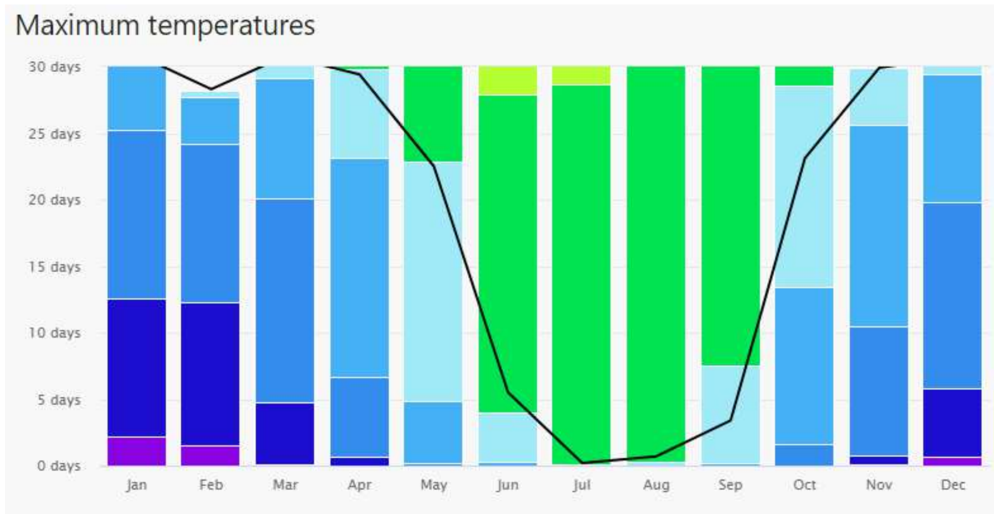


Fig. 57: Maximum temperatures

2.8 Ice Architecture

The earliest edifice composed of ice or snow material was the „Igloo“ created by the Inuit people in the Arctic areas, which has a lengthy history. Today, a great deal of ice architecture studies are focused on three areas: improved ice shell structure, altered materials, and novel construction techniques. Harbin Ice and Snow World is one of the prime examples of contemporary Chinese ice shell architecture. Faculty members and pupils from the Architectural Research Facility at the School of Architecture, Harbin Institute of Technology, developed and oversaw the project. The outside of the ice restaurant is composed of several, uniformly sized ice arches that are tightly connected in a radial design.[15] Students from the Netherlands, Belgium, and China constructed the highest ice tower ever using fiber-reinforced ice to demonstrate what an excellent construction resource snow and ice can serve as. From 21 to 30 meters, they beat their record. The cellulose is combined with the ice to strengthen the structure. Because it is sturdy despite thicknesses of just 3-5 centimeters, composite siding is a dependable building material. The structure consists of a vertical tube that is 30 meters tall and has 6 openings. The audience must ascend one of the six translucent solid ice block staircases to reach the tower‘s interior.[16] The very first 3D printed grid-shell made of ice with fiber reinforcement was produced by academics at the Technical University of Eindhoven. The majority of the print was done by hand using tools resembling piping bags. As a temporary support, the mixture was positioned on a net-like framework that was stretched over a balloon.[17]

Fig. 58: Harbin Ice and Snow World

Fig. 59: Harbin Ice and Snow World Interior

2.9 Igloo

An igloo is a makeshift hunting lodge used by Canadian and Greenland Inuit (Eskimos) during the winter months.[18] The hard Arctic climate has long since adapted to the Inuit. Due to their mostly carnivorous diets, Inuit hunters traveled from their villages to the noticeably cooler areas near sea ice where they could kill seals. The hunters could stay in their igloos for a whole winter or for just for several days at a time. The Inuit almost exclusively utilize igloos as hunting sites. Even though most of Inuit now live in conventional housing, igloos are still occasionally used on hunting expeditions.[19]

Igloos generally had a diameter of 3.5 to 4.5 m and a height of 3 to 3.5 m. Larger igloos may hold up to 20 people. Hunters would occasionally build smaller igloos, roughly 1.5 m high and 2 m in diameter, to help keep them warm at nighttime or during m high and 2 m in diameter, to help keep them warm at nighttime or during a storm. Styles of the igloos utilized by Inuit tribes differed. Some individuals lined the inside of the igloo with animal skins. When igloos were constructed in groups, the living quarters may have shared an entrance tunnel or another common facility, such as a dining room or a dance hall.[20]

Air that is warm climbs to the top of the igloo whereas cold air falls at the bottom because of their different densities. For this, the igloo ground is divided into terraces. A frigid sink is located on the lowest sunken level, while people sleep on the warm top layer and utilize the middle layer for cooking and fires. The insulated snow walls shield people from the chilly wind outside and prevent them from losing body heat. As a consequence, an igloo regulates the temperature of its surroundings using the body's heat that evaporates from our bodies.[21] When it comes to how to build an igloo, It is rather amazing to learn that all you need to make an igloo is plenty of snow, some time, and a few simple tools. It's due to the igloo was designed to be cozy, strong, and straightforward to construct. Igloo builders use tools such as blades crafted from metals or whale bone to cut out large snow slabs. These stones form the inwardly sloping walls of the igloo. From within the impending snow house, the spiral-shaped igloo is being constructed around this spot. The doors are made of snow blocks that hide the entranceway. Windows for the igloo can be made out of clear lake ice or a translucent part of seal gut skin. The top and entrance of the igloo are left open during construction to let heat escape. When the construction is built and the snow has fallen, the contractors plug in any holes for keeping the interior warm. The cozy atmosphere inside and the freezing Arctic air outdoors, which freezes any melting pieces, reinforce the igloo's structure even more.[22]

Fig. 60: Inuit October 1909

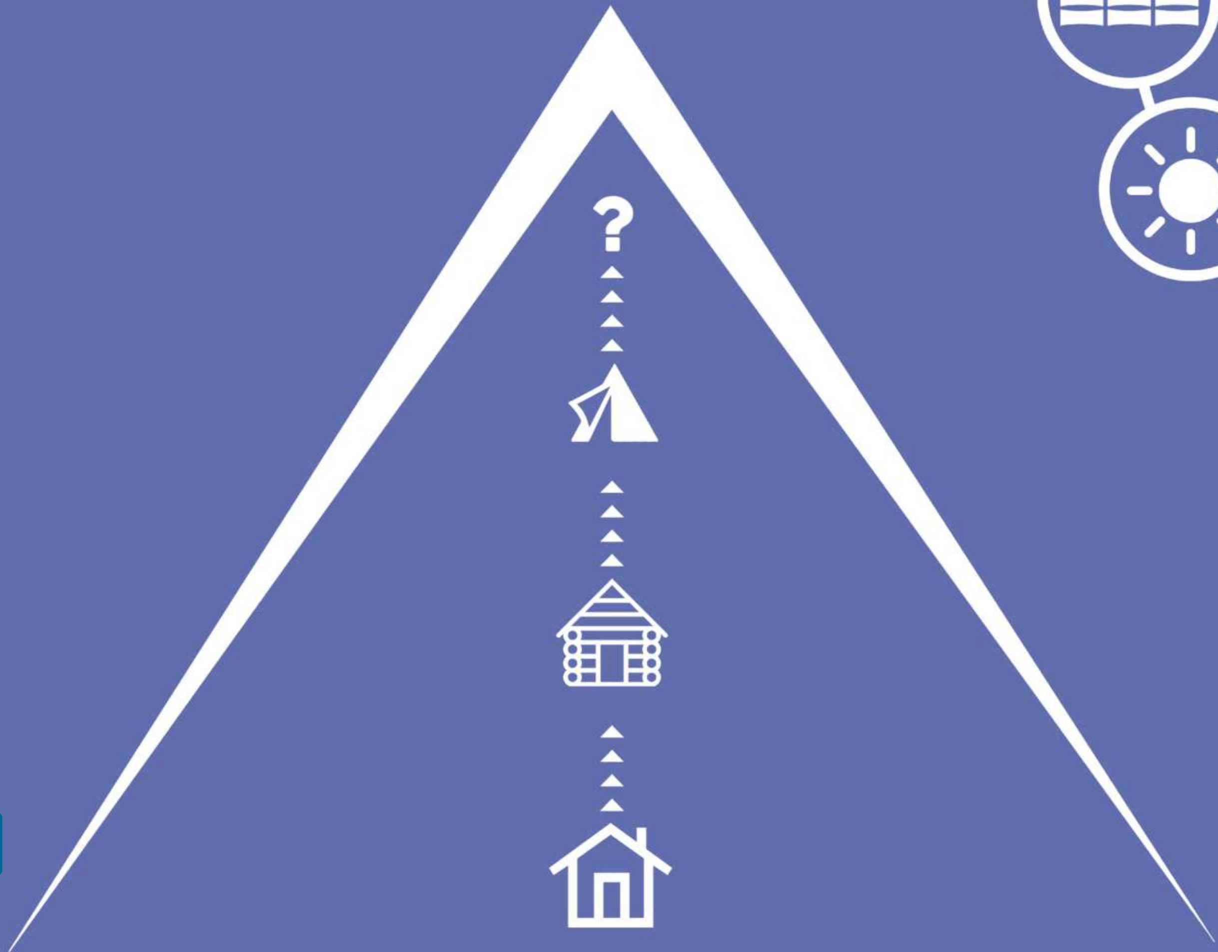

Fig. 61: Igloo

3. OBJECTIVES

3.1 Non-Footprint Architcture

Mountaineering, and thereby tourism, is one of the main economic sources of income for Nepal. The number of expeditions to the Mount Everest summit is reaching almost 900 ascents yearly. Additionally, hundreds of mountain climbers are trekking to the Basecamp every year. This implicates major challenges for the infrastructure and accommodations in the Himalayan region.[23] The concept of non-footprint architecture is to create designs with as little impact on the environment and emissions as possible.[24] The Ice Lodge embodies a circular system that leaves the construction site untouched. Glacial water gets used for the ice shells and bamboo as columns for support. The water, applied in layers, freezes and the bamboo tribes are tied into bundles. When the usage of the Lodge expires, the sun melts the ice and turns it back into water. The bamboo tribes can be used for further construction projects or as firewood.

Fig. 62: Non-Footprint Architecture



4. METHODOLOGY

4.1 Ice Experiments

Starting the design phase with Ice Experiments led to an understanding of the material and its character. There were two different approaches. Firstly, based on the igloo research stacking layers of ice and creating an ice dome. After inflating a balloon, tissues were sprayed with water layer by layer, came on top, and put into the freezer. After freezing the shape the balloon got removed and the construction was solid. For the second approach, a rainwater hose got filled with water and hung between two trees generating a catenary curve. The structure stayed one night while -7 degrees outside but did not freeze, unfortunately. This showed that freezing a large amount of water with temperatures above -10 degrees is rather problematic. In contrast, freezing a small amount of water in layers, forming a construction, has high potential.


Fig. 63: Water spray


Fig. 64: Ice Experiment Utensils


Fig. 65: Ice papier mache

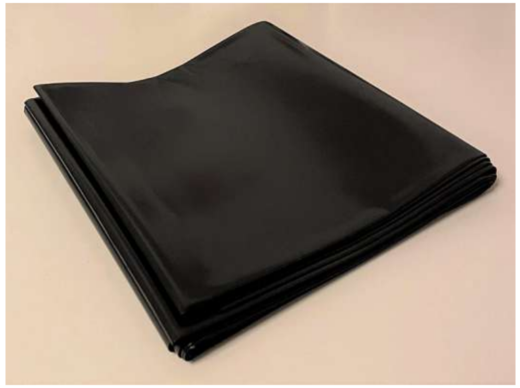


Fig. 65: Rainwater hose


Fig. 66: Ice papier mache frozen


Fig. 67: Hanging rainwater hose filled with water

4.2 Form Finding

Starting with a simple cube shape, the form-finding process evolved into different dome variations and designs. The geometries were based on the balloon Ice Experiment and generated with an opening on one side. Criteria were the assimilation to something inflatable or mass of snow underneath the shell and sprayed water to reach the complete shape. Creating some shape studies should help to find suitable options.

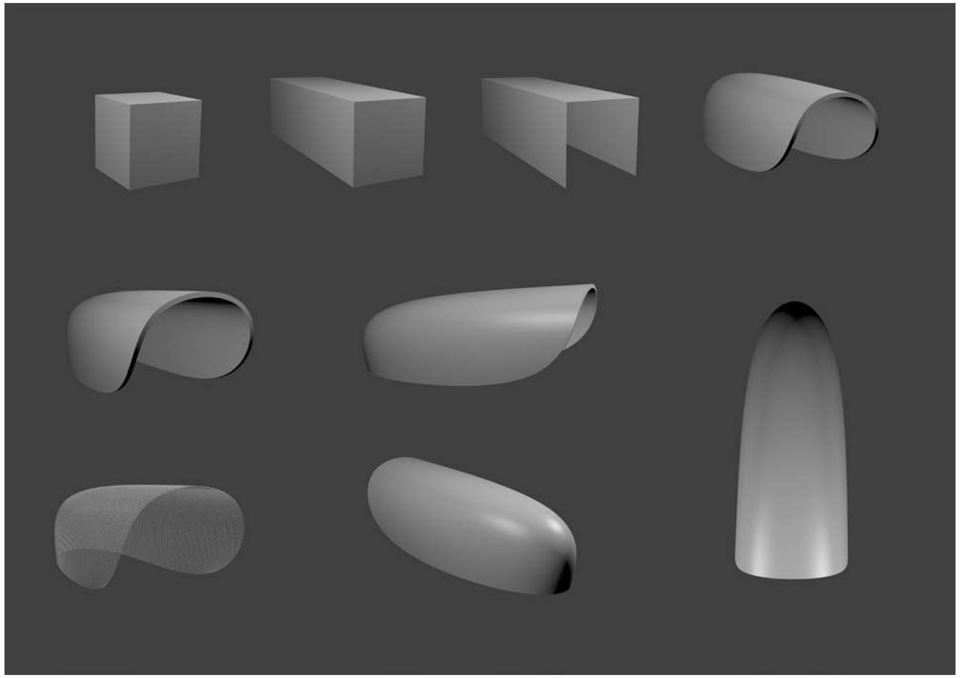


Fig. 68: Form Finding 1

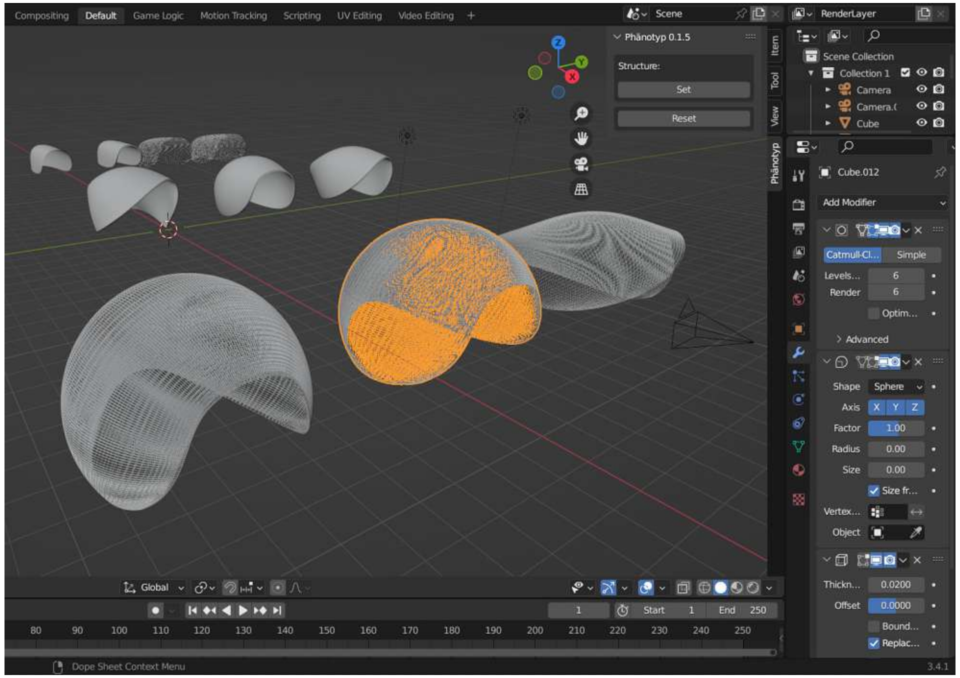


Fig. 69: Form Finding Blender file

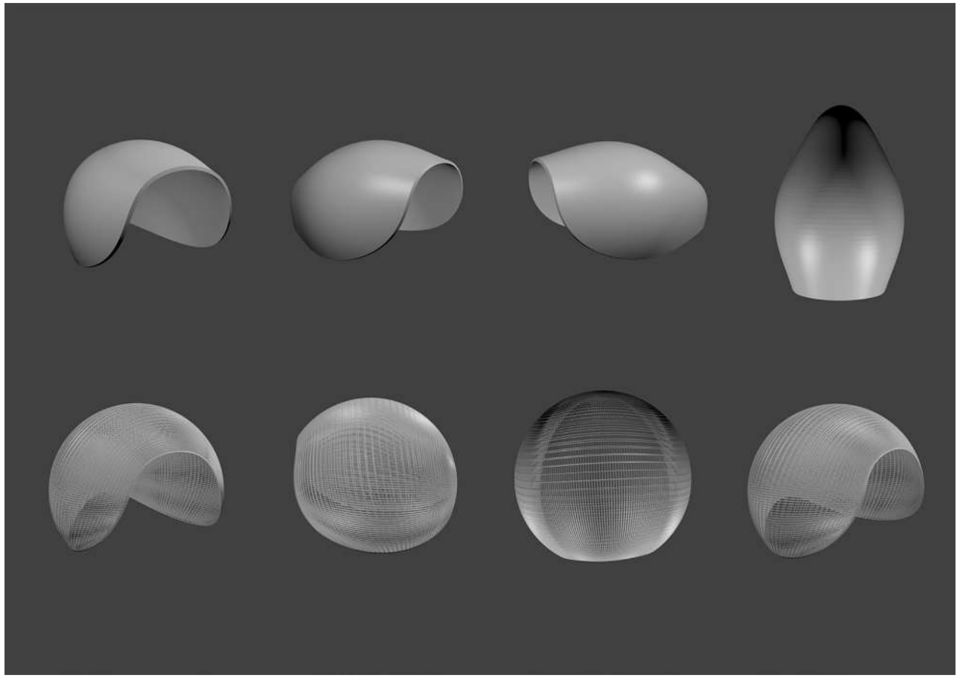


Fig. 70: Form Finding 2

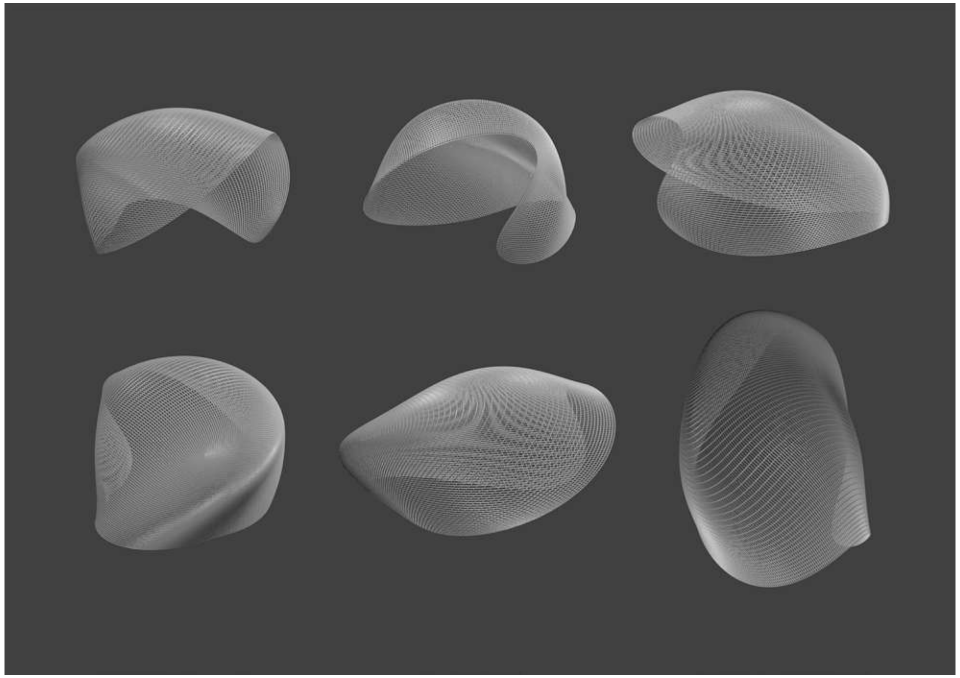
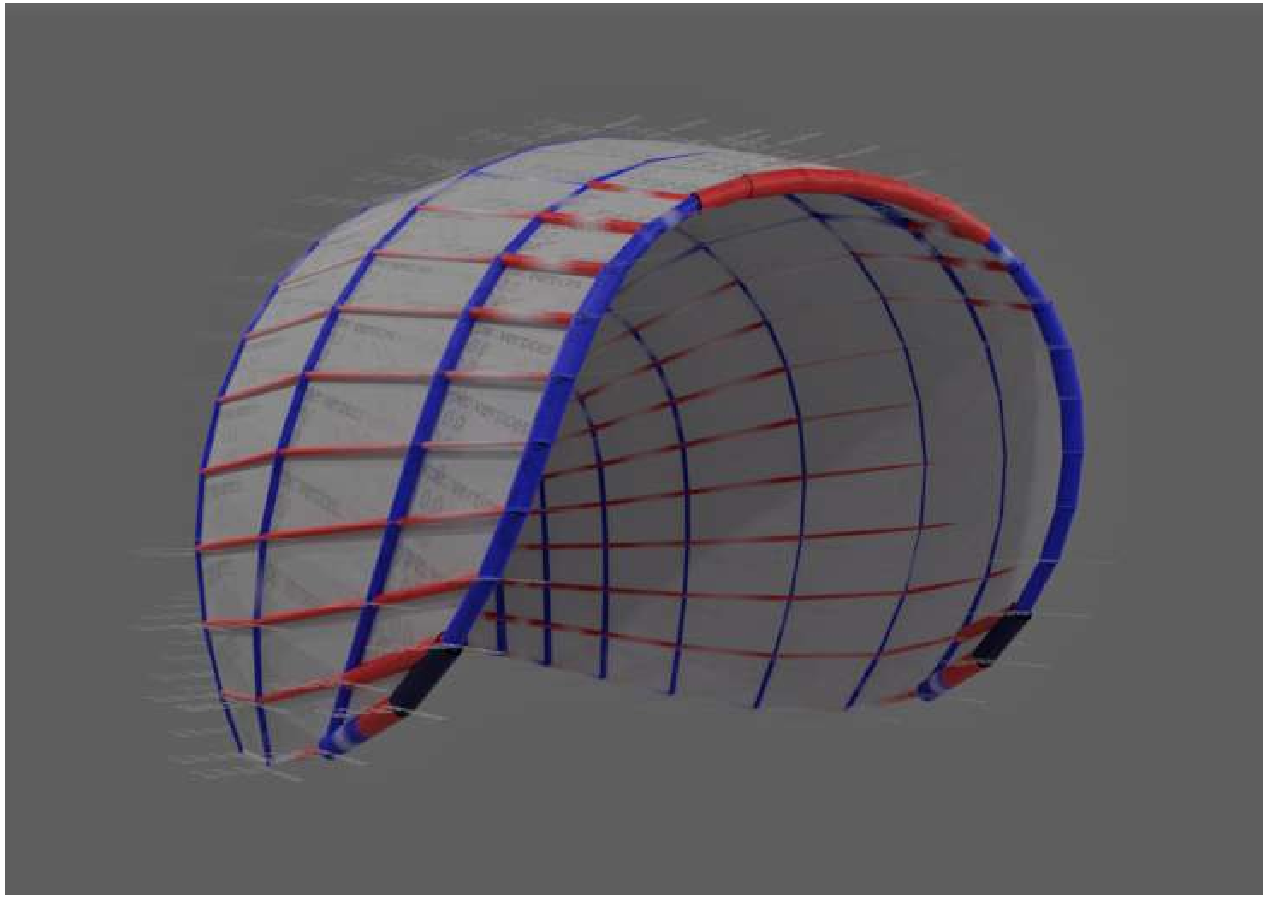


Fig. 71: Form Finding 3

4.3 Calculation of Forces

With the aid of Phänotyp, an Add-On for Blender, developed by Bewegende Architektur e.U. and Karl Deix, it was possible to calculate the forces of the shell shape. Phänotyp permits architectural structures to undergo genetic alteration. It may also be used to examine moving shapes. Especially when working on dynamic architectural projects Phänotyp is extremely helpful.[25] The calculation showed that the current shape endures many tensile forces. High tensile forces could be demonstrated, particularly in the upper vertex. Beyond that, in the lower arched area occurs an overload of forces. Knowing that ice cannot deal with a high number of tensile forces the decision to create a form, that only generating compressive forces, was made.

Fig. 72: Calculation of Forces



Tensile Force

Compressive Force

Force overloaded Area

4.4 Chain Models

Robert Hooke discovered in 1670 that a chain line, a curving line created by a chain or thread anchored at both ends and pushed by its weight, could be used, in reverse, to locate vaulted structures. By fusing the creation of design and construction shapes into a single process, he thereby laid the groundwork for a brand-new design methodology. With his now-famous string model, Antoni Gaudi not only demonstrated the vaulted architecture of the Sagrada Familia but also the full and intricate framework of the edifice.[26] After analyzing the system and operating mode of chain models, I created a variation of them to generate a shell structure with only compressive forces and no tensile forces. The chains form different domes for individual functions.

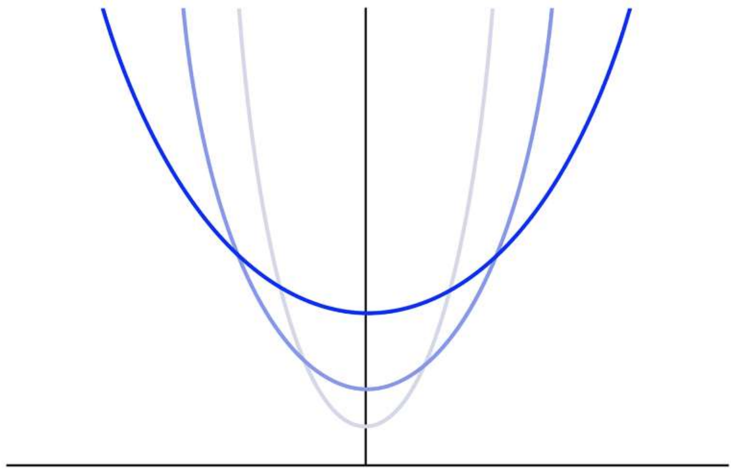


Fig. 73: Catenary Curve

Fig. 74: Chain Model

Fig. 75: Linking up the paper clips

Fig. 76: Hanging test

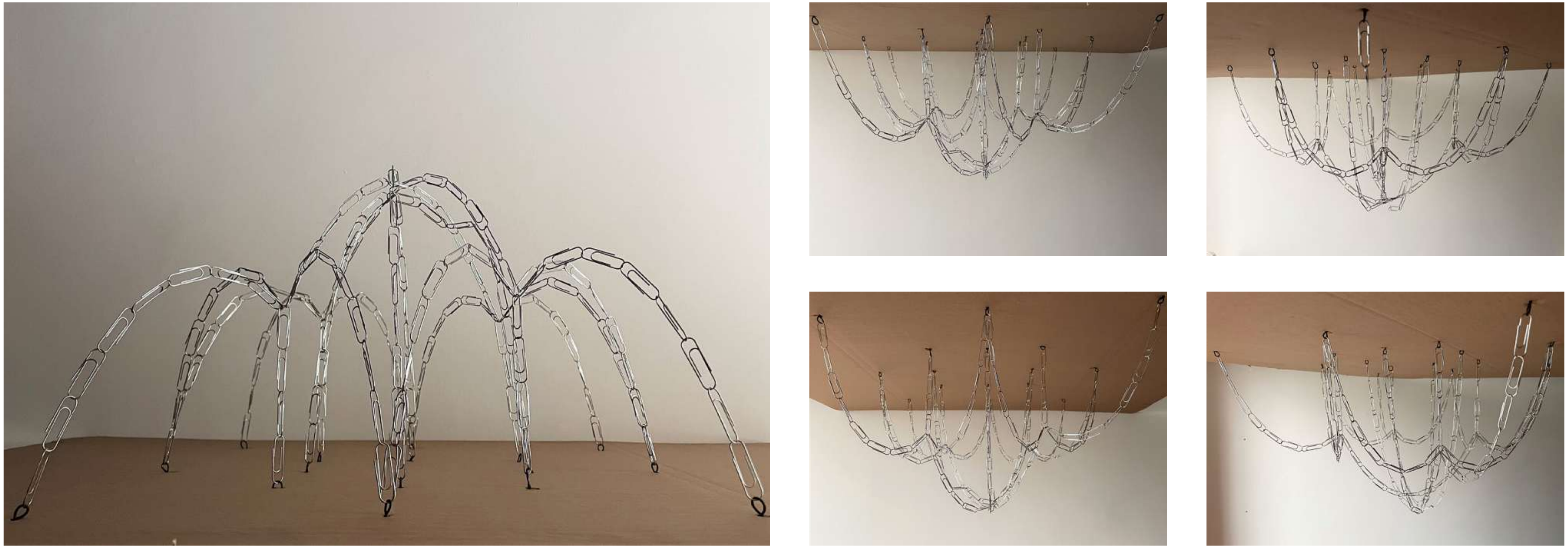


Fig. 77: Chain Model 1 various Views

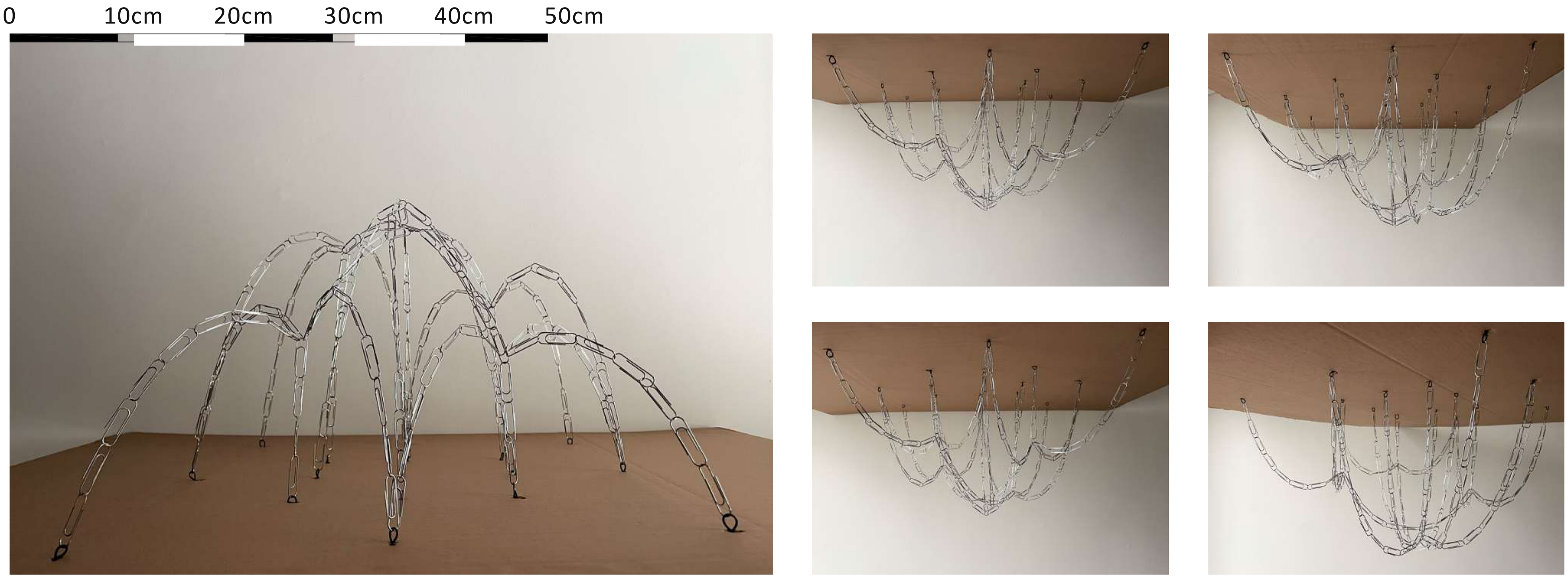


Fig. 79: Chain Model 3 various Views

Fig. 78: Chain Model 2 various Views

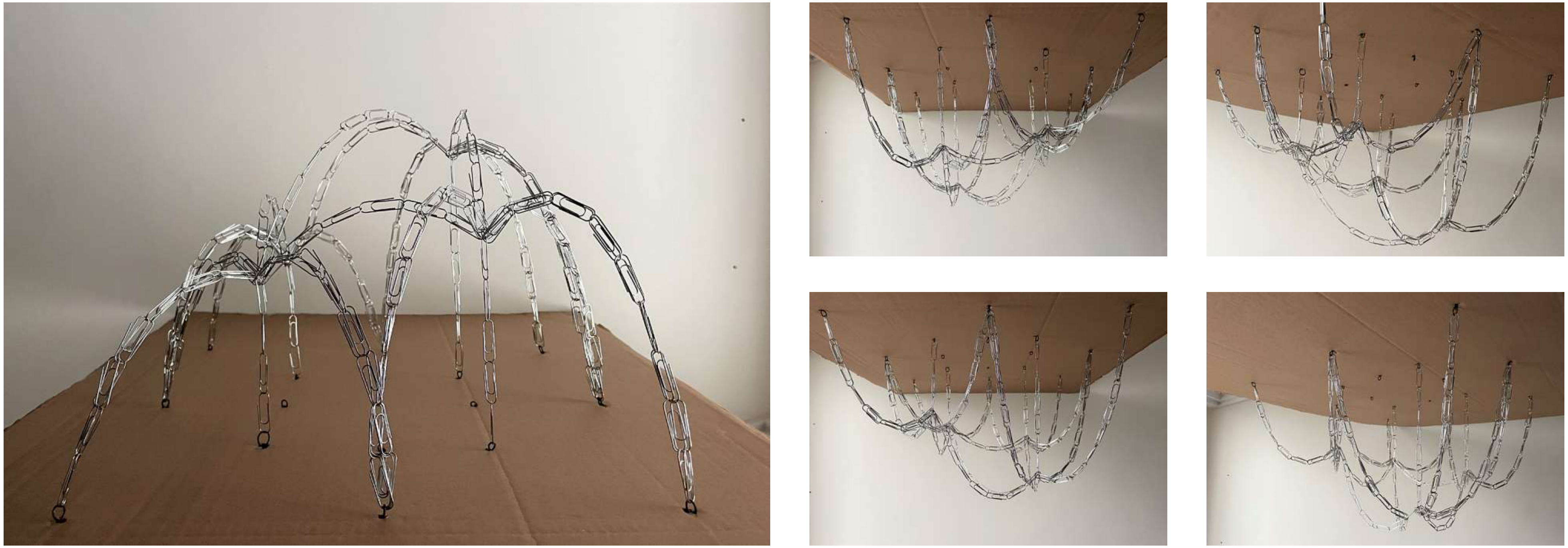


Fig. 80: Chain Model 4 various Views

4.5 Form Variations

Depending on the different functions of each ice cone the positions and dimensions vary. Using irregular sizes brings agitation to the design. After trying out a series of form variations the final concept represents a bigger and higher dome in the center with 6 smaller ones, having different heights, surrounding it. The cone in the middle operates as an allocator and offers space for common functions. After finalizing the form, it was time to create the ice material with the aid of Nodes in Blender.

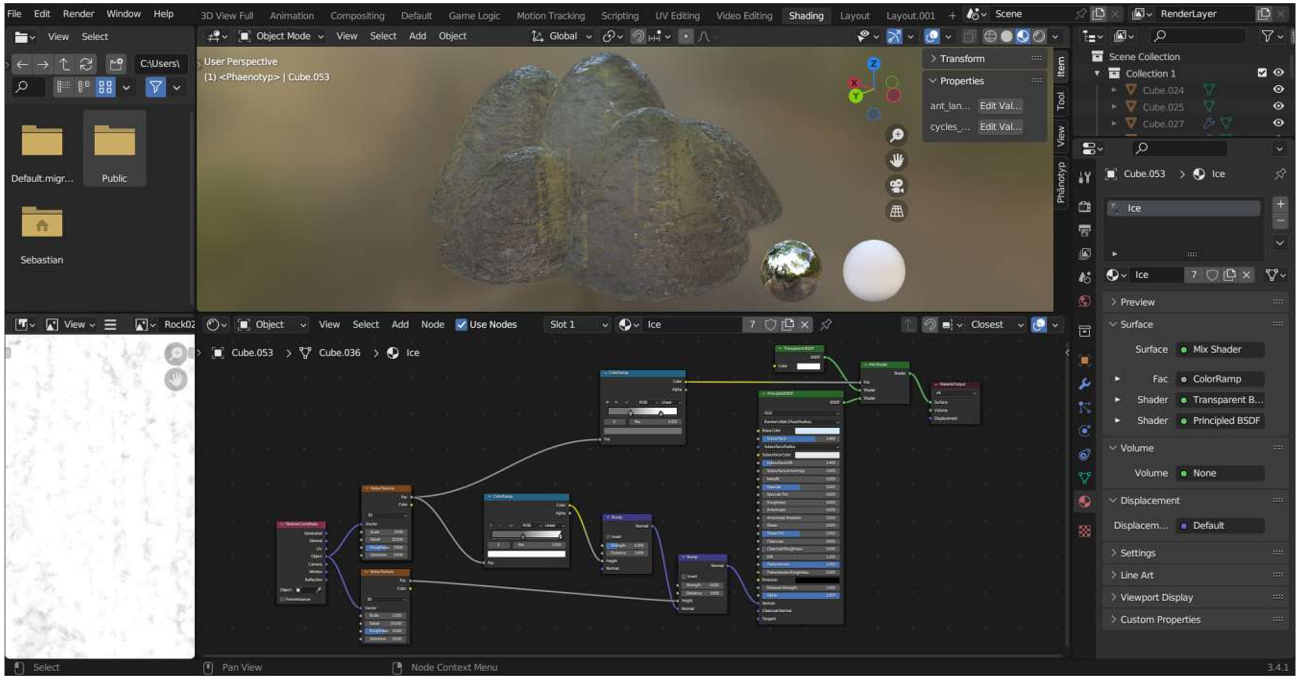


Fig. 81: Blender Nodes to create the Ice Material

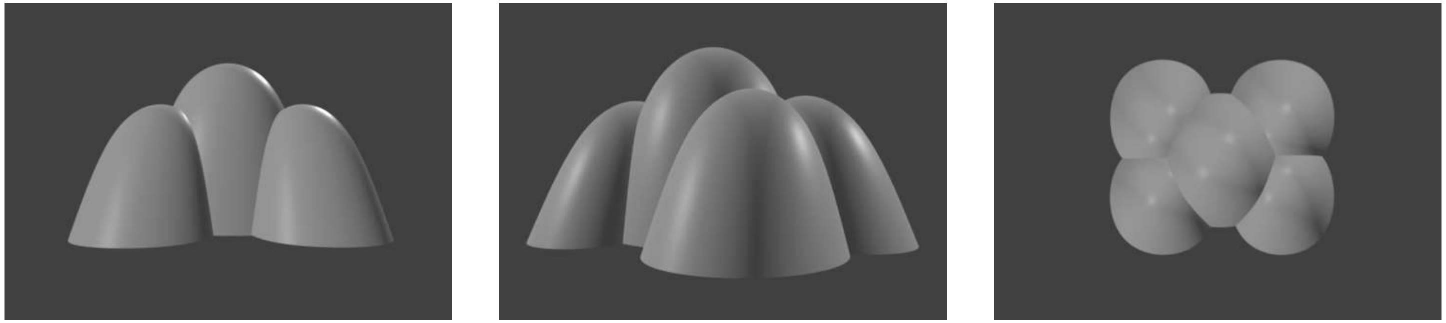


Fig. 82: Form Variation 1 various Views

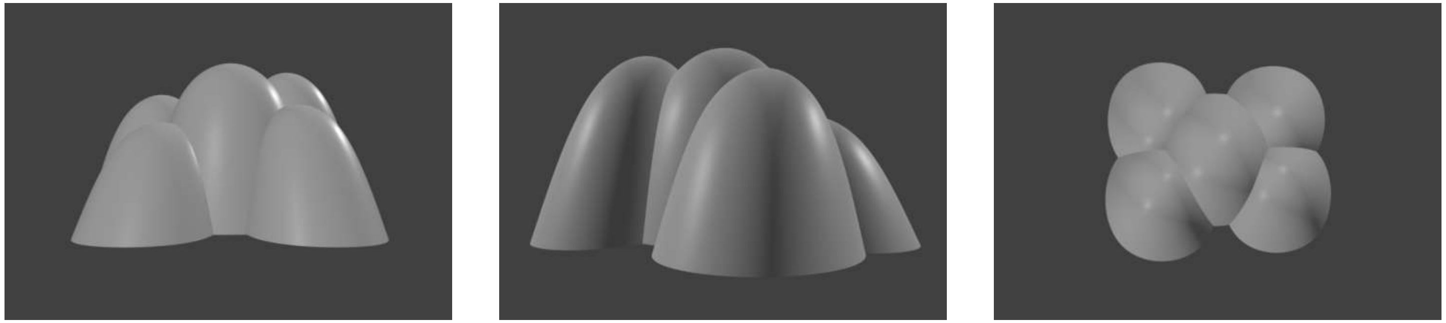


Fig. 83: Form Variation 2 various Views

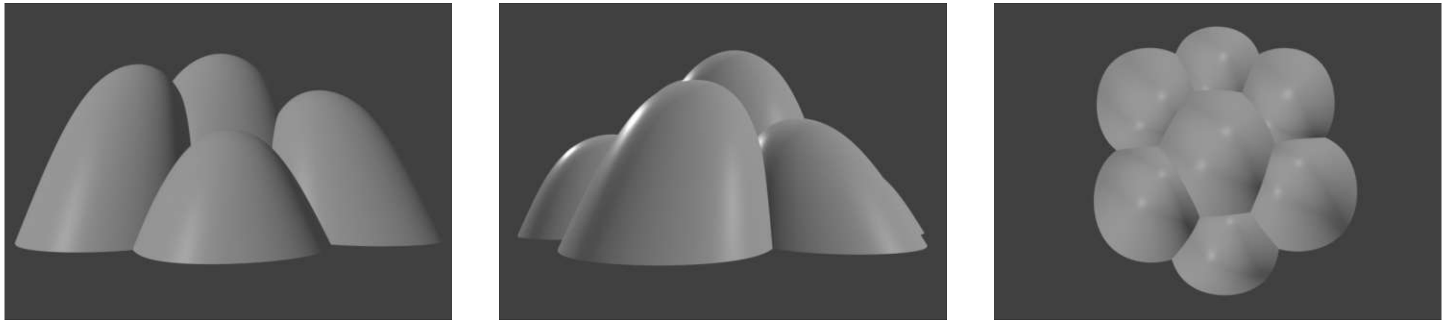


Fig. 84: Form Variation 3 various Views

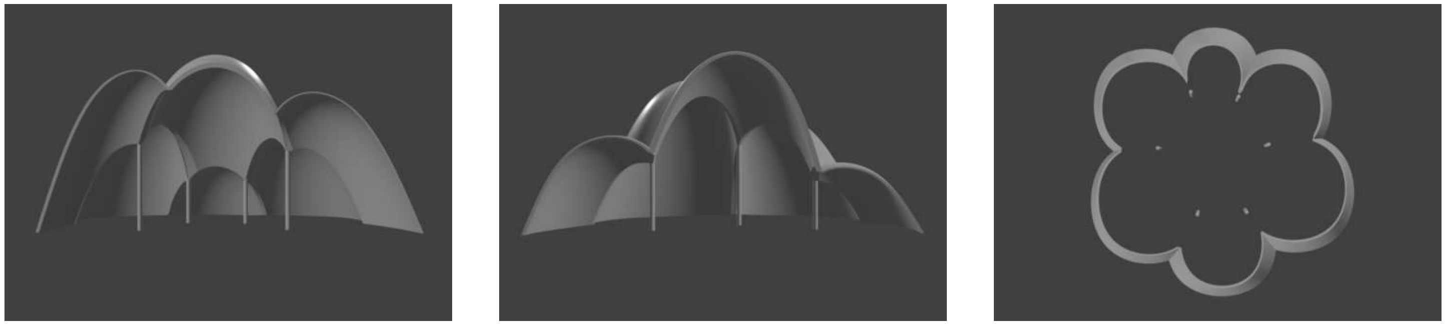


Fig. 85: Form Variation 3 Sections

4.6 Ice Material Tests

The creation of an extremely durable substance from a frozen combination of pulped wood and water was found by two American academics in the early months of 1943. They gave this substance the name Pykrete in honor of Geoffrey Pyke, who had previously suggested building ships out of ice. This is the account of a top-secret World War II initiative to study the utilization of ice in shipbuilding.[27] To improve the compressive strength of the ice, based on the knowledge of Pykrete, I created ice material samples with various components and conducted material tests at the Technical Test and Research Institute of the University of Innsbruck. This undertaking started with preparing the samples and mixing the components.

10 identical bowls, with the dimensions 9 x 6 x 5cm, a surface area of 54m², a mass of 400g, and an average density of 1,48g/cm³, got filled with:

- Sample 1: 100% water
- Sample 2: 79% water + 14% sawdust + 7% linseed flour
- Sample 3: 79% water + 14% sawdust + 7% seitan-base
- Sample 4: 79% water + 21% sawdust
- Sample 5: 86% water + 14% sawdust
- Sample 6: 86% water + 14% wood shavings
- Sample 7: 92% water + 4% wood shavings + 4% linseed flour
- Sample 8: 93% water + 7% carton
- Sample 9: 96% water + 4% sawdust
- Sample 10: 96% water + 4% wood shavings

After mixing the ingredients the liquid samples got frozen in a freezer. In the last step, the frozen samples got placed in the hydraulic press, one after another, to document their performance under compressive force and later evaluate the differences.

Test Cuboid	
A: a x b = 9 x 6 =	54 cm^2
V: a x b x h = 9 x 6 x 5 =	270 cm^3
m:	400 g
p: m/V = 400/270 =	1,48 g/cm^3

Used Components:

	wasser	water
	karton	carton
sm	sägemehl	sawdust
ssp	sägespäne	wood shavings
lm	leinmehl	linseed flour
sb	seitan-basis	seitan-base


Fig. 86: Bowls


Fig. 87: Scale and water measuring cup

Fig. 88: Seitan-Base

Fig. 89: Linseed Flour


Fig. 90: Bowls as Test Cuboids


Fig. 91: Wood Shavings and Sawdust

Fig. 92: Mixing the Samples

Fig. 93: Conducting the Material Tests

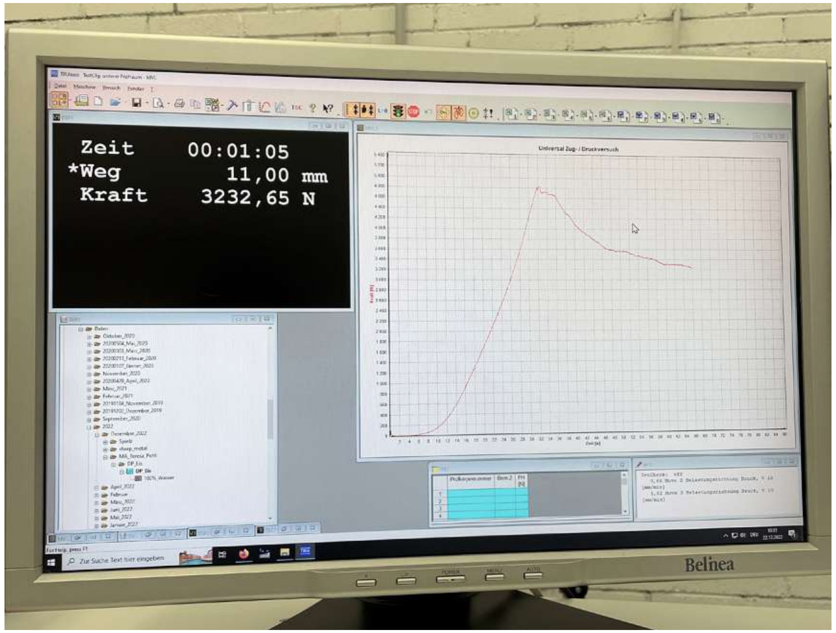


Fig. 94: Plotting the graph


Fig. 95: Sample 1


Fig. 96: Sample 2


Fig. 97: Sample 3


Fig. 98: Sample 4


Fig. 99: Sample 5


Fig. 100: Sample 6


Fig. 101: Sample 7


Fig. 102: Sample 8

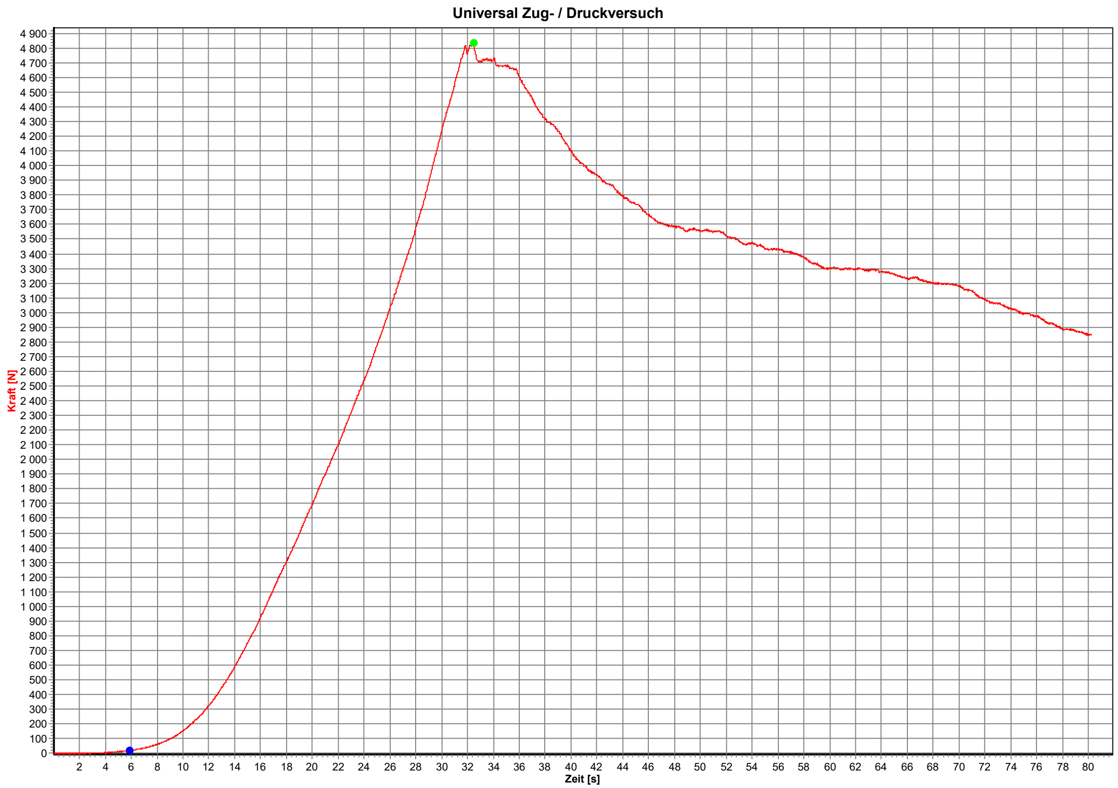

Fig. 103: Sample 9


Fig. 104: Sample 10

Sample 1: 100% water

Prüfparameter

Maschinentyp: TT 28150
Kraftaufnehmer: 150kN
Prüfgeschwindigkeiten: V0 = 10 mm/min; V1 = 10 mm/min



Ergebnis-Tabelle

	Prüfkörpernummer	Bem.2	FH N
1	100%_Wasser		4841,25

Fig. 105: Graph Sample 1

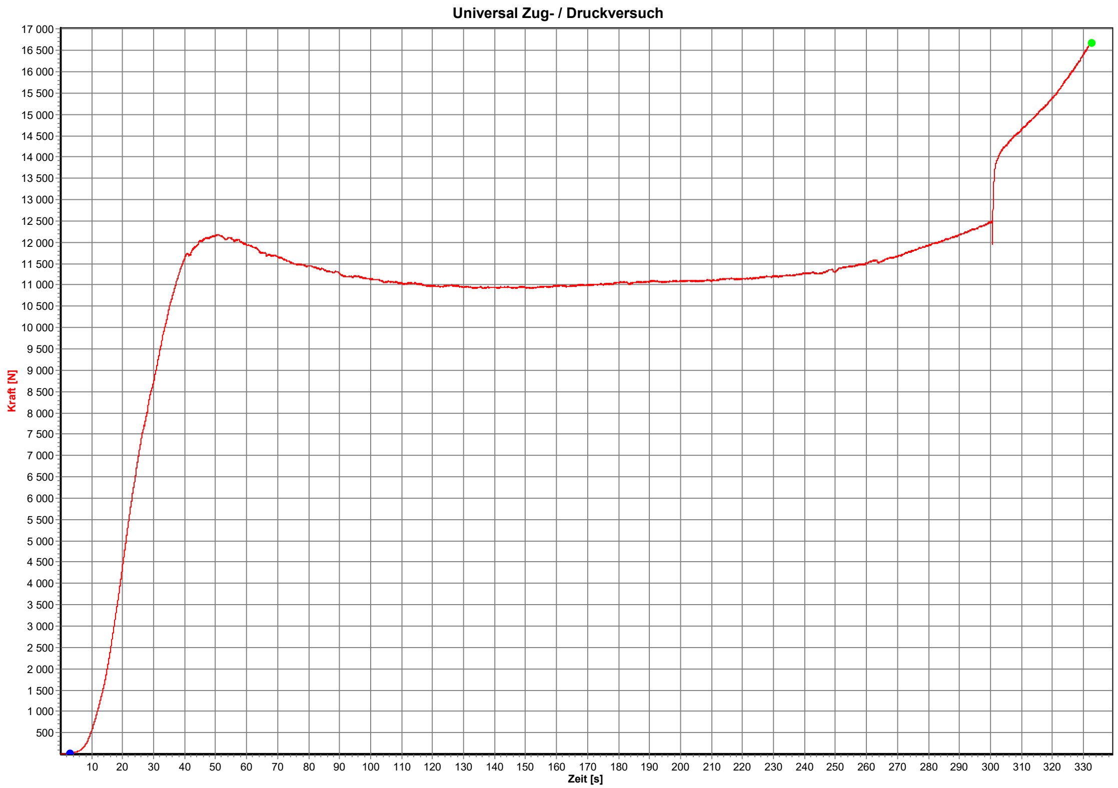
Fig. 106: Test 1.1

Fig. 107: Test 1.2

Sample 2: 79% water + 14% sawdust + 7% linseed flour

Prüfparameter

Maschinentyp: TT 28150
Kraftaufnehmer: 150kN
Prüfgeschwindigkeiten: V0 = 10 mm/min; V1 = 10 mm/min



Ergebnis-Tabelle

	Prüfkörpernummer	Bem.2	FH N
2	79%w_14%sm_7%lm		16695,90

Fig. 108: Graph Sample 2

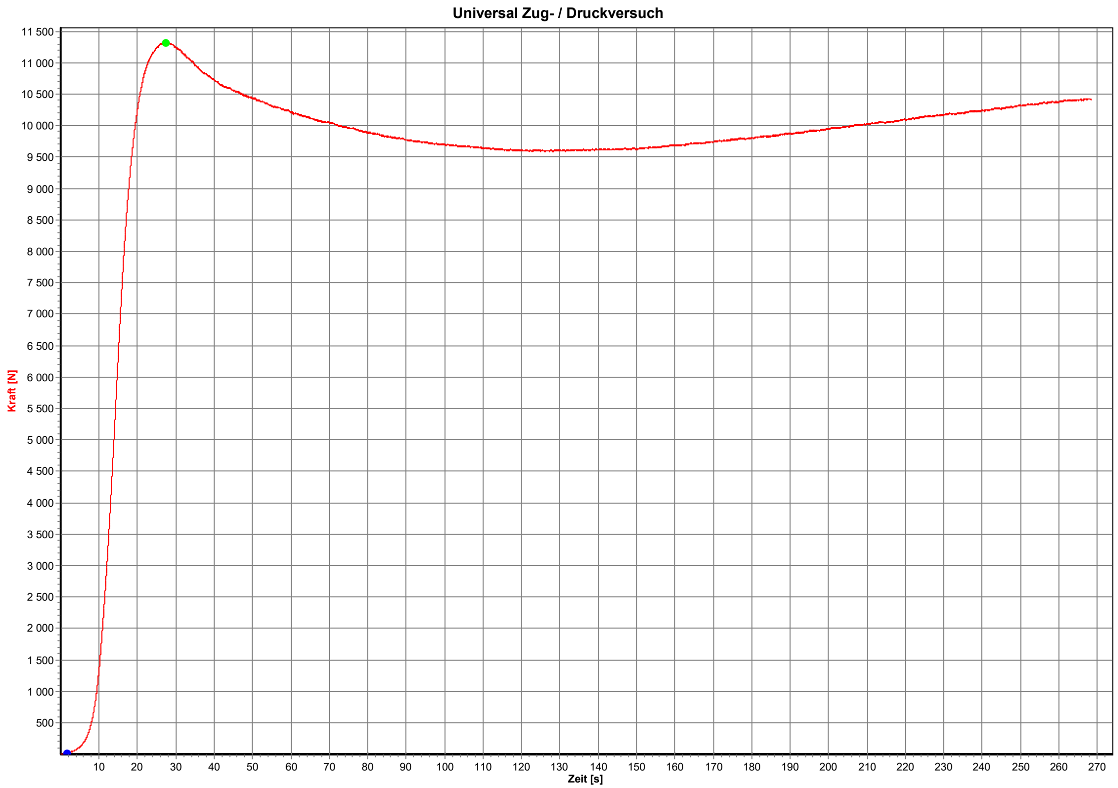
Fig. 109: Test 2.1

Fig. 110: Test 2.2

Sample 3: 79% water + 14% sawdust + 7% seitan-base

Prüfparameter

Maschinentyp: TT 28150
Kraftaufnehmer: 150kN
Prüfgeschwindigkeiten: V0 = 10 mm/min; V1 = 10 mm/min



Ergebnis-Tabelle

	Prüfkörpernummer	Bem.2	FH N
5	79%w_14%sm_7%sb		11329,35

Fig. 111: Graph Sample 3

Fig. 112: Test 3.1

Fig. 113: Test 3.2

Sample 4: 79% water + 21% sawdust

Prüfparameter

Maschinentyp: TT 28150
Kraftaufnehmer: 150kN
Prüfgeschwindigkeiten: V0 = 10 mm/min; V1 = 10 mm/min

Ergebnis-Tabelle

	Prüfkörpernummer	Bem.2	FH N
3	79%w_21%sm		21497,70

Fig. 114: Graph Sample 4

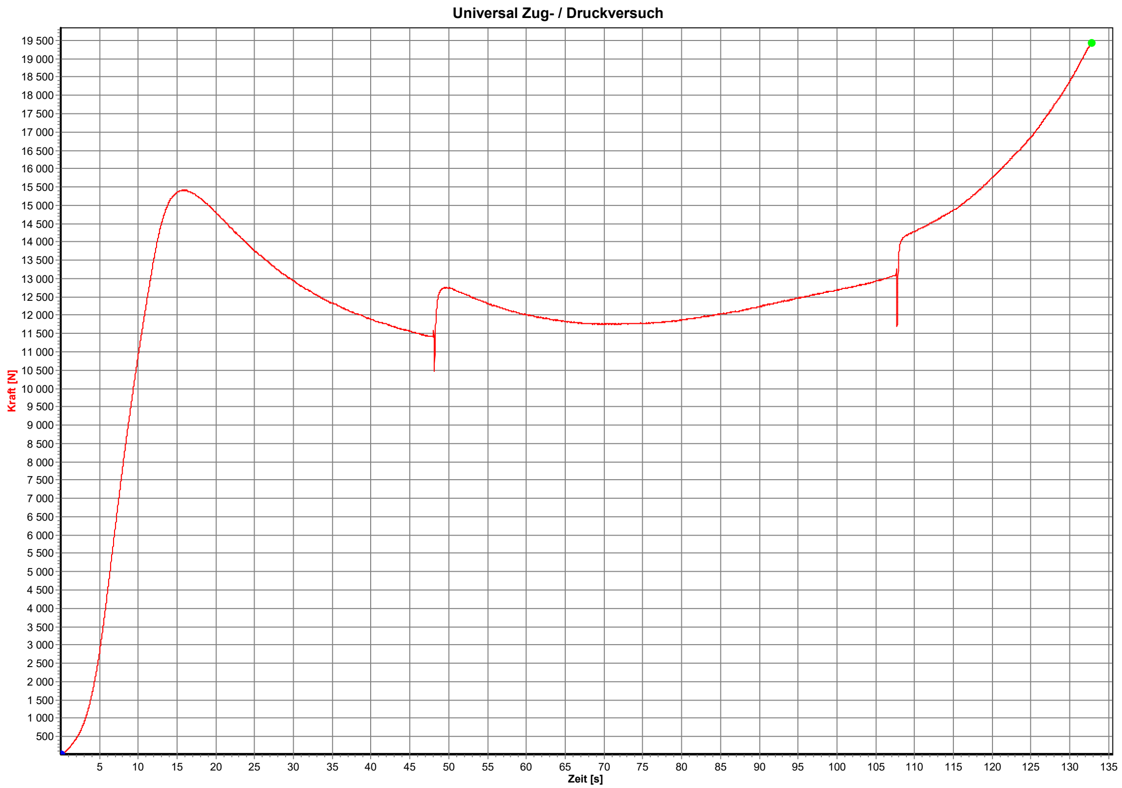
Fig. 115: Test 4.1

Fig. 116: Test 4.2

Sample 5: 86% water + 14% sawdust

Prüfparameter

Maschinentyp: TT 28150
Kraftaufnehmer: 150kN
Prüfgeschwindigkeiten: V0 = 20 mm/min; V1 = 20 mm/min



Ergebnis-Tabelle

	Prüfkörpernummer	Bem.2	FH N
10	86%w_14%sm		19454,85

Fig. 117: Graph Sample 5

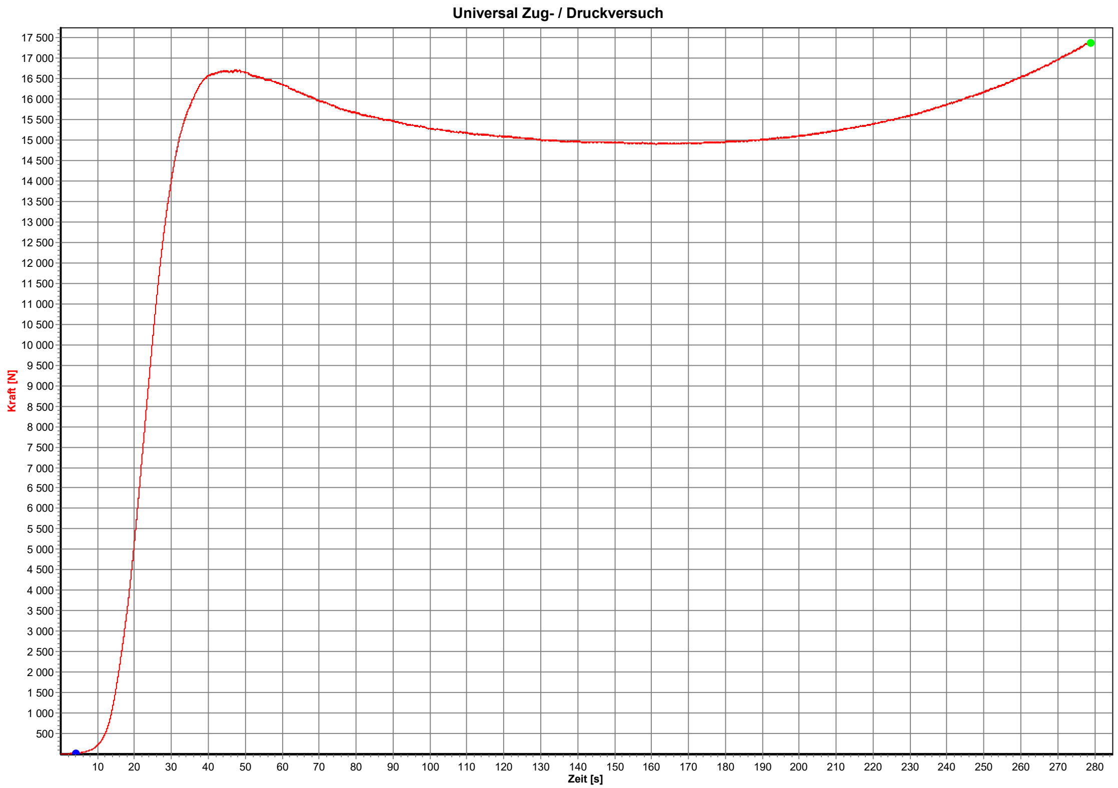
Fig. 118: Test 5.1

Fig. 119: Test 5.2

Sample 6: 86% water + 14% wood shavings

Prüfparameter

Maschinentyp: TT 28150
Kraftaufnehmer: 150kN
Prüfgeschwindigkeiten: V0 = 10 mm/min; V1 = 10 mm/min



Ergebnis-Tabelle

	Prüfkörpernummer	Bem.2	FH N
6	86%w_14%ssp		17394,30

Fig. 120: Graph Sample 6

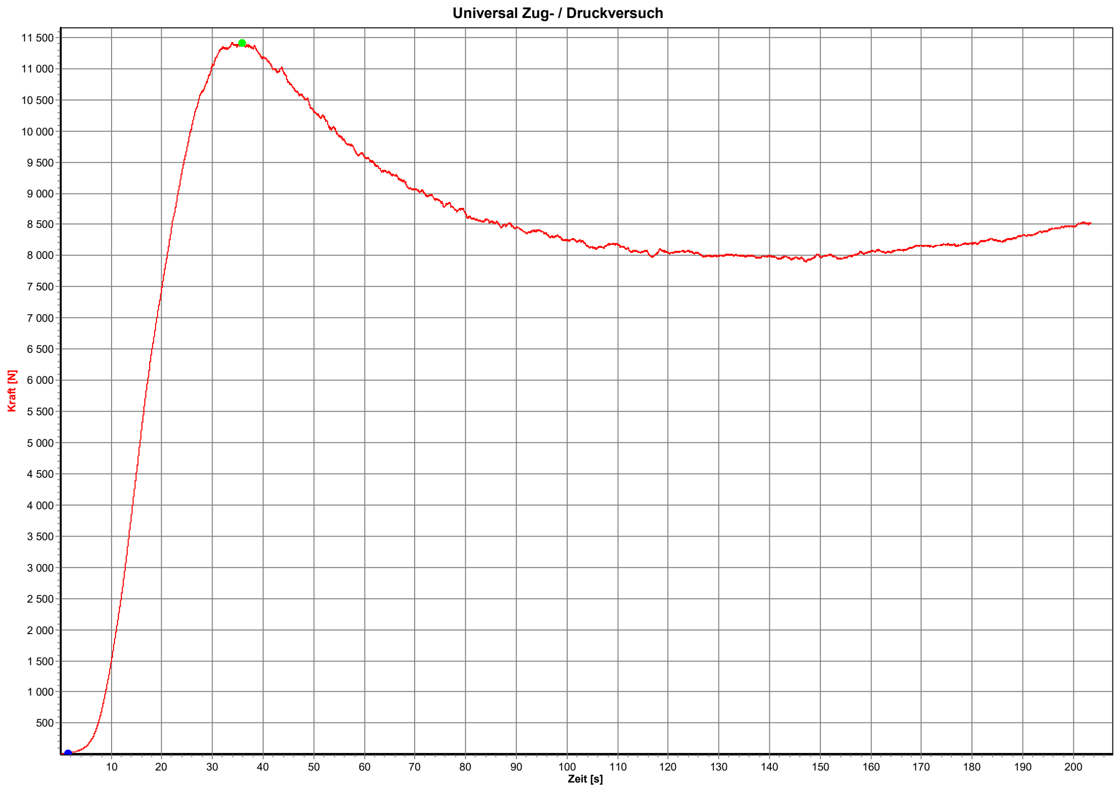
Fig. 121: Test 6.1

Fig. 122: Test 6.2

Sample 7: 92% water + 4% wood shavings + 4% linseed flour

Prüfparameter

Maschinentyp: TT 28150
Kraftaufnehmer: 150kN
Prüfgeschwindigkeiten: V0 = 10 mm/min; V1 = 10 mm/min



Ergebnis-Tabelle

	Prüfkörpernummer	Bem.2	FH N
8	92%w_4%ssp_4%lm		11425,80

Fig. 123: Graph Sample 7

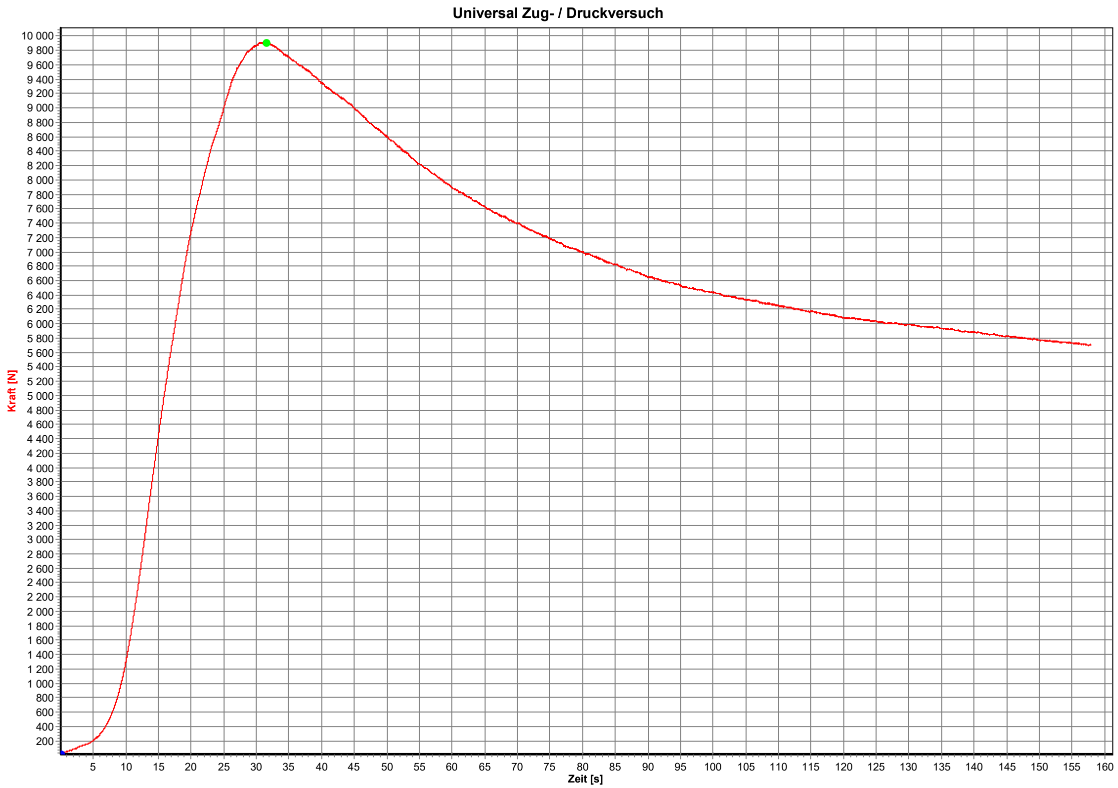
Fig. 124: Test 7.1

Fig. 125: Test 7.2

Sample 8: 93% water + 7% carton

Prüfparameter

Maschinentyp: TT 28150
Kraftaufnehmer: 150kN
Prüfgeschwindigkeiten: V0 = 10 mm/min; V1 = 10 mm/min



Ergebnis-Tabelle

	Prüfkörpernummer	Bem.2	FH N
9	93%w_7%karton		9917,10

Fig. 126: Graph Sample 8

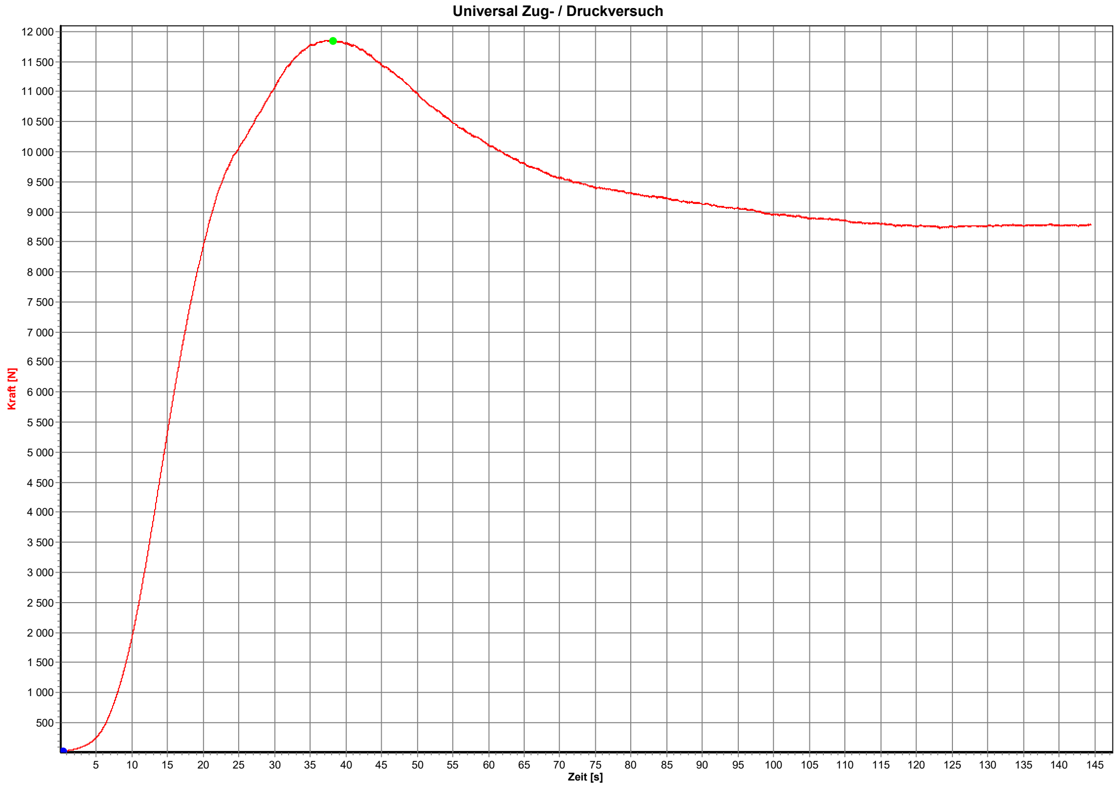
Fig. 127: Test 8.1

Fig. 128: Test 8.2

Sample 9: 96% water + 4% sawdust

Prüfparameter

Maschinentyp: TT 28150
Kraftaufnehmer: 150kN
Prüfgeschwindigkeiten: V0 = 10 mm/min; V1 = 10 mm/min



Ergebnis-Tabelle

	Prüfkörpernummer	Bem.2	FH N
4	96%w_4%sm		11856,75

Fig. 129: Graph Sample 9

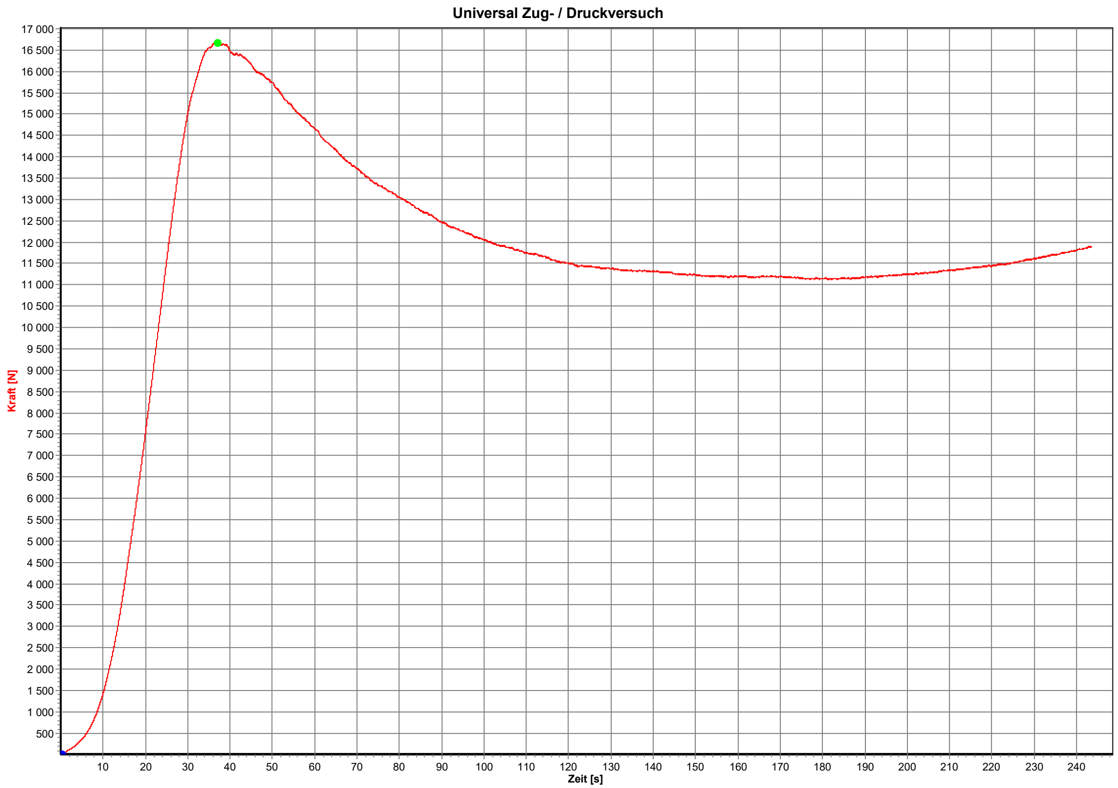
Fig. 130: Test 9.1

Fig. 131: Test 9.2

Sample 10: 96% water + 4% wood shavings

Prüfparameter

Maschinentyp: TT 28150
Kraftaufnehmer: 150kN
Prüfgeschwindigkeiten: V0 = 10 mm/min; V1 = 10 mm/min



Ergebnis-Tabelle

	Prüfkörpernummer	Bem.2	FH N
7	96%w_4%ssp		16687,05

Fig. 132: Graph Sample 10

Fig. 133: Test 10.1

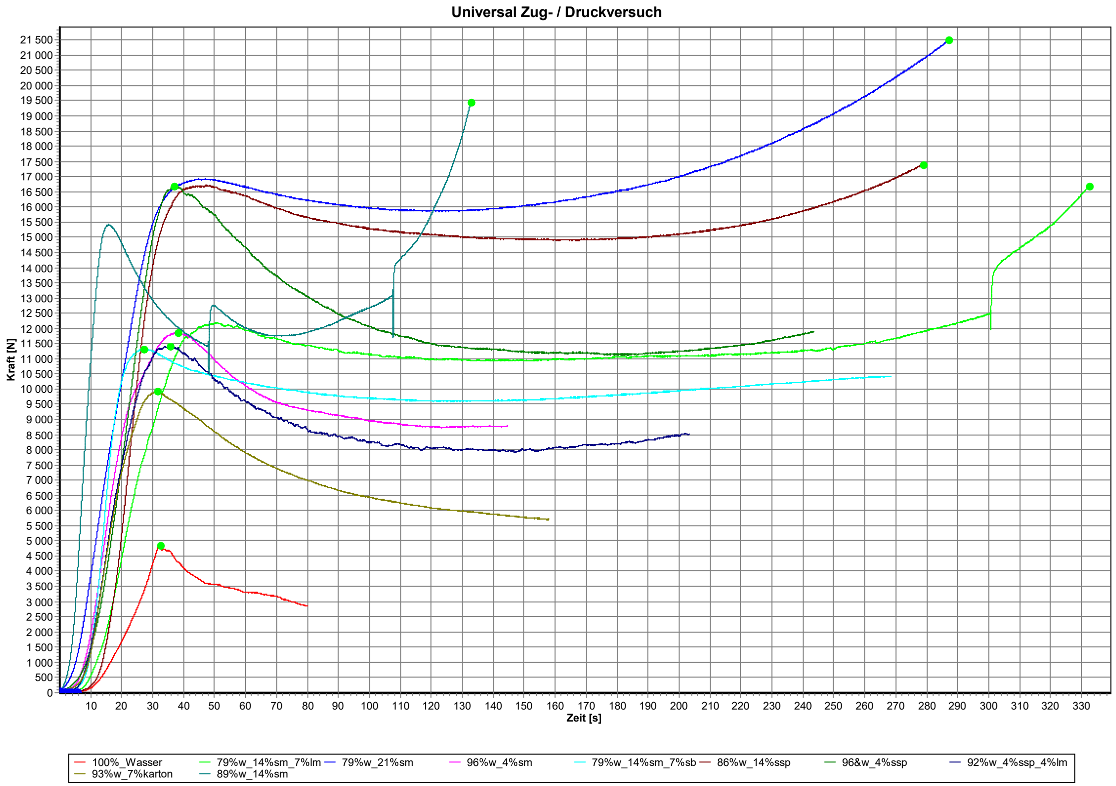
Fig. 134: Test 10.2

Evaluation of the Ice Material Tests

The tests have shown that the compressibility of the material, similar to concrete, increases when various additives and binders are added. Pure ice has a compressibility of 4500 N/s, being the lowest result. (Sample 1: 100% water) In the center span, with 10000-12500 N/s, are the samples with a high amount of sawdust and wood shavings, as well as binders, ranked. (Sample 2: 79% water + 14% sawdust + 7% linseed flour and Sample 3: 79% water + 14% sawdust + 7% seitan-base) Also, the sample with carton can be found in this middle span. (Sample 8: 93% water + 7% carton) Surprisingly, the sample with the biggest amount of sawdust, but without any binders, got the highest score of 17000 N/s. (Sample 4: 79% water + 21% sawdust)

Prüfparameter

Maschinentyp: TT 28150
Kraftaufnehmer: 150kN
Prüfgeschwindigkeiten: V0 = 20 mm/min; V1 = 20 mm/min



Ergebnis-Tabelle

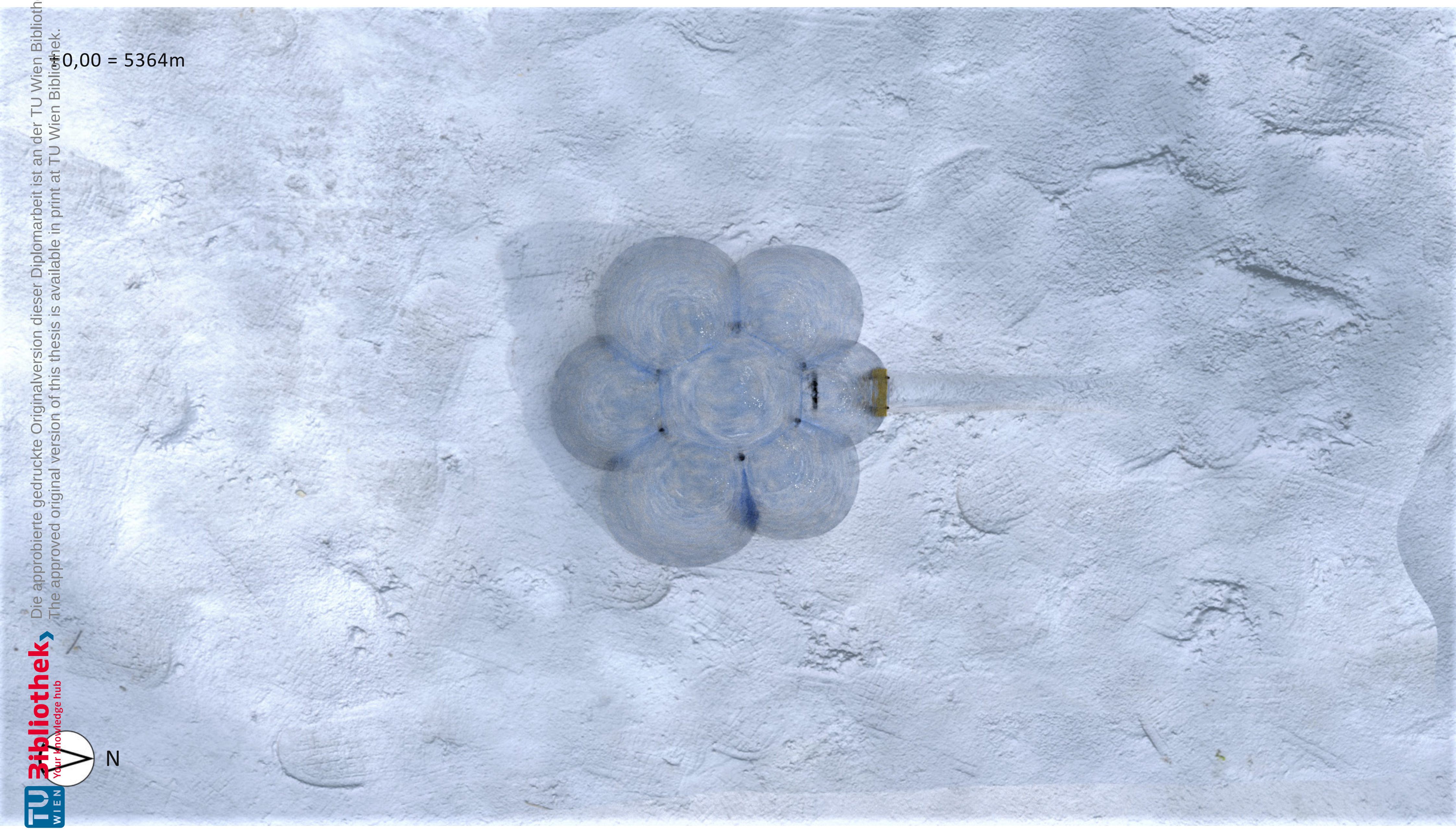
	Prüfkörpernummer	Bem.2	FH N
1	100%_Wasser		4841,25
2	79%w_14%sm_7%lm		16695,90
3	79%w_21%sm		21497,70
4	96%w_4%sm		11856,75
5	79%w_14%sm_7%sb		11329,35
6	86%w_14%ssp		17394,30
7	96%w_4%ssp		16687,05
8	92%w_4%ssp_4%lm		11425,80
9	93%w_7%karton		9917,10
10	86%w_14%sm		19454,85

Fig. 135: Graph Comparison all Samples

5. RESULT

5.1 Site Plan

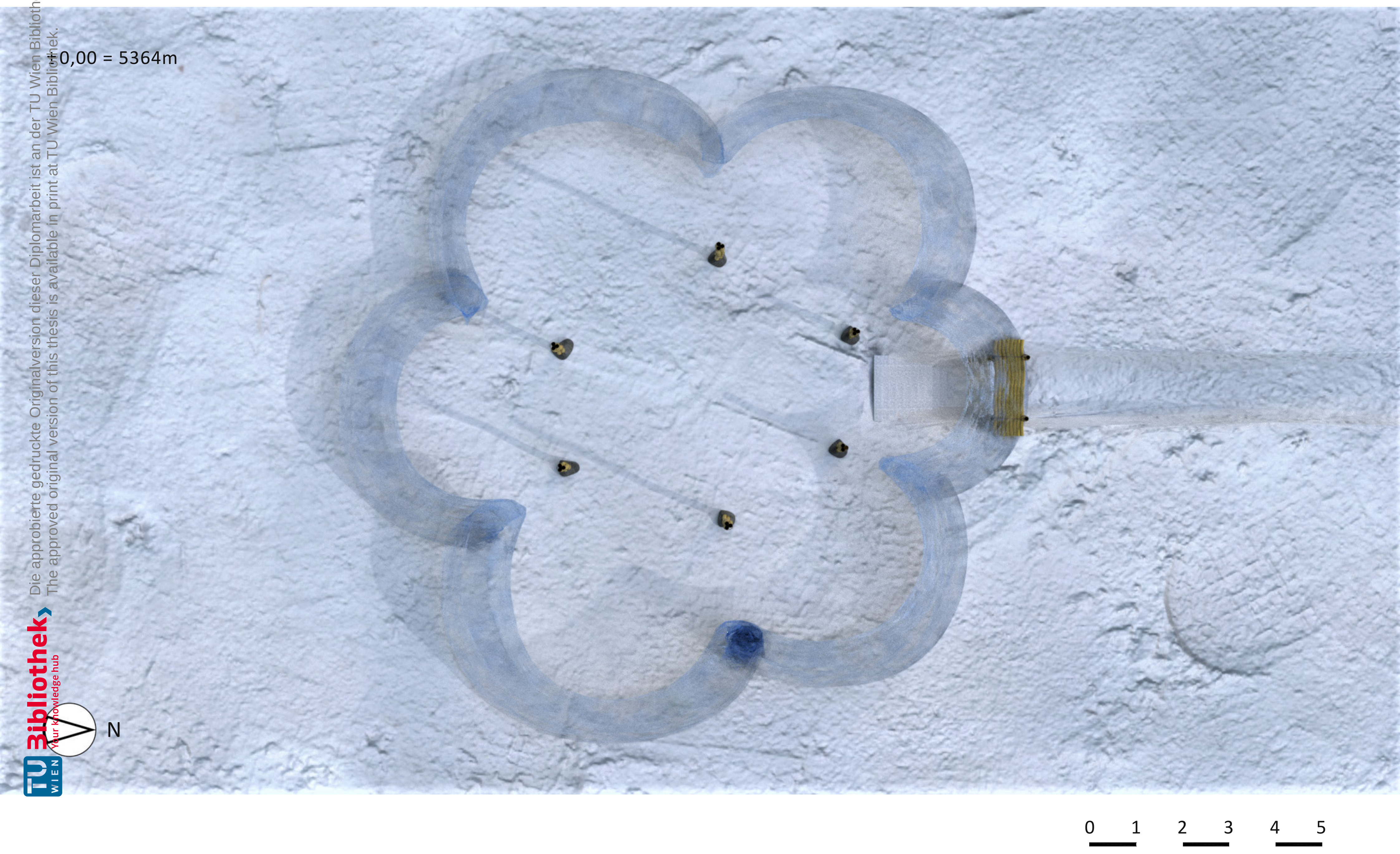
Fig. 136



0 1 2 3 4 5 6 7 8 9

5.2 Floor Plan

Fig. 137



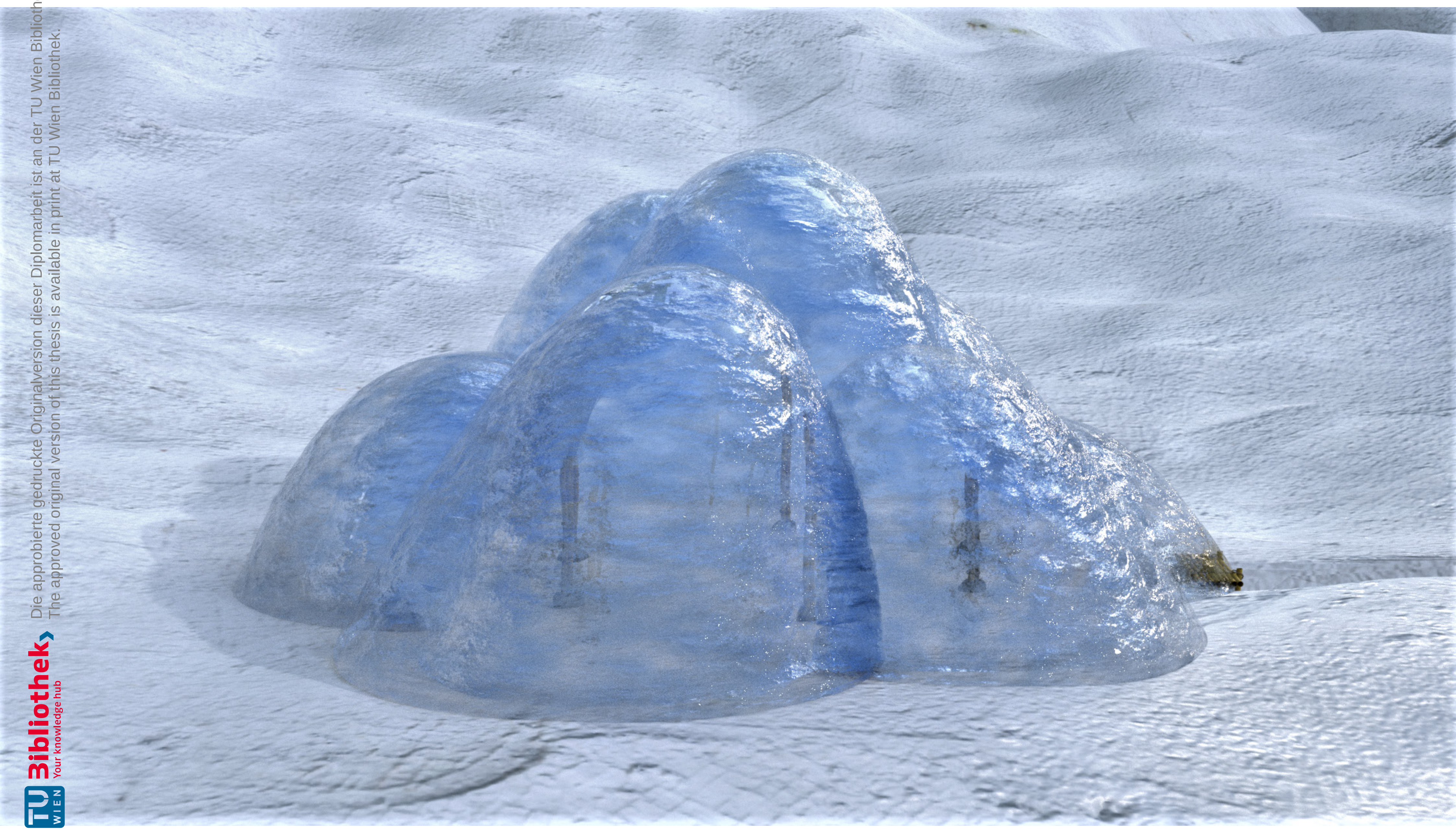
5.3 North View

Fig. 138

0 1 2 3 4 5

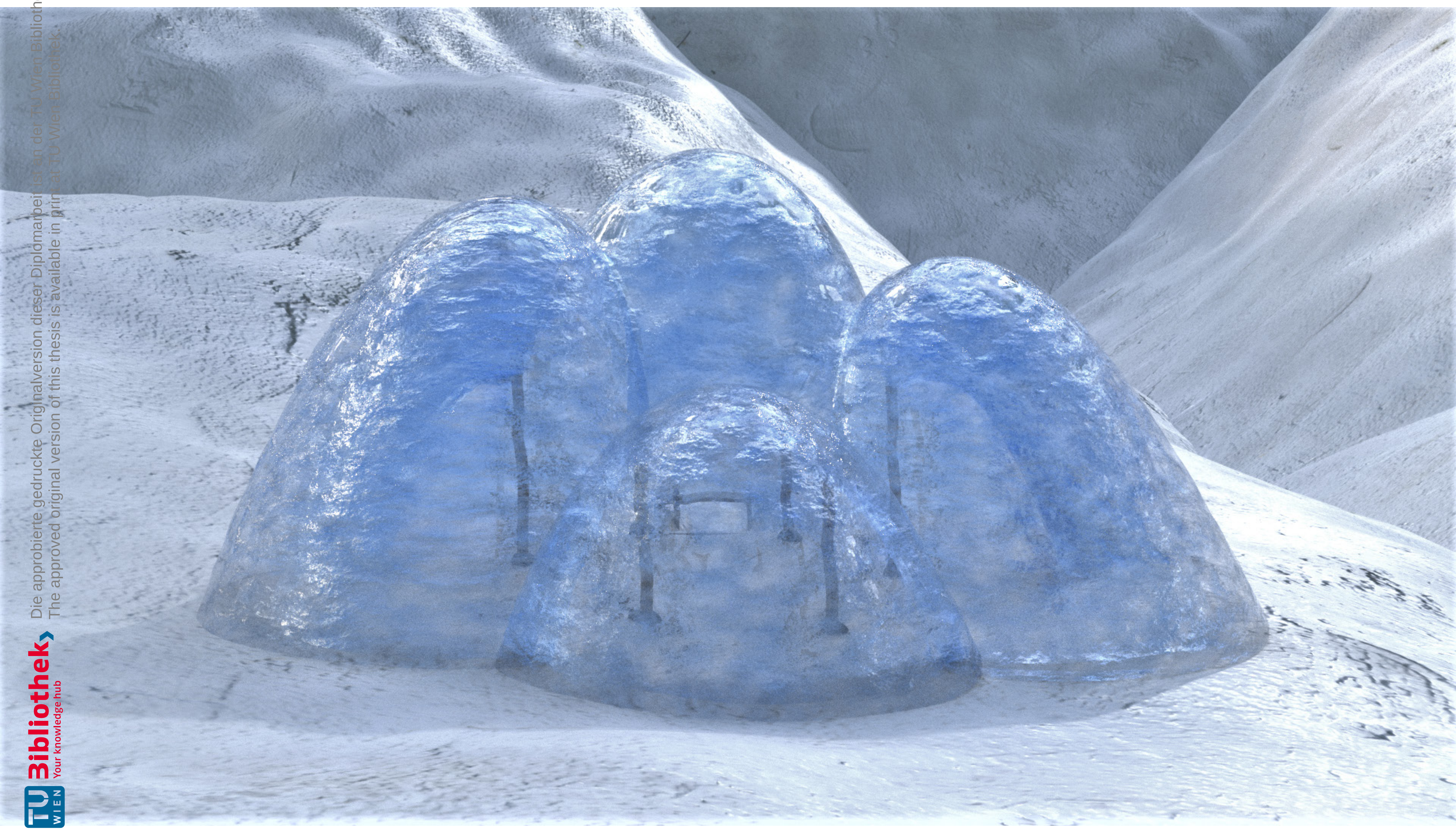
5.4 East View

Fig. 139



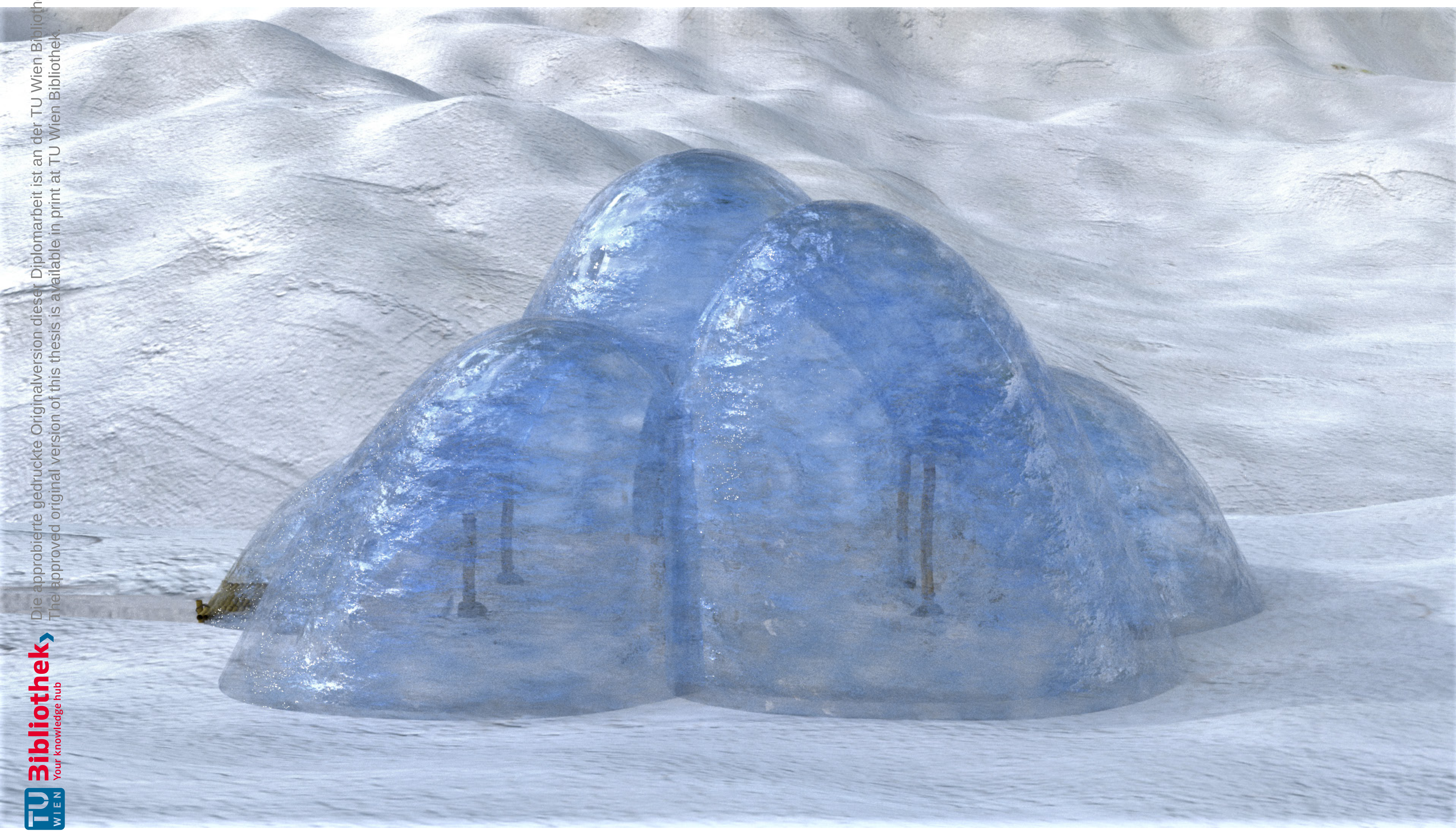
5.5 South View

Fig. 140



5.6 West View

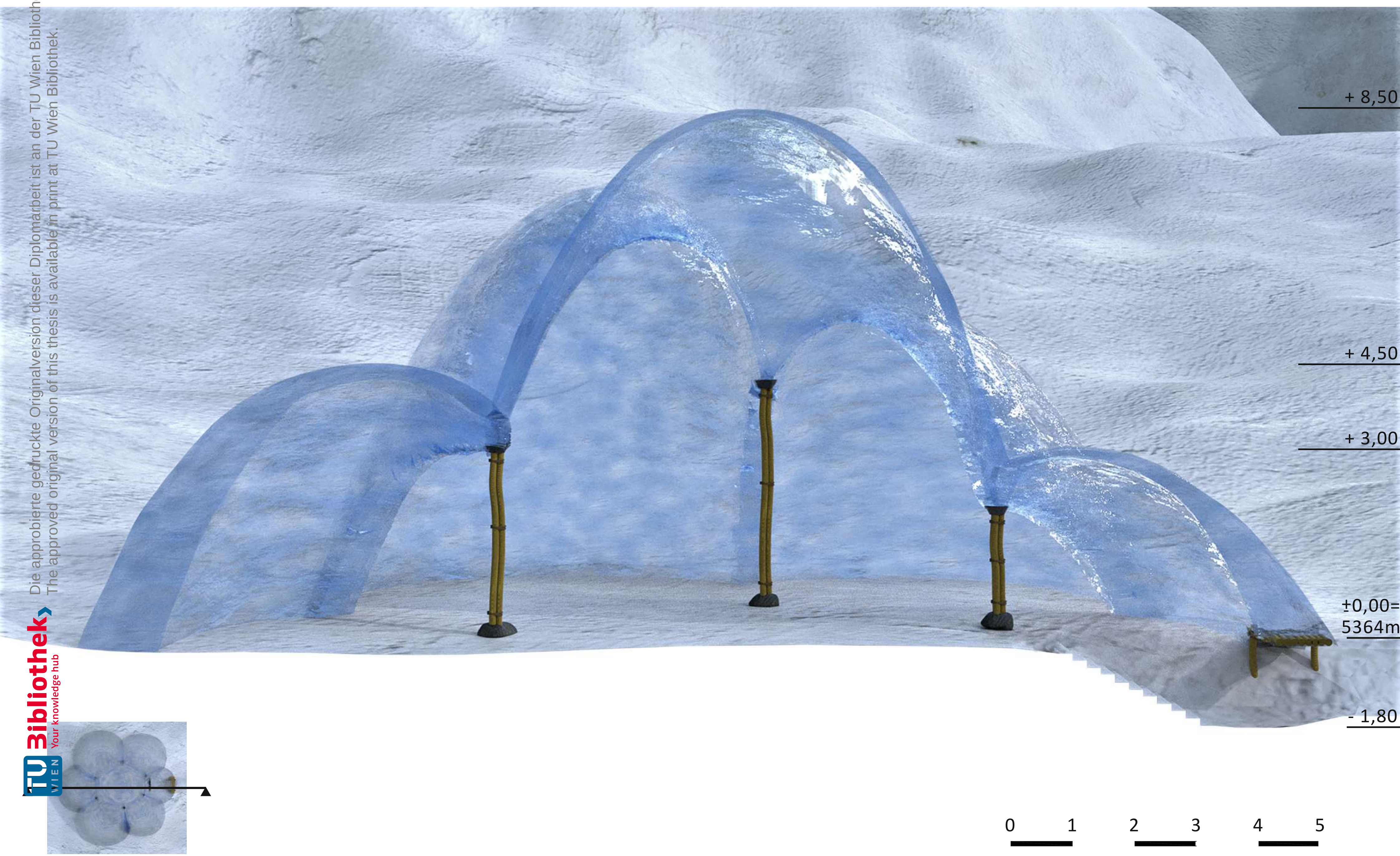
Fig. 141



0 1 2 3 4 5

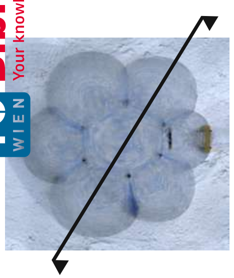
5.7 Section A-A

Fig. 142



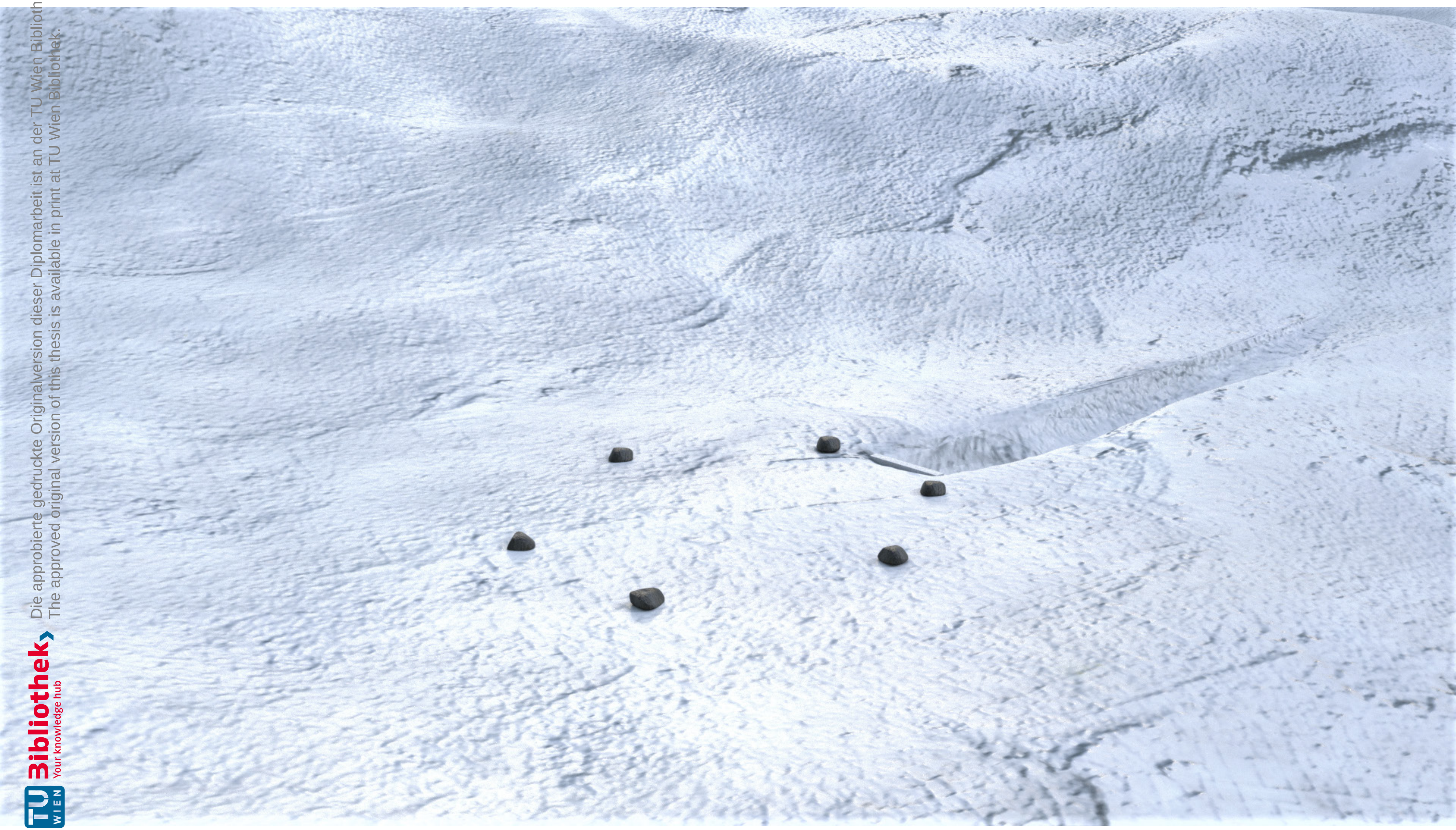
5.8 Section B-B

Fig. 143



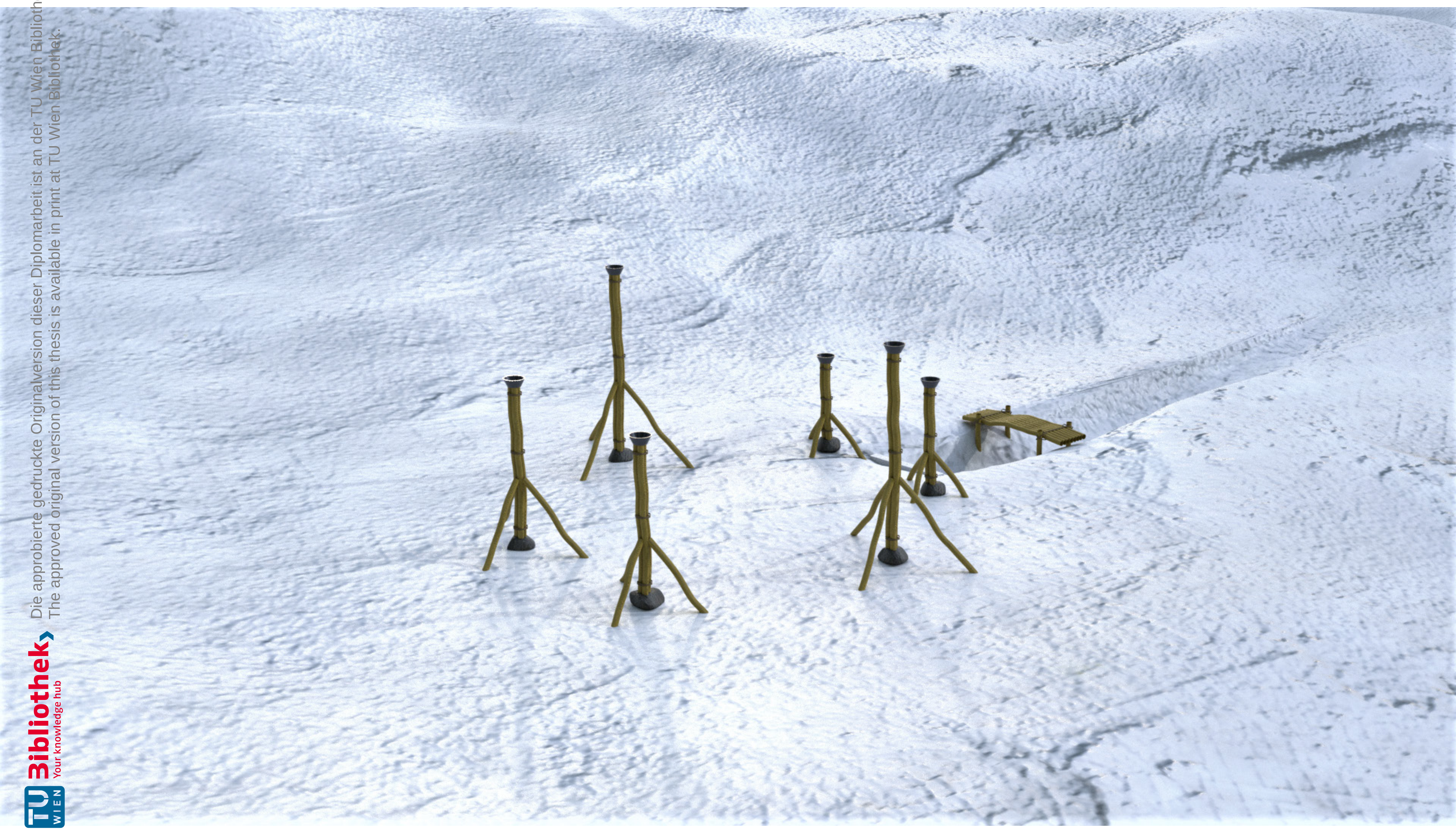
5.9 Construction Process

Fig. 144: Step 1



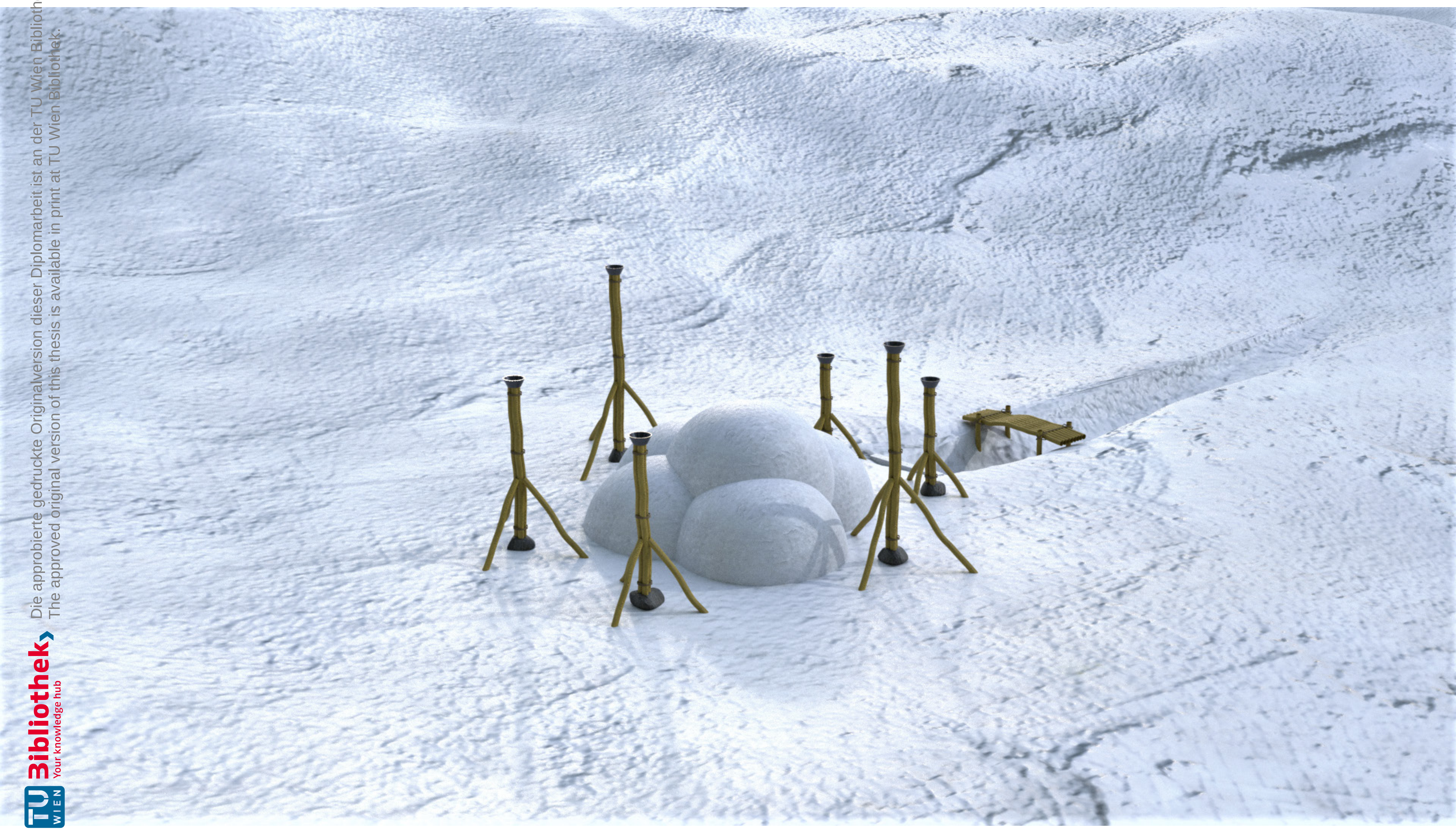
Step 1: excavating the ramp and positioning the footing stones

Fig. 145: Step 2



Step 2: Setting up the bamboo columns and bridge bearing above the entrance

Fig. 146: Step 3



Step 3: piling up snow

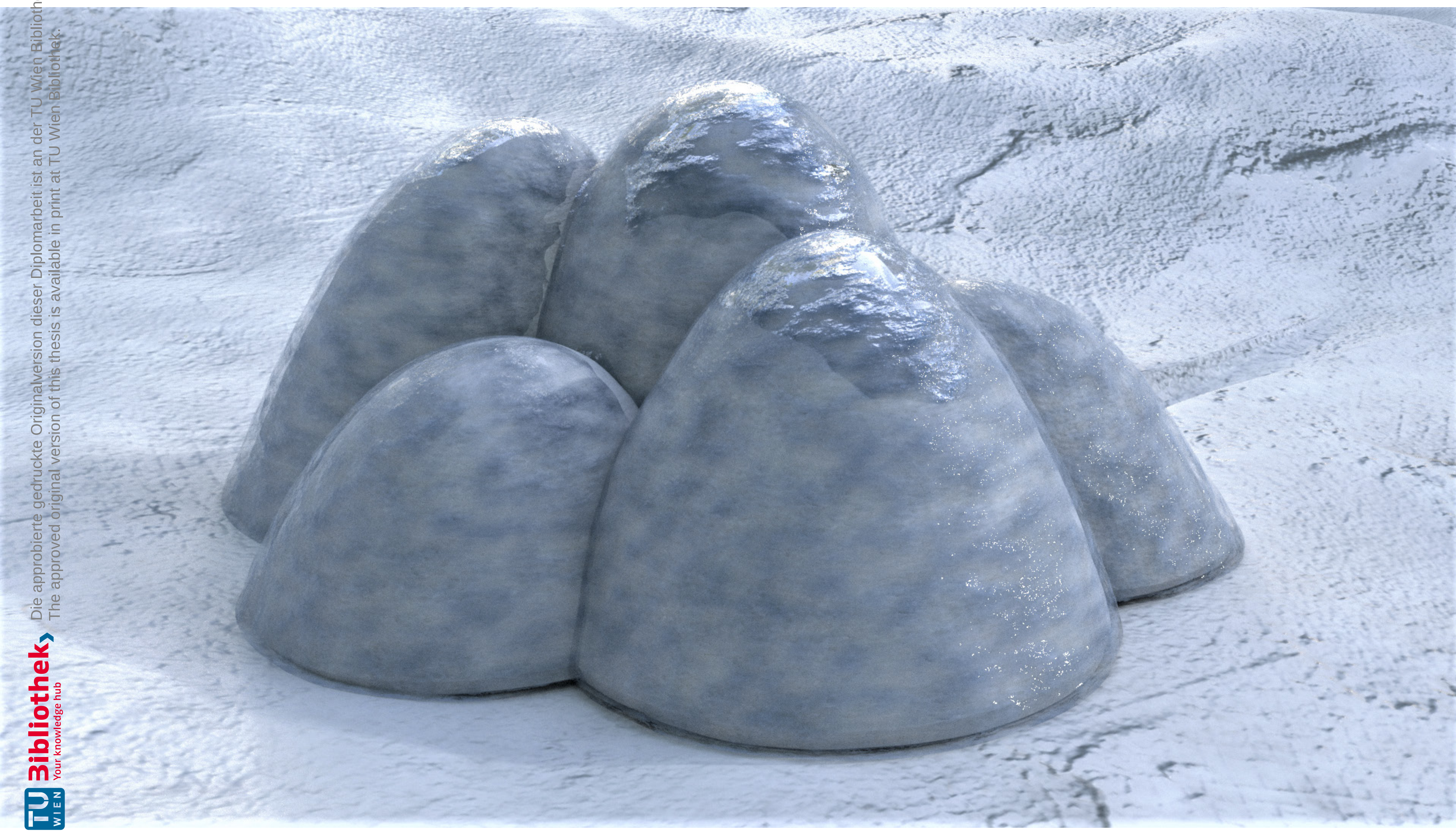
Fig. 147: Step 4

Step 4: continuing piling up snow

Fig. 148: Step 5

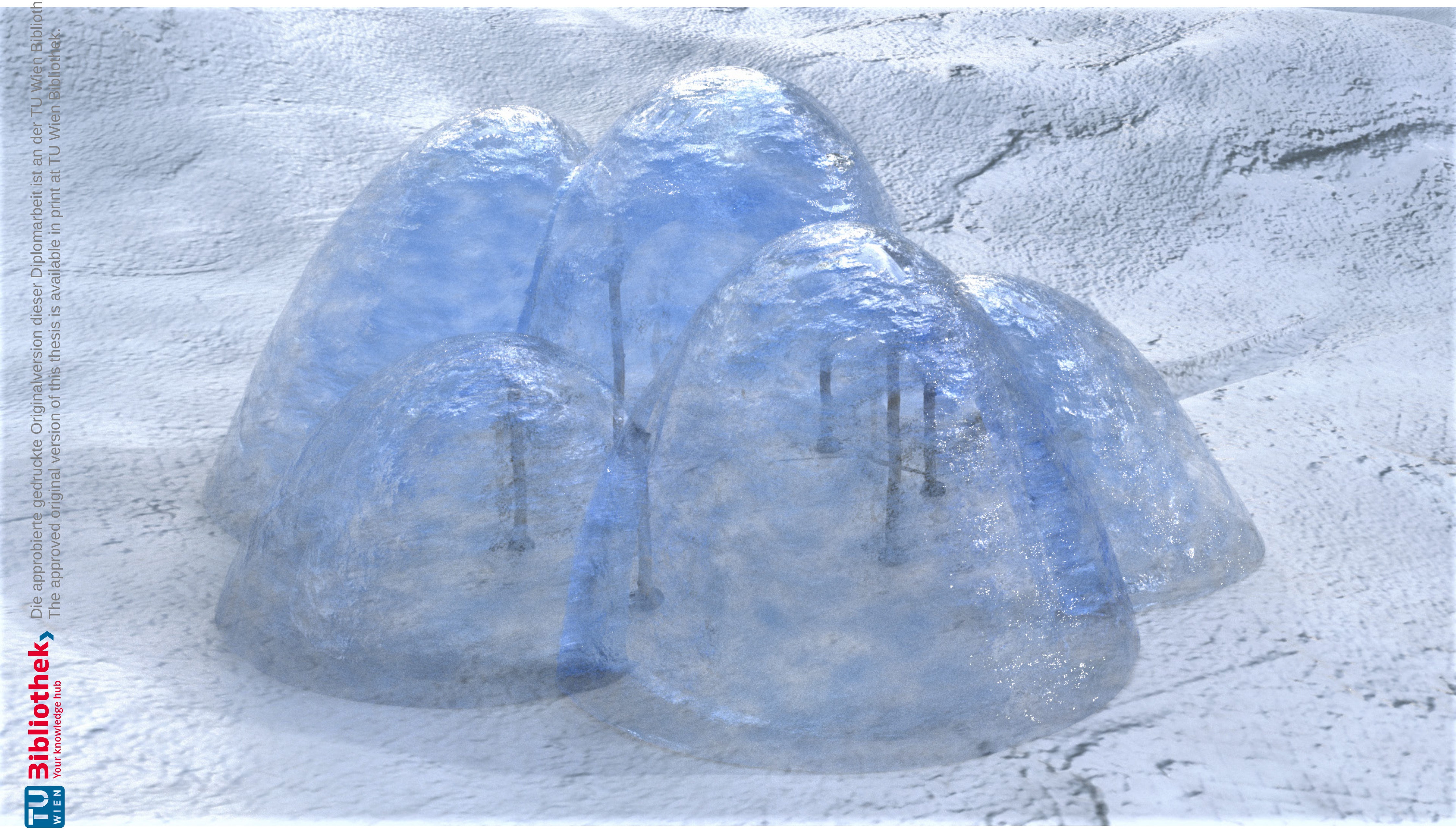
Step 5: customizing the snow pile according to the final shape

Fig. 149: Step 6



Step 6: Spraying water on top of the snow pile and letting it freeze layer by layer

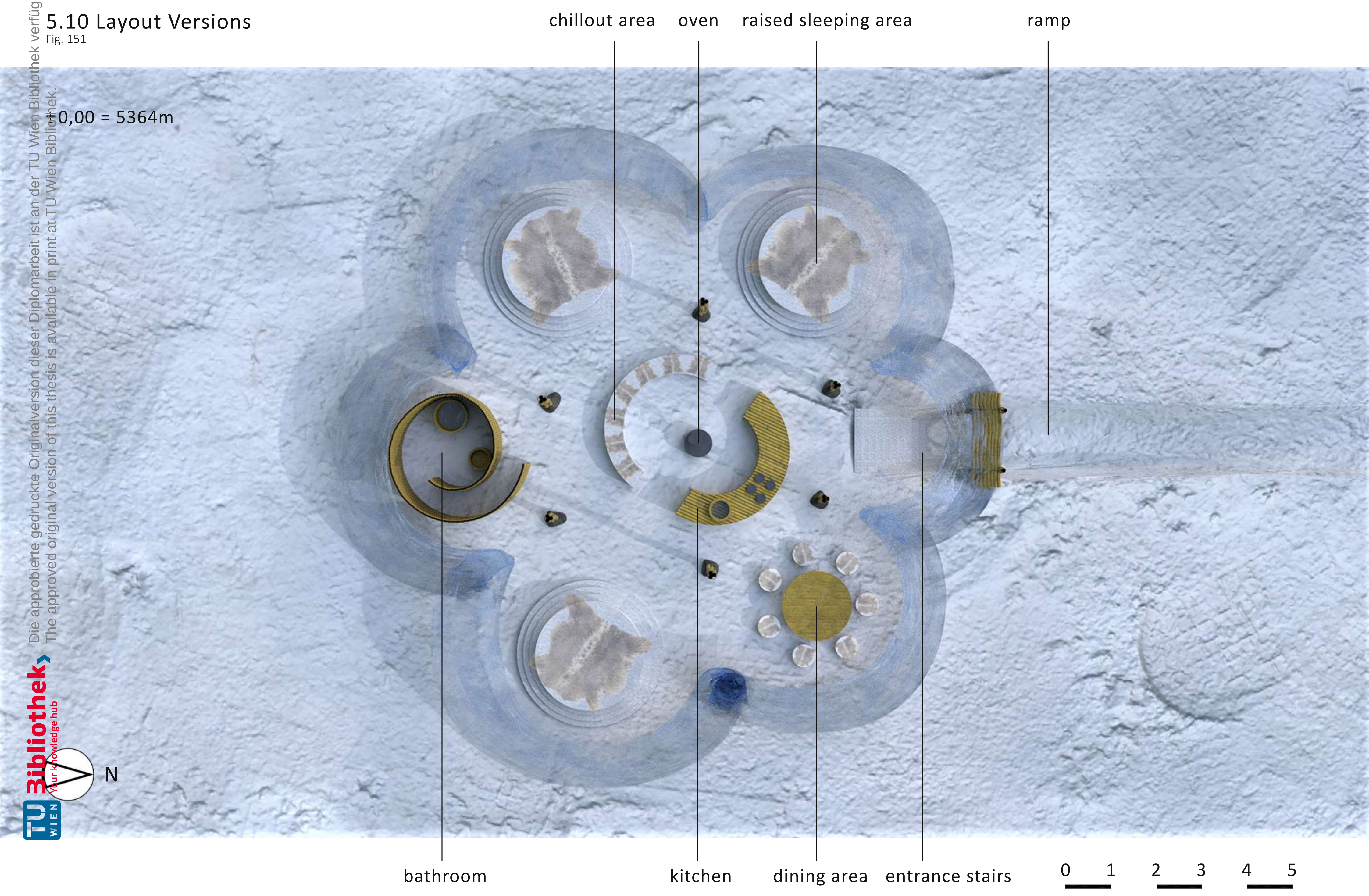
Fig. 150: Step 7



Step 7: Removing the snow pile underneath the ice shells

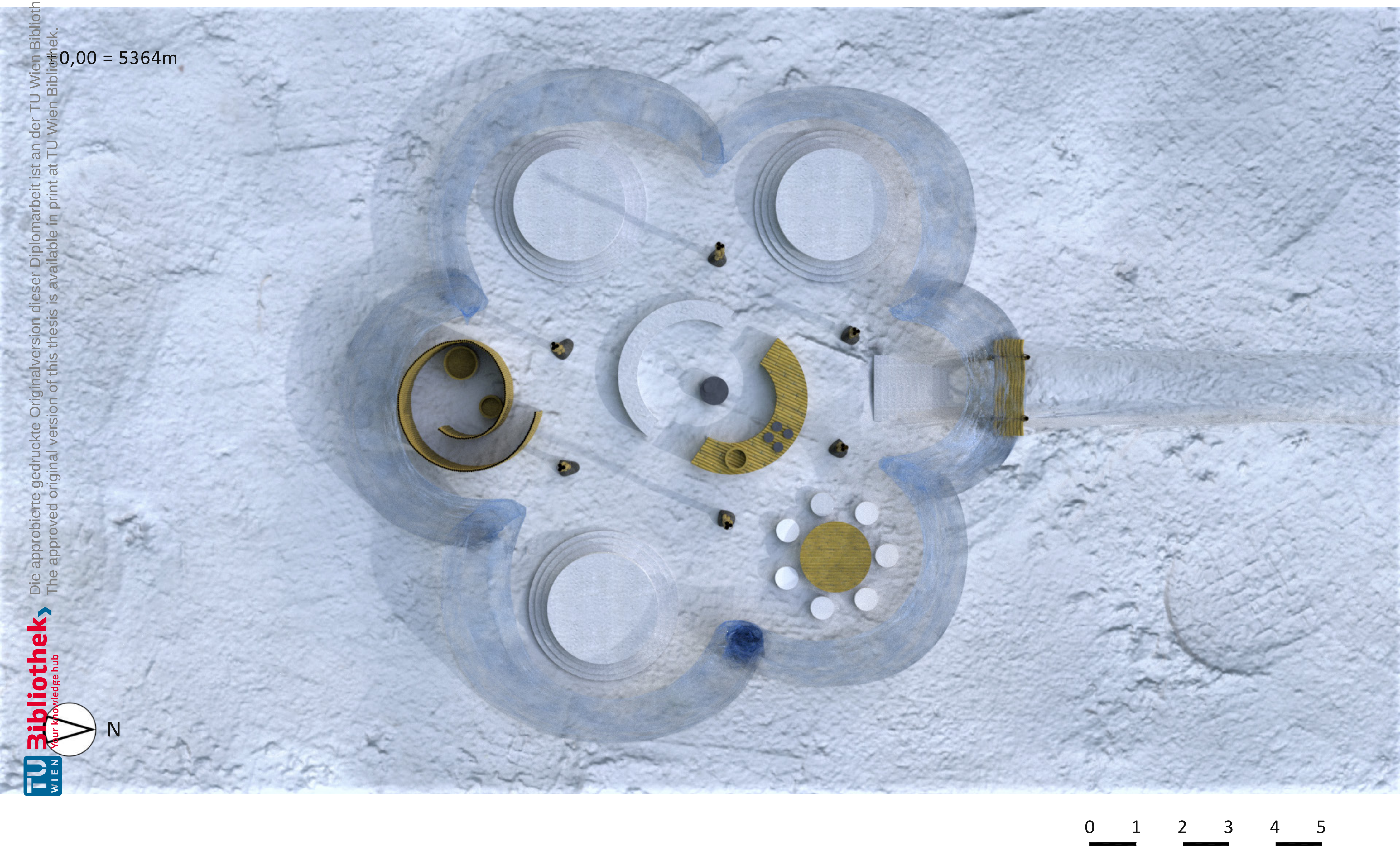
5.10 Layout Versions

Fig. 151

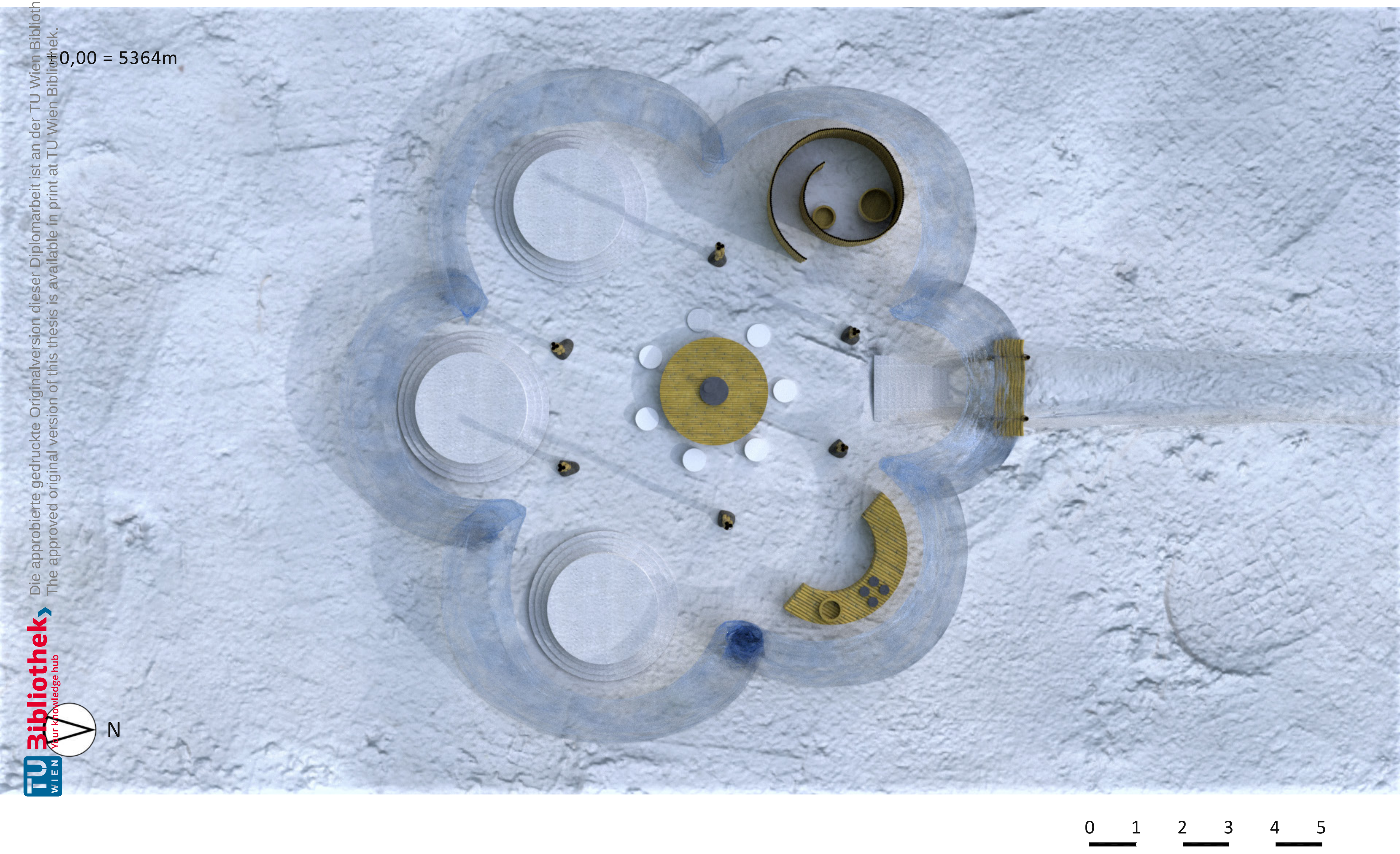


Version 1

Fig. 152

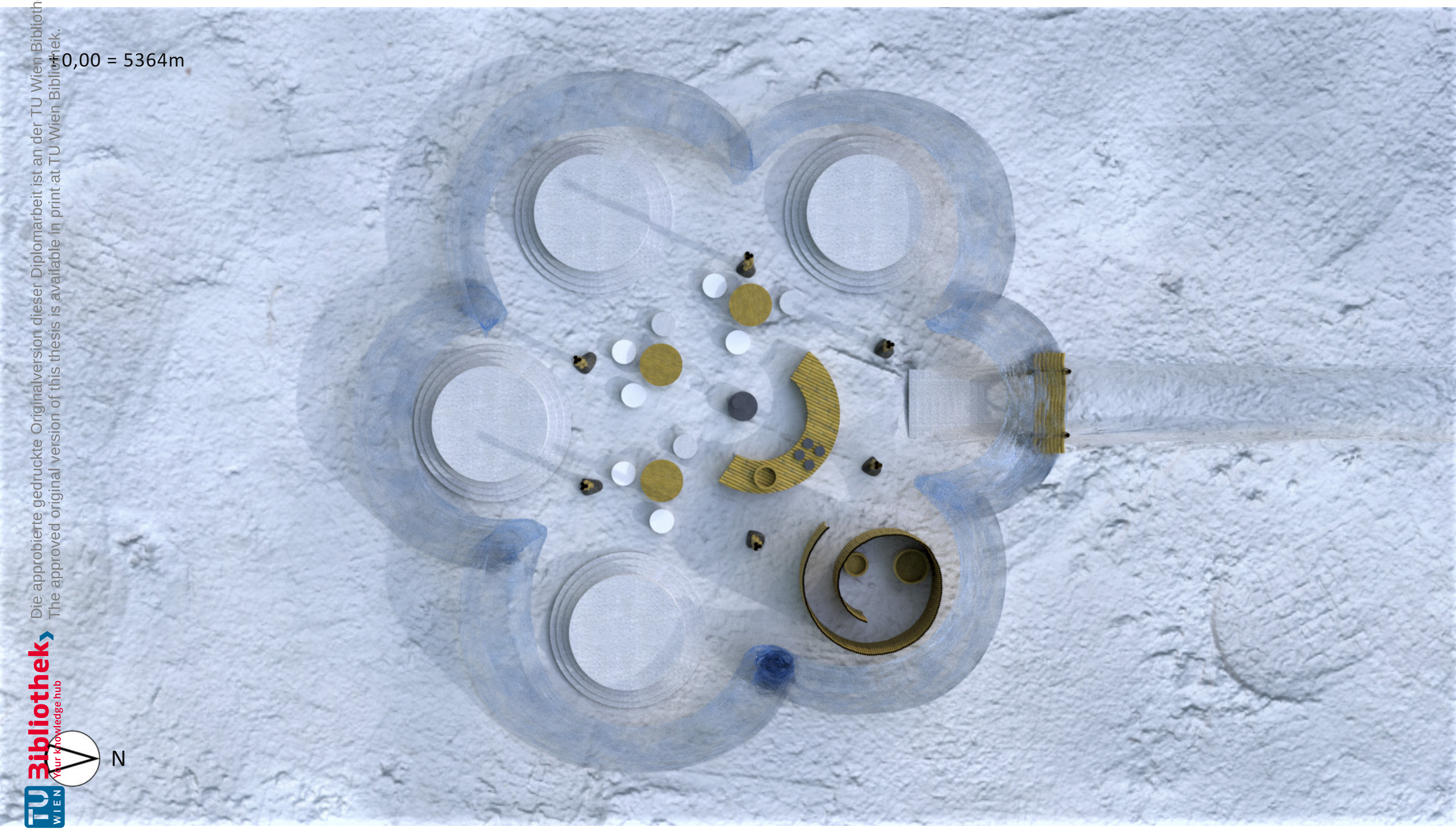


Version 2
Fig. 153



Version 3

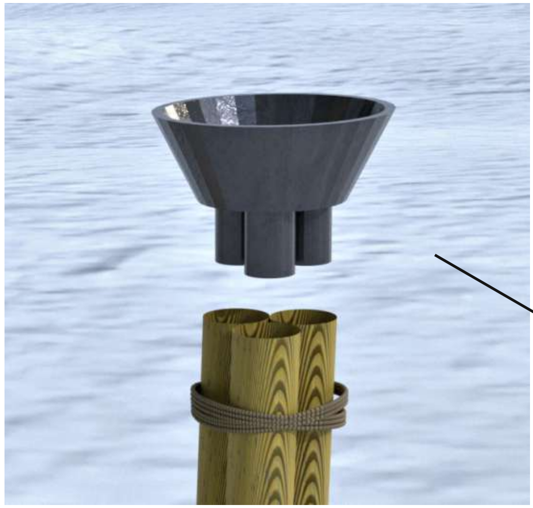
Fig. 154



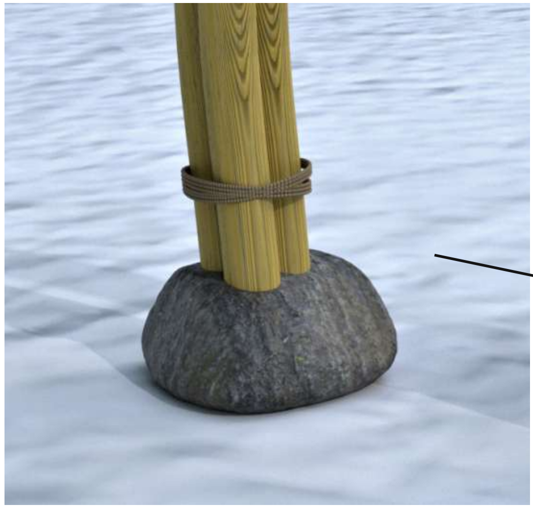
0 1 2 3 4 5

5.11 Details

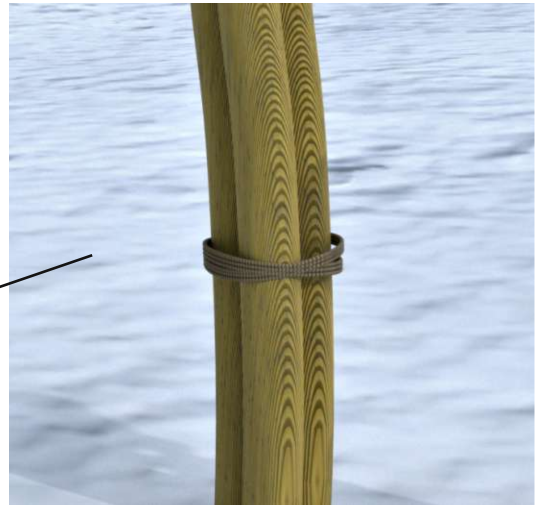
Fig. 155



connection between Ice shells and bamboo columns via metal hopper plugged into the bamboo canes



footing via traditional Asian stone and bamboo resting connection



3 bamboo canes bundled
and tied together

5.12 Renderings

Fig. 156: Rendering 1

Fig. 157: Rendering 2

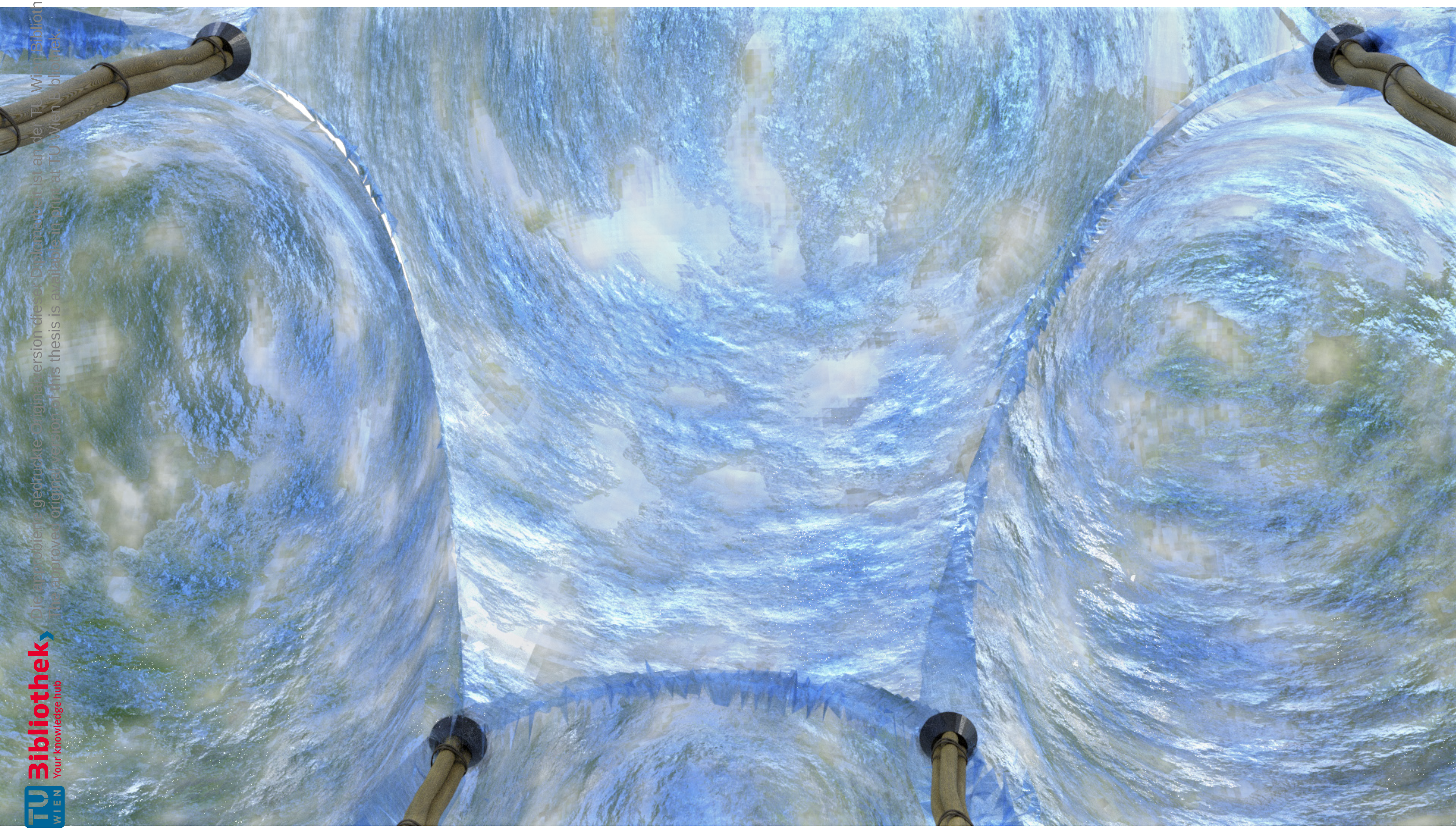


Fig. 158: Rendering 3

Fig. 159: Rendering 4

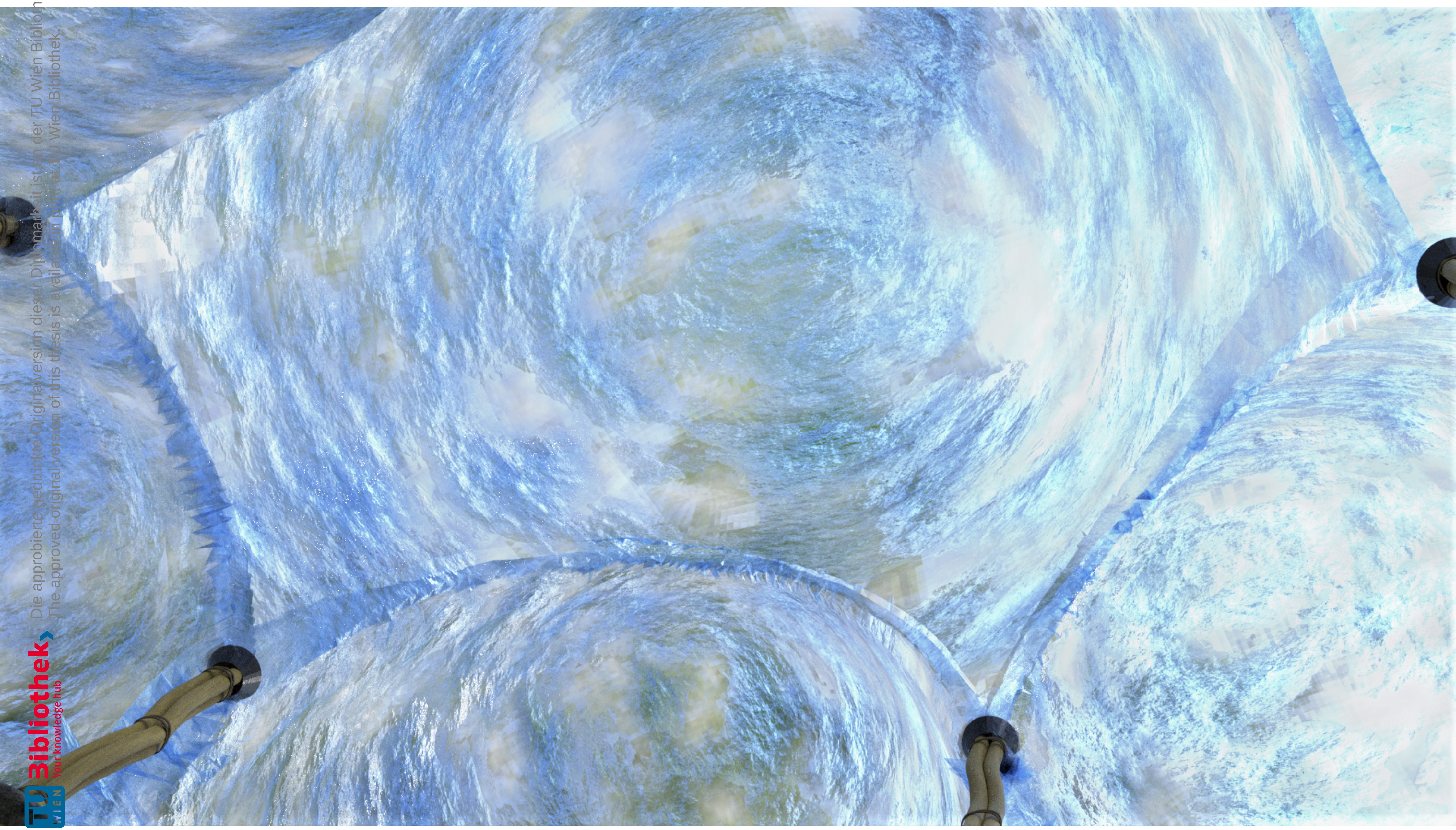


Fig. 160: Rendering 5

Fig. 161 Rendering: 6

6. EVALUATION AND OUTLOOK

6. Evaluation and Outlook

Diving into the Nepali climbing culture locally and climbing up Mount Everest Basecamp really was a one in a lifetime experience. Doing fundamental research about the Lodges, Sherpa Community, Khubu Valley, the Glacier, Climate at the Basecamp, Ice Architecture and Igloos opened doors to totally new possibilities regarding building on Mountains in extreme heights. Analyzing the user profile and exchanging thoughts and ideas with mountaineers and climbers showed that sustainability for accommodations in the mountains is one of the main concerns. Therefore, using a non-footprint material with a circular ecological life cycle could be a promising solution. The Ice Experiments and the Material Tests prove that Ice is more resilient and functional, especially when it comes to compressive force, then we would think. When mixing the ice with additives and binders, such as saw dust and wood shavings, it could be used even for multistoried buildings. The calcualtions of forces with Phänotyp revealed that freely generated shell geometries bear too many tensile forces onto the ice. With the aid of chain models, based on the catenary curve, diverse shall shapes with solely compressive forces were created.

It will still take some time before unconventional building materials like ice will be integrated and used in everyday life. Until then, there is still a need for research and connecting different expertise. Today, the constant climate change is in focus and changes the climatic conditions and requirements all around the world. Therefore, the next step will be to adapt architecture and building materials more to their natural environment and the climatic setting. Our society has to reconsider its approach to resources and waste to move toward circularity. A new way of thinking is necessary, especially in the architecture and building sector. The earth and its resources provide us with nearly unlimited ways of reusable materials without wasting them and by incorporating them into a cycle of sustainable circularity.

THANK YOU...

...TU Vienna for granting me the KUWI-Scholarship and making my trip to Nepal and hiking up Mount Everest Basecamp financially possible.

...Manfred Berthold and Christoph Müller for all the meetings, discussions, advices, and excellent mentoring.

...to my Family, especially my parents and grand-parents, for their tremendous support throughout all the years of studying.

...to my boyfriend Ozan for his backup and fond support during this project.

...my Nepali Family, Birgit, Raj, and Tara for making my stay in Nepal unforgettable and supporting me throughout the whole journey.

...Prabal Thapa for being my advisor abroad and inviting me to work with Prabal Thapa Architects.

... Socialtours for helping me organize the Trekking Tour. Special thanks to Sujan and Parbati for making sure I'll return safe and sound from the Trek.

...to the Technical Test and Research Institute of the University of Innsbruck for letting me perform my material tests in your facilities. Special thanks to Andreas Andreatta and Niklas Kofler.

...to my uncle Hans for all the discussions, exchange of ideas, and support.

...to Prateek and Emil for all the meetings in your working space in Kathmandu, discussions, and input about Nepali Architecture.

...Ang Babu Sherpa for taking the time for the Interview.

...to all my friends for supporting me and always listening to my ideas and opinions.

I dedicate this work to my parents, who taught me to never give up and always do my best for all challenges in life.


Fig. 162: Suspension Bridge


Fig. 163: Selfie with Sujan my Guide/Porter


Fig. 166: View to Namche


Fig. 167: The trekking group

Fig. 164: Parbati in Phortse

Fig. 165: Cairns

Fig. 168: Yaks

Fig. 169: Exploring Everest Basecamp

7. REFERENCES

TABLE OF FIGURES

LITERATURE AND WEBPAGES

1 Purja, Nirmal (2021): 14 Peaks: Nothing Is Impossible [movie], Nepal: Little Monster Films, Maekersuite, Media Ltd

2 Scheidtweiler PR (2018): Der Mount Everest - Das Dach der Welt, 7summit4help, [online] https://7summits4help.com/die-seven-summits/der-mount-everest-das-dach-der-welt/ [retrieved 12.04.2023]

3 WeDesignTrips (2023): Nepal Klassiker: Tipps & Infos rund um den Everest Basecamp Trek, WeDesignTrips, [online] https://wedesigntrips.com/de/i/nepal-everest-base-camp-trek [retrieved 12.04.2023]

2 Seyfferth, Günter (2019): The mountains of Himalaya, himalaya-info, [online] https://www.himalaya-info.org/khumbu_trekks.htm [retrieved 12.04.2023]

3 IOL (2008): Everest pioneers will be remembered, IOL, [online] https://www.iol.co.za/technology/everest-pioneers-will-be-remembered-388740 [retrieved 12.04.2023]

4 Schneider, Kurt (2019): Der Imker, der den Mount Everest eroberte, GEO, [online] https://www.geo.de/wissen/21696-rtkl-edmund-hillary-der-imker-der-den-mount-everest-eroberte [retrieved 12.04.2023]

7 Drescher, Cynthia (2016): This Is the World‘s Most Dangerous Airport, Conde Nast Traveler, [online] https://www.cntraveler.com/stories/2016-04-12/this-is-the-worlds-most-dangerous-airport [retrieved 12.04.2023]

8, 9 + 10 Sherpa Culture Museam, Sherwi Khangba Center, established 1990, Namche Bazar, visited at 30.04.2022, website: https://sherpa-culture.com.np/

11 IASToppers (2022): Khumbu Glacier, IASToppers, [online] https://www.iastoppers.com/articles/khumbu-glacier [retrieved 08.03.2023]

12 Nestler, Stefan (2020): Mount Everest: Wie der Khumbu-Eisbruch fließt, Abenteuer Berg, [online] https://abenteuer-berg.de/mount-everest-wie-der-khumbu-eisbruch-fliesst/ [retrieved 08.03.2023]

13 Sherpa Culture Museam, Sherwi Khangba Center, established 1990, Namche Bazar, visited at 30.04.2022, website: https://sherpa-culture.com.np/

14 Meteoblue (2023): Simulierte historische Klima- und Wetterdaten für Everest Base Camp, Meteoblue, [online] https://www.meteoblue.com/de/wetter/historyclimate/climatemodelled/everest-base-camp_china_10237388 [retrieved 10.05.2023]

5 SAGE Publications (2022): Ice Architecture, SAGE journals, [online] https://journals.sagepub.com/doi/full/10.1177/09560599211000961 - Book!! [retrieved 15.05.2023]

16 MaterialDistrict (2018): Ice Architecture: The World‘s tallest Ice Tower and Ice Hotel, MaterialDistrict, [online] https://materialdistrict.com/article/ice-architecture/ [retrieved 15.05.2023]

17 MaterialDistrict (2018): 3D Printing with Fibre-Reinforced Ice, MaterialDistrict, [online] https://materialdistrict.com/article/3d-printing-fibre-reinforced-ice/ [retrieved 15.05.2023]

18 The Editors of Encyclopaedia Britannica (2022): Igloo, The Editors of Encyclopaedia Britannica, [online] https://www.britannica.com/technology/shotgun-house [retrieved 20.03.2023]

19 Hoyt, Alia: How Igloos Work, howstuffworks, [online] https://people.howstuffworks.com/igloo.htm [retrieved 20.03.2023]

20 Gadacz, Rene R. (2006): Igloo, The Canadian Encyclopedia, [online] https://www.thecanadianencyclopedia.ca/en/article/igloo [retrieved 20.03.2023]

21 Raveendran, Rugma (2022): How Does An Igloo Keep You Warm?, Science ABC, [online] https://www.scienceabc.com/nature/how-does-an-igloo-keep-you-warm.html [retrieved 20.03.2023]

22 Gadacz, Rene R. (2006): Igloo, The Canadian Encyclopedia, [online] https://www.thecanadianencyclopedia.ca/en/article/igloo [retrieved 20.03.2023]

23 Bocksch, Rene (2021): Es wird voll auf dem Everest, Statista, [online] https://de.statista.com/infografik/24929/geschaetzte-anzahl-der-erfolgreichen-besteigungen-des-mt-everest/#:~:text=Wie%20steil%20die%20Anzahl%20der,Gipfel%2020Everest%20besucht. [retrieved 05.05.2023]

24 Design City Team (2021): No Footprint House by A-01 is a prototype for integrally sustainable development, Design City Team, [online] https://designcitylab.com/post/architecture/no-footprint-house-by-a-01-is-a-prototype-for-integrally-sustainable-development [retrieved 05.05.2023]

25 Bewegende Architektur e.U. and Karl Deix: Phänotyp, [online] https://phaenotyp.bewegende-architektur.com/doku.php?id=start [retrieved 22.05.2023]

26 Rainer, Graefe (1983): Article: Zum Entwerfen mit Hilfe von Hängemodellen, Magazine: Werk, Bauen + Wohnen, Volume 70/Issue 11, pages 24-28

27 Pitt, George H.: Pykrete - Experimental Ice Ships in the Rockies, Combined Operations, [online] https://www.combinedops.com/Pykrete.htm [retrieved 26.04.2023]

8. CURRICULUM VITAE

LANGUAGES:

German	native language
English	C2

AWARDS:

2022 February	KUWI-Scholarship for scientific research abroad from TU Vienna
2017 January	exhibition model for spatial design at TU Vienna
2015 June	Tirolean offspring engineer award for the project: Bivouac – Emergency shelter in high altitude alpine region

IT- AND PROGRAMM SKILLS:

AutoCAD, Allplan, Blender, Photoshop, InDesign, Lumion	very good
ArchiCAD, Archiphysik, Rhino, Sketchup	good
Microsoft Word, Excel, Power Point	very good

SOFTSKILLS:

Construction survey: 3D laser scanning + photogrammetry
Technical comprehension and know-how
Design development
Leadership qualities
Working precise and independent
Team player and cosmopolitan

INTERESTS:

sport	climbing, hiking, table tennis, skiing, swimming, dancing
creativity	drawing, fashion, design
music	playing the clarinet, singing, member of the marching band Mils
traveling	experiencing architecture all around the world: Chicago, Istanbul, Copenhagen, Paris, Barcelona, Lisbon, Milan, Rome, Athens

PERSONAL DATA

NAME:	Teresa Pohl
DATE OF BIRTH:	01.06.1996
ADDRESS:	1160 Ottakring Vienna
NATIONALITY:	Austria
E-MAIL:	teresa.pohl@cni.at

EDUCATION:

2021 July- 2023 June	Master for Architecture TU Vienna
2015 October- 2021 July	Bachelor for Architecture TU Vienna
2010 September- 2015 June	Technical High School for Interior Design and Wood Technology Imst, Tirol

SEMESTER ABROAD:

2021 September- 2022 February	Erasmus winter semester Istanbul Technical University Turkey
2020 February- June	Erasmus spring semester University of Nicosia Cyprus

EXCURSIONS:

2022 April- June	Scientific research on mountain accommodation and climbing up Mount Everest Basecamp for my Master Thesis Kathmandu, Nepal
2020 October	Construction survey and building research at Tomba di Barberini Rome, Italy
2018 December	Experimental building research on Tuff Opus Reticulatum Mayen, Germany

WORK EXPERIENCE:

Architecture office Baupuls GmbH in Kematen, Tirol:

2022 November- today 2020 October- 2021 June	Part-time: designing residential and commercial buildings, creating submission and implementation plans
2018- 2022 each July- August	Full-time: building architectural models, creating renderings, site supervision of constructions
2020 October- 2021 June	Student Assistant as Mentor at TU Vienna: performing lectures and organizing student events
2015 November- 2019 June	Part-time job at Easystaff human & resources GmbH as waitress, hostess and promoter
2017 August	Internship at Prabal Thapa Architects, Kathmandu, Nepal: designing a residential building
2017 July	Internship at the mountain railway Imst, Tirol: sales
2015 July- August	Internship at the mountain railway Imst, Tirol: customer service and sales
2014 July- August	Au Pair in St. Louis, USA
2013 July- August	Internship at the Architecture office Pohl ZT GmbH Ötztal-Bahnhof, Tirol: designing apartment buildings
2012 August	Internship at Pohl Metall GmbH