LUKAS STAMPFER

EMBRACING THE NORTH

TECHNISCHE UNIVERSITÄT WIEN
Vienna | Austria

Diplomarbeit

Embracing the North

Investigating a possible use of traditional Icelandic turf constructions in today's architecture

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

Ao. Univ. Prof. Dipl. Ing. Dr. phil. Andrea Rieger-Jandl

E251 - Institut für Kunstgeschichte, Bauforschung und Denkmalpflege
Abteilung Bauforschung

eingereicht an der

Technischen Universität Wien
Fakultät für Architektur und Raumplanung

von

Lukas Stampfer 0927176

Wien, am 5. April 2018

abstract

For more than 1000 years buildings made from turf served as the predominant habitat for Icelanders. Through the absence of oxygen in water saturated soils incompletely decomposed plant remains accumulate to a dense weave of fibres. Cut from the ground with scythe-like tools and spades in different patterns, pieces are used to construct shells that, filled with rammed earth, form the main walls of the cluster-like turf farms. Carried by a wooden structure separated from the turf on the inside the same material is used to cover the roof and make it waterproof.

The aim of this work is to analyse if, through adaptation of these historic techniques, turf buildings could find application in current architecture. Through introducing some modern building materials and alternating some problem areas in the construction, it is believed that this could result in a highly insulated and locally inspired architecture, that is mainly constructed from natural and bio-degradable materials. Massive walls and the ability to blend into the landscape with green walls and roofs carry potential to be used as architectural tools to inspire a progressive interpretation of this building heritage.

Reviving this tradition could further help in the preservation of historic turf buildings as, through constant decay of material, these structures are highly dependent on the customary periodic rebuilding.

Kurzfassung

Seit mehr als 1000 Jahren bieten Torfhäuser den Bewohnern Islands Schutz vor den rauen Wetterbedingungen auf der Insel. Ein hoher Wasserspiegel im Erdreich führt durch den Ausschluss von Sauerstoff zu einer unvollständigen Verrottung von abgestorbenen Pflanzen, welche sich folglich in Form eines dichten Geflechts ablagern. Dieses wird mit Torf-Sichel oder Spaten aus dem Boden gestochen und bildet, als Schalenmauerwerk, gefüllt mit komprimierter Erde, die Außenhaut für die cluster-artigen Torffarmen. Getragen von einer Holzkonstruktion im Innenraum, wird auch das Dach mit Hilfe von Torfstücken wasserdicht ausgebildet.

Ziel dieser Arbeit ist es zu analysieren welche Adaptionen der historischen Techniken notwendig wären, um eine Anwendung in zeitgemäßer Architektur zu finden. Es besteht die Hoffnung, dass durch die Adaptierung von Problemstellen mit aktuellen Möglichkeiten und Baustoffen eine äußerst energie-effiziente, ortsbezogene Architektur, vorwiegend aus natürlichen sowie biologisch abbaubaren Materialien, entstehen kann. Die Massivität der Wände sowie das Einfügen in die Landschaft mit grünen Wänden und Dächern bergen ein architektonisches Potential, welches eine progressive Verwendung dieser historischen Techniken inspirieren könnte.

Durch die kontinuierliche Erosion der Außenhaut sind Torfhäuser weitestgehend abhängig von einer periodischen Erneuerung, welche traditionell auch so gelebt wurde. Eine Wiederbelebung dieser Tradition könnte hiermit weiters den Fortbestand historischer Anlagen sicherstellen.

1 introduction

figure 01 - Glaumbær turf farm in Skagafjörður

1.1 preface

“People are not ashamed of their heritage anymore “

A random stranger assesses the attitude of Icelanders towards their architectural history during a ride with a foreign traveller in his car. After being the most common building type for hundreds of years, the Icelandic turf house was moved into the museums, a relic, not suitable for today in the eyes of the people. But after years of trying to get away from the (maybe even self-proclaimed) image of being the ones living in dirt-holes, there seems to be a sense of resurrection in the air. With the biggest part of these buildings disappearing from the landscape during the last century, people now seem to understand that a tradition that kept their ancestors alive, and frankly made life on this island possible at all, is about to be lost. Besides preserving a few examples in form of outdoor museums, there seems to be an increasing engagement of locals in acquiring the knowledge of these ancient construction methods again and learn how to build houses out of the earth and ground they own.

It is this momentum that makes confident it is time to engage in the topic and think about how a transformation of this tradition could lead to structures suitable for today's expectations in a home.

There are three major points that are deemed to bare the biggest potential in turf building. First of all, thermal insulation - for hundreds of years the walls of these turf houses have kept the Icelandic people warm and protected them from wind, rain and cold. With increasing awareness about the need to build more energy efficient, this is more important than ever. The second point is the very concept of building a house out of the ground it stands on. Relying on materials that are already available at the building site or at least in its surrounding reduces construction cost not just by reducing transport distances but also by making use of a resource that seems to be available in abundance – land. Finally, the idea of building something out of the ground it is based upon gives the architect or person building the house a very strong design tool. The building merges with its surrounding, becomes one with it - showing itself at some points, disappearing at others.

Learning about all this, the idea was born to start working on turf houses for this master thesis. During a trip throughout the country, all alone and exposed to the elements with only the things a person can carry, the intention was to learn more about the environment these buildings are embedded in. An architecture that seems to serve as a catalyst enhancing all the impressions a visitor of Nordic countries might come to value. Architecture in a conversation with its surrounding, promoting it, resisting it, one with it.

1.2 terminology

turf / peat / sod

The three terms at hand are often used as synonyms. To be precise in the naming of material they were traced in their meaning and etymology. Websters dictionary of biology treats the three as synonyms of a grass cover.[1] Webster online dictionary already diversifies, saying sod is the same as turf, said grasscover, but peat is either turf dried for fuel or partially carbonized vegetable tissue formed by uncomplete decomposition in water.[2] This is supported by WEDGWOOD explaining peat used to name pieces of turf cut and dried for fuel and later extended to the meaning of said partially decomposed plat remains. It is believed to have derived from old English bete, meaning "to mend" or "to kindle a fire".[3]

Following the Icelandic etymology of turf, MAGNÚSSON says it describes the grass cover and bog-soil, originating from the Germanic term *turba-

---

1 see COLE 2015

2 MERRIAM-WEBSTER.COM web page last visited March 30th, 2018

3 WEDGWOOD 1862 p. 496

figure 02 - turf or peat or sod before being cut from the ground

and indoeuropean *derbh-, meaning “to turn” or “winding into each other”.[4] Said meaning is supported by KROONEN[5] and POKORNY.[6] Having the woven fibre-structure of turf in mind, this explanation appears adequate.

4 MAGNÚSSON 1989 p. 1053

5 KROONEN 2013 p. 527

6 POKORNY 1958 p. 593

To conclude it can be said, that while etymologically there are differences at hand, the terms are used as synonyms in modern English and can therefore be understood as such. For the sake of consistency to the Icelandic term, “turf” will be used preferential, sod and peat can nevertheless be understood as synonyms in this work.

turf house

To start with it is imperative to determine what constitutes a turf house. Direct contact with locals and people involved with turf building showed that definitions might vary.

In personal communication with Hannes LÁRUSSON[7] from Íslenski bærinn he expressed that it is not only the use of this special material that qualifies a building to be called “turf house”, but also the nonsymmetric, organic grown layout of the structure that is characteristic. But since buildings with its main material being turf can also be found outside of Iceland, it appears reasonable to separate the terminology of the material from the one representing the cluster-like layout of the Icelandic bær.

A typical Icelandic turf house consists of two main elements: the not load-bearing outside walls, that are erected out of turf and a separated wooden structure on the inside carrying the turf roof and eventual wooden planking on the inside. The rooms can partwise be dug into the ground to reduce the height of the walls necessary as well as amount of surface exposed to the weather. Increasing rapidly with the lift of the Royal trade monopoly[8] 1787

---

7 LÁRUSSON personal communication June 11th, 2017

8 see GUNNARSON 1987

figure 03 - front facade of Laufás turf farm

foreign handicraft and new building materials are introduced and implemented in traditional structures blurring the clear definition more and more.

Today there are modern architectural projects that call themselves turf houses while adopting only single elements of the tradition. For the sake of understandability, this work will follow the definition of Icelandic architect Rögnvaldur ÓLAFSSON. He says that in the Icelandic language, a turf house is a house whose walls were built solely from turf or in combination with stones. He argues, that a stone-walled house with a timber roof construction is still called a stone house and a wooden house is not called a turf house even though it has a turf roof. Therefore, the material of the walls is the key factor in determining the name of the construction method.[9] To live up to the mentioned hybrids, it seems fair to say that a house can still be called a turf house, characterizing this unique building technique, if there is at least some of this material used in a clearly visible manner to construct the outside walls.

the Icelandic bær

Since there is no translation describing the Icelandic word "bær" properly, further definition of the term is necessary. The etymological dictionary describes it as "sveitabær; íbúðarhús; kaupstaður, borg" [10], which, after comparing various dictionaries,[11] is best translated as "farm (sveit = countryside); residential building; town (kaup = isl. purchase; staður = isl. site); city".
Tracing the genesis of the word,[12] its roots can be found in the Indo-

9 ÓLAFSSON 1911 p. 187
10 MAGNÚSSON 1989 p. 100
11 DICT.CC; TRANSLATE; UWDC ICELANDIC ONLINE DICTIONARY web pages visited October 23rd, 2017
12 WIKTIONARY web page visited October 23rd, 2017

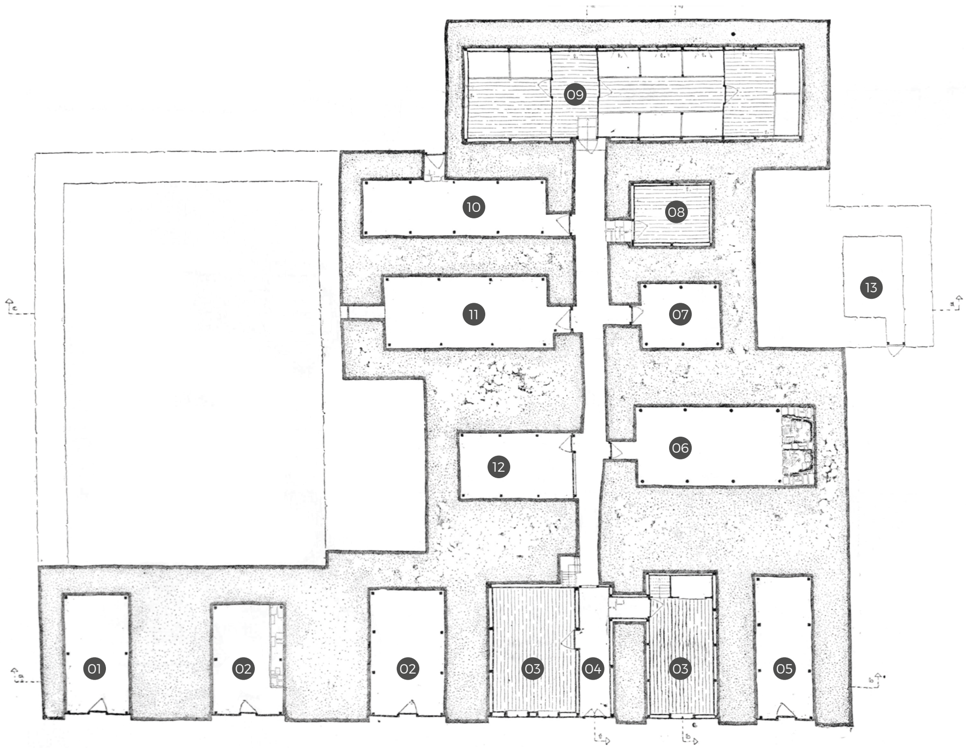
Germanic *bheu-[13], which can be understood as "to be, to grow, to arise".[14] This gives a much stronger continuous aspect to the term than "farm" or "village", which seems to be more suitable, especially in the tradition of being built and rebuilt from turf through generations. As LÁRUSSON argues in his article:

> "A house can be finished; it will then take on its finished structure. Bær is a process that spins its continuum from inner necessity. Therefore, bær cannot be finished."[15]

With this knowledge it seems the Icelandic bær can be defined as a settlement with residential and agricultural purpose that is growing in an ongoing process from a core cell throughout centuries to various extent. The increase of structures can occur in form of attached or implemented functional units to the core cell as well as with satellite elements in the vicinity. Combined with the building material turf and its necessity of being rebuilt and refurbished after a certain amount of time, it is typical to the Icelandic bær to live through an evolution of frequently and gradually adapting to its context.

---

13 DUDEN HERKUNFTSWÖRTERBUCH 2014 p. 153
14 POKORNY 1958 pp. 146-150
15 LÁRUSSON 2014 p. 14


09
10
08
13
11
07
06
12
01
02
02
03
04
03
05

01 - smithy
02 - storeroom (Skemma)
03 - guest room (Stofa)
04 - central hallway
05 - fuel storage
06 - kitchen (Eldhús)
07 - main pantry (Búr)
08 - study
09 - Baðstofa
10 - southern exit
11 - long pantry
12 - dairy
13 - haystack

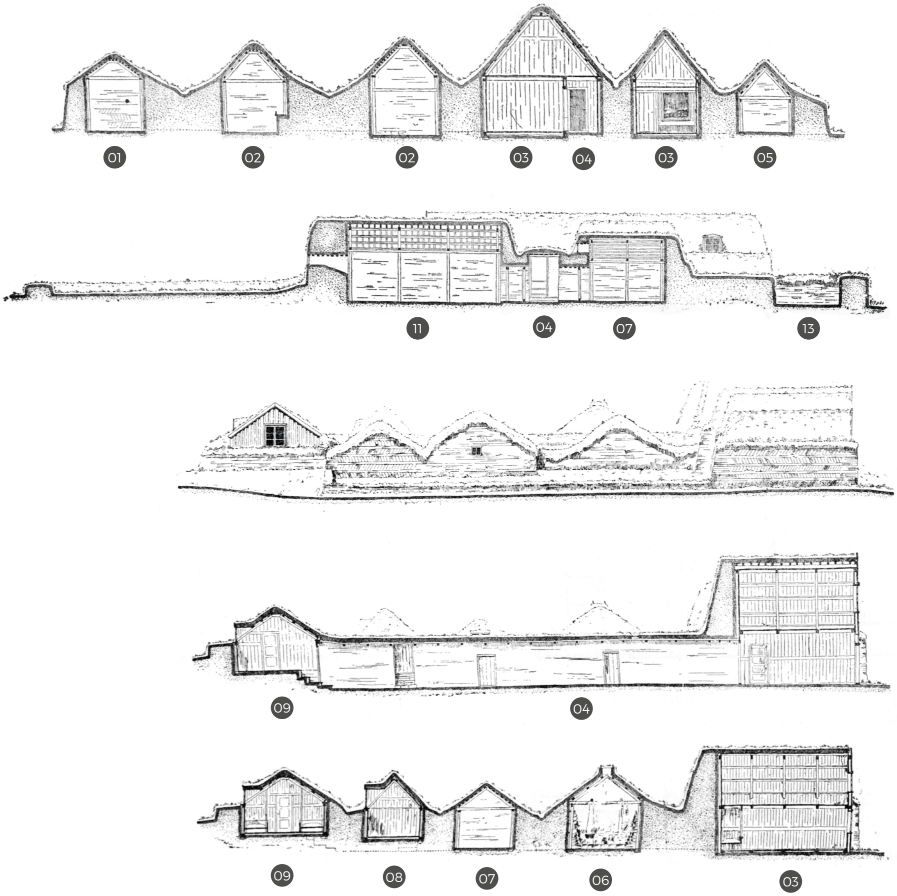


figure 04 - floorplan, section and elevation drawings of Glaubær turf farm scale 1 : 250

1.3 materials and methods

literature

When reviewing literature about the Icelandic building tradition, one soon comes to realize that very little information is at hand. When the National Architectural Heritage Board of Iceland was founded in 1969, it came to the same realization. Therefore a work was commissioned that should help them gauge the extent of the architectural heritage.[16] Resulting from that, in the year 1998 the first Edition of Hörður ÁGÚSTSSONs two volume Íslensk byggingararfleifð (= Icelandic cultural heritage) was published, which today is still one of the main sources on the topic. It tries to give a general overview on architecture in Iceland, “a country which experienced primitive living conditions well into the 20th century, when it suddenly turned into a modern technological society.”[17] Working in a timeframe from 1750 to 1940, the author tries to categorize according to building materials and then give an overview on the chronological development and distinct typological patterns – one of

16 ÁGÚSTSSON 1998 p. 437
17 ÁGÚSTSSON 1998 p. 437

the chapters covering turf buildings. A more specific piece adressing the topic at hand is the 2013 published Af jörðu: íslensk torfhús (= From the earth/ ground: Icelandic Turf house) by Hjörleifur STEFÁNSSON. It gives a comprehensive overview on the building techniques and the tools in use followed by documentation of turf buildings that are still visible today including some parts of the historic development.[18]

The two works in combination are a solid base of information for everyone intending to work on Icelandic turf buildings. It is unfortunate that both are written in Icelandic, which makes it quite hard for foreign scholars to participate in a scientific discourse without adopting a decent extend of knowledge on the language. Furthermore, it is almost impossible to discuss Icelandic tradition without considering the language to some extent. As seen in the chapter before, a simple translation cannot live up to the task of delivering the information the word contains - already the most basic terms need definition. One of the first foreign monographies on the topic that can be found seems to be the dissertation “Die aus Grassoden und Holz gebauten Höfe und Kirchen in Island”[19] by Edwin SACHER, submitted in 1938. Translated as “The farms and churches built of sod and wood in Iceland” SACHER provides a rather technical approach on how turf buildings are constructed down to the detail and, furthermore, includes some classification of layout types. With no literature on the topic available at the time, his arguments are mostly based on the cultural and mythological background of Iceland. The set of beautifully and detailed illustrations to his observations included in the book should be mentioned here in particular. Byggðasafn Skagfirðinga, the Skagafjörður Heritage Museum is an institution that seems to be especial-

18 see STEFÁNSSON 2013

19 see SACHER 1938

figure 05 - instructions at the turf building course

ly active in terms of communicating the things they know and learn in the process of preserving the turf buildings in their care. Several booklets involving various authors were published describing general turf building techniques, archaeological findings as well as a cultural background to the life in turf buildings. They are published originally in Icelandic but translations into different languages are available as well.[20]

20 see SIGURÐARDÓTTIR 2007; 2011a; 2011b; SIGURÐARSON, ZOËGA & SIGURÐARDÓTTIR 2014

turf building course

To acquire an understanding of the topic at hand and to be able to contribute an architectural point of view it is essential to have a certain amount of hands-on experience. Therefore, a participation in a turf building course was arranged. Hosted by Fornverkaskólinn (= school of old crafts), a cooperation of Byggðasafn Skagfirðinga, North-western University and the department of Tourism of the University of Hólar, the course was held at a farm called Tyrfingsstaðir in the municipality of Akrahreppi. While the turf buildings are not inhabited anymore, the land is still farmed by a family living in a timber house in the vicinity. First mentioned in a letter dated January 8th, 1478, most of the parts that can be seen there today were built between 1870 and 1895.[21]

The aim of the course was to learn how to cut turf and construct walls with it. With eleven participants and two instructors on site, it was possible to clean out the ruins and reconstruct the outside walls of a sheep-house within three days. The focus was on preserving old parts of the structure that were still in good shape and replenish the rest in the same technique that was used in the earlier state - as far as this was still readable in the ruins. The tools used were mainly hand tools, although an excavator was at hand for backfilling and pieces of "torfa", a specific kind of cut turf, were prepared before. Through this experience it was possible to gather a certain insight into the hard labor that is necessary to construct a building with this technique. Also, the importance of being able to read the land and earth layers to assure a certain quality of the material used could be observed. Still it is open to discussion if the practice of imitating the old structure in terms of construction

---

21 STEFÁNSSON 2013 p. 158

technique is blurring the border between preserved and reconstructed parts too much to make the history readable in accordance with current practice of building preservation.[22] The project leader of Fornverkaskólinn was Bryndís Zoëga, an employee of Byggðasafn Skagfirðinga, and the instructor was Helgi Sigurðsson, a local craftsman with a focus on stone and turf buildings and their preservation.[23]

personal communication

While no extensive literature on turf building techniques exists, there are still people practicing these traditional methods today. Through making contact with these craftsmen in person it was possible to acquire a very practical point of view on the subject. While there might be several individuals still carrying the knowledge of turf building, research and conversation with Icelanders repeatedly brought up three specific names. Helgi SIGURÐSSON was already discovered quite early, appearing in several YouTube videos of people describing their experiences with turf building courses or projects he did for them.[24] As he was the instructor for the turf building course, there was the opportunity to ask questions on the subject and learn from his experience. Though a man of few words it could be seen that he has extensive knowledge of the materials and the traditional techniques of how to work with them as well as the crafting skills to do so.

---

22 see ICOMOS 1964 Article 12

23 FORNVERK.IS web page last visited October 31st, 2017

24 YOUTUBE.COM; Arc Architects Turf Building In Iceland 2014; YOUTUBE.COM; Iceland - Helgi Sigurðsson - cutting turf for house building 2016; YOUTUBE.COM; Turf house adventure 2015 web pages visited October 31st, 2017

In Þorlákshöfn, located the south-west of Iceland, Guðjón KRISTINSSON is a professional landscaper working a lot with turf and stone constructions. As a member of the turf network, a collective of landscape architects, designers, craftsmen and artists, it appears that some of his projects are oriented more towards a Viking-style turf building.[25]

A third individual that helped a lot in gaining insight into the Icelandic turf building tradition was Hannes LÁRUSSON, who together with Kristín MAGNÚSDÓTTIR founded and is running a museum called "Íslenski bærinn" in the outskirts of Selfoss, also in the south-west of Iceland.[26] He is working extensively to promote an engagement with not only the building technique, but also the cultural aspect and ambience of living in a turf building. The museum is located at the old farmstead of Austur-Meðalholt and shows a variety of new built traditional turf buildings, analyses, and photo documentation in an exhibition hall that could be interpreted as a modern turf building. While working by himself on promoting turf architecture and its tradition, LÁRUSSON is also very critical about the current conservational practices by the Icelandic National Museum.[27]

---

25 THETURF.NET web page last visited October 31st, 2017

26 ISLENSKIBAERINN.IS web page last visited October 31st, 2017

27 see HAFSTEINSSON 2010 and LÁRUSSON personal communication June 11th, 2017

context

2

figure 06 - View over Möðrudalur

2.1 the land of ice and snow

The island of Iceland is located in the North Atlantic between the latitudes 66°23'N and 66°32'N, just below the Arctic Circle (approximately at 66°33'). It is therefore almost at a point where the sun is not setting during summer solstice and not rising during winter solstice, which means the difference between the longest and the shortest day is almost 24 hours. Iceland's closest neighbours are Greenland, with a distance of about 290km, the United Kingdom with Scotland (800 km) away and Norway (970 km).

The whole island is mountainous with elevations up to 2110 m (Hvannadalshnjúkur) around the glaciers of the highlands. Most of the land along the shore shows little inclination, with exception of the western and eastern fjords. Along the coast is also where most of the populated areas can be found, many of them connected by Hringvegur, the ring street leading all around Iceland.

While being of average size in comparision with other European countries, Iceland is quite exceptional in terms of density. With more than three quarters being wasteland (62,7 %), lake (2,7 %) or glacier (11,6 %) and the climatic conditions of living just below the arctic circle, population is scarce. The

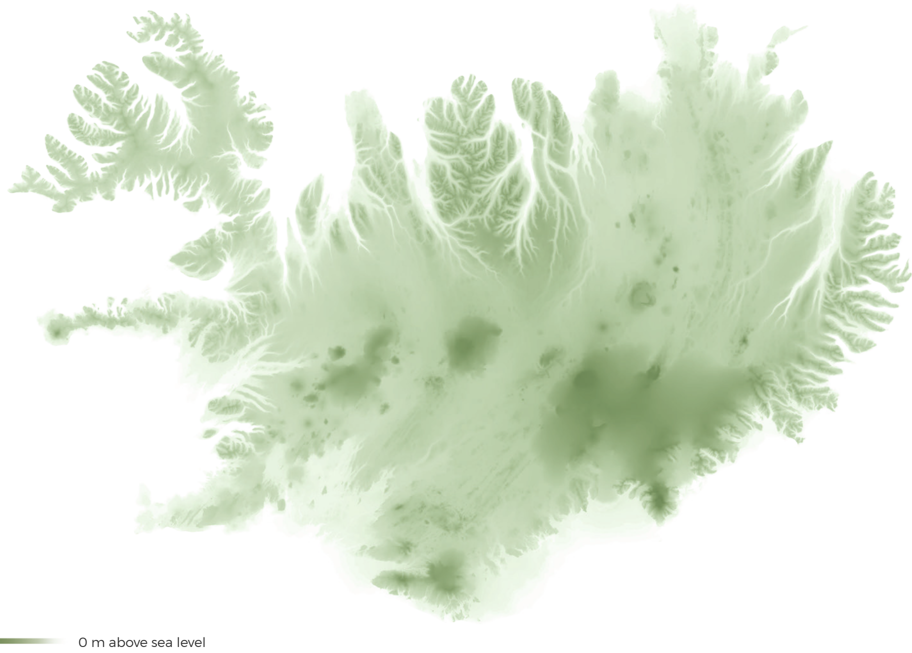
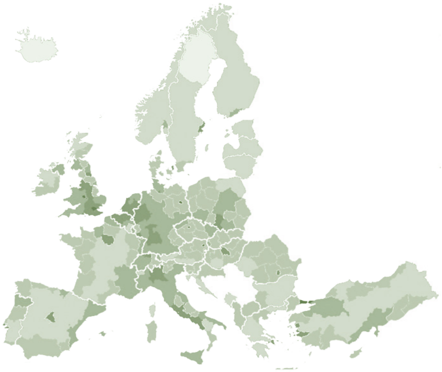


figure 07 - elevation map of Iceland

338 349 inhabitants are sharing the country's area of 103 000 km^2.[28] When comparing to the whole of Europe, one can see that Iceland is a very low-density, well-educated country with a high price level and an exceptional usage of renewable energy resources. As tourism is increasing to a level comparable with well-visited places in continental Europe, unemployment is far below average. All maps shown compare at a level of NUTS 2 regions or state level, which in the case of Iceland is the same.[29]

28 STATISTICS ICELAND 2017

29 EUROSTAT web page last visited November 3rd, 2017



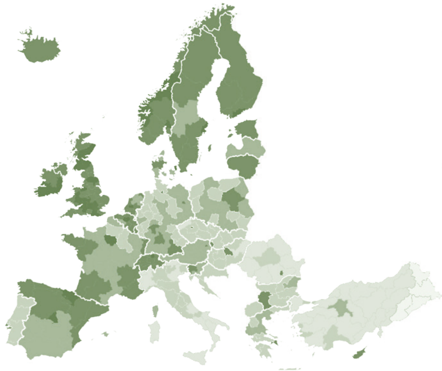


figure 08 - population density; percentage of people with tertiary education

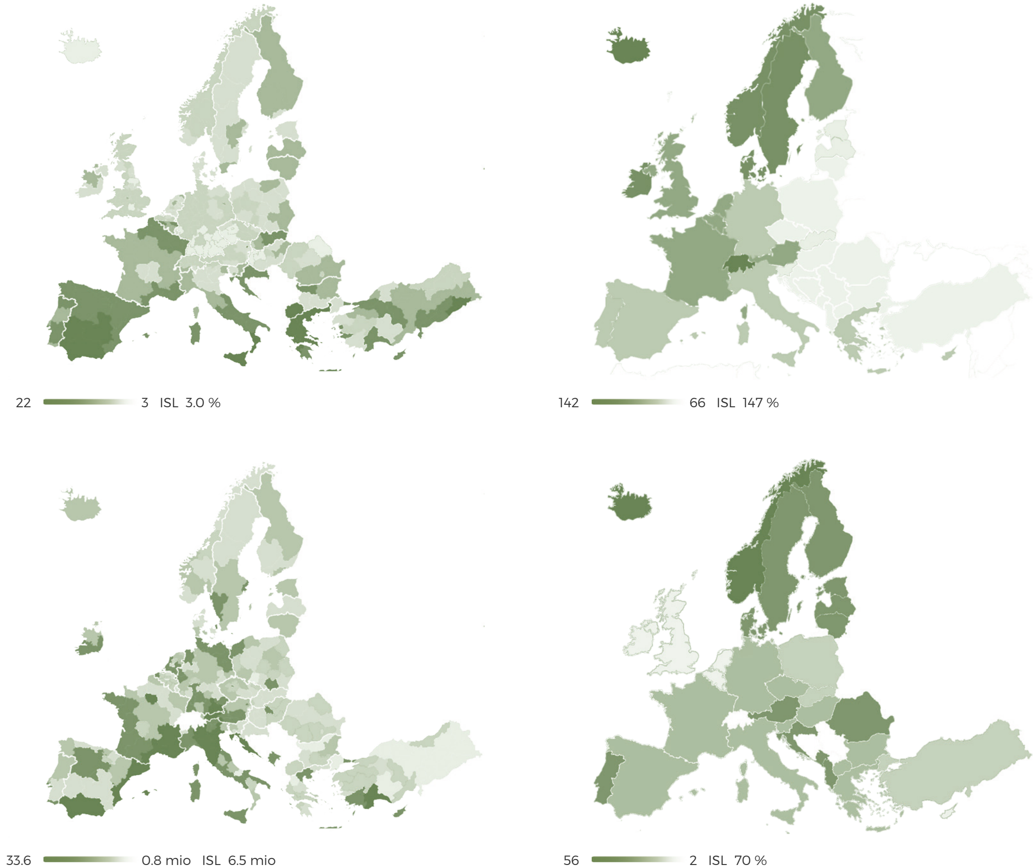


figure 09 - unemployment rate; price level % of EU 28 mean;
tourism nights spent; share of renewable energy

A closer look at some statistical numbers and comparing them to the author's home country, a continental European state of similar size, helps getting a better idea about the conditions. [30]

30 FISCHER WELTALMANACH 2017 web page last visited November 3rd, 2017

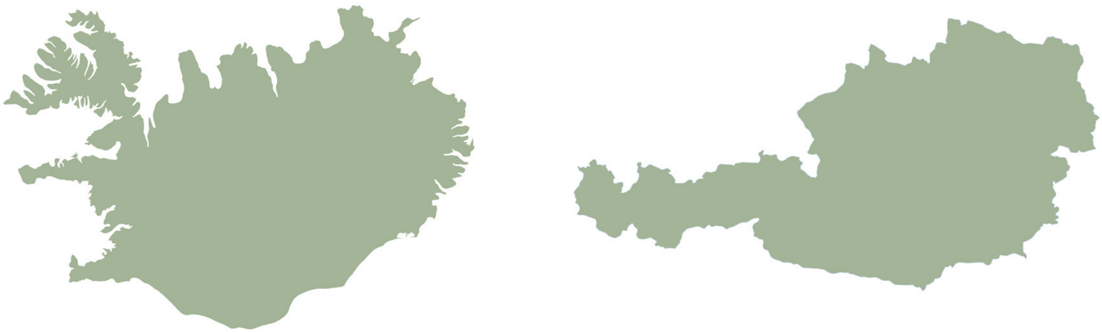


figure 10 - comparision of size between Iceland and Austria

Iceland		Austria
103 000 km^2	area (2017)	83 882 km^2
338 347	inhabitants (2017) [31]	8.700.471
3,3 [ ] /km^2	density (2017)	103,7 [ ] /km^2
94,2 %	population in urban areas (2016)	66,0 %
465 777	sheep (2014)	340 000
70,2 %	share of renewable in grossenergy consumption (2016) [32]	33,0 %
6,1 t	annual CO2 emissions per person (2013)	7,4 t
0,5 / 17,0 / 1,2 %	share of forest (2015)/ pasture- (2014)/ cropland (2014)	46,9 / 15,5 / 16,1 %
519 265 m^3	renewable water resources (2014)	6 439 m^3
1,8 %	usage of water resources (2014)	6,3 %
1 289 000	tourists entering the country (2015)	26 719 000

31 STATISTICS ICELAND 2017; STATISTIK AUSTRIA 2017

32 EUROSTATweb page last visited November 3rd, 2017

Very alike its relatively late settlement, Iceland is also geologically a very young country. This attempt to shed some light on the geological setting at hand is based on the work of THORDARSON and HOSKULDSSON, if not stated otherwise. About 70 million years ago, the landmasses on either side of the north Atlantic were merged with each other but started to break off and drift apart. The gash between the two continental plates continuously allows molten rock, known as magma, to stream up and cool down to fill the fissure. As this process is still active today, a spreading of about 2 cm occurs throughout every year. 24 million years ago, this lead the Iceland basalt plateau to start building up. Usually mid-ocean ridges do not build up like this, but due to the Iceland mantle plume – a hot spot with particularly high temperature and liquid magma within the earth's mantle - they do at this spot.

Only about 30 % of the plateau's approximately 350 000 km^2 are above sea level today, creating the ~ 103 000 km^2 landmass at the meeting point of the Mid-Atlantic Ridge and the Greenland-Iceland-Faeroe Ridge, we know as Iceland.[33] To illustrate the briefness of Iceland's existence the age of the earth could be compared to a year. Within that year Iceland was born in the last two days, regional glaciers appeared about five hours ago and Holocene warming removed this ice cover just a minute ago.[34]

Today there are 31 active volcanic systems in Iceland covering about one third or 30 000 km^2 of its surface as regions of active volcanism. Each of them has a distinct magma chemistry and they can be seen above ground in form

33 THORDARSON & LARSEN 2007 p. 119

34 GUÐMUNDSSON 2012

of singular central volcanos, fissure swarms or both. It is hard to determine the number of eruptions that have taken place through the years, but an extrapolation of observations in recent history allows us to estimate a series of about 200 eruptions within the last 1000 years. Because of the volcanic activity in Iceland, a large number of geothermal areas are present. Groundwater fills up cracks and voids in the top 1 - 2 km of the crust and, as temperature rapidly increases by 50 - 200°C per km in depth, is quickly heated up. Geothermal water is used in many different forms in Iceland, for example to supply households with heating and warm water, to temperate pools, but also to provide a cheap and sustainable energy supply for the island and some heavy industries producing there.

As eruptions cover wide-spread areas in ash and tephra, layers of their deposit can be seen in profiles of the topsoil. With some covering up to 7000 years of volcanism, they can be used to date geological formations as well as archaeological finds. Introduced during the 20th century by the Icelandic volcanologist Sigurður ÞÓRARINSSON, this method is called Tephrochronology and is widely used today.

terrain analysis

Placing a 10 x 10 km raster over the whole DEM (Digital Elevation Model) based on data from National Land Survey of Iceland,[35] an average altitude of about 640 m was calculated. If the same calculation is done with data from only within a 10 km offset from the coastline, the average altitude is about 250 m. Excluding the steep shorelines of the western and eastern fjords, the value is reduced even further to about 180 m. Considering that overall less than 25% of the country are below 200 m, this shows how much of the lower altitudes in the country are found along the coast.

soil

As the whole landmass of Iceland is of volcanic origin, the soil is strongly influenced by the material surfaced through eruptions. To be able to name the soil types that are found, different national and international systems are at hand. The most recent research on the subject, done at the Agricultural University of Iceland in Borgarnes by Olafur ARNALDS[36] uses the World Reference Base by the United Nations Food and Agriculture Organization[37] (short WRB). Some references to the US Soil Taxonomy[38] are included, but to simplify and as the systems are strongly harmonized, this work will limit itself on the first mentioned. Different groups of soils are defined by their contents, especially carbon (C) and other chemical elements as well as their material properties like pH-value, bulk density and grain size.

---

35 LANDMÆLINGAR ÍSLANDS 2016

36 ARNALDS 2008; 2015

37 WRB IUSS WORKING GROUP 2014

38 SOIL SURVEY STAFF 1999

figure 11 - population density in districts

Most of the soils found in Iceland can be categorized in the group of the Andosols, which are defined by the WRB to "[...] accommodate soils that develop in glass-rich volcanic ejecta under almost any climate [...]".[39] The name of these typically dark soils of volcanic landscapes originates from the Japanese an = dark and do = soil.

In variation to the WRB, ARNALDS further differentiates between Andosols and Vitrisols, the soil of the Icelandic desert areas. As part of the Andosols within the WRB, he argues that besides an extensive coverage of about 40% of the island, they have very different soil properties, genesis, and eco-system services and therefore need separation.[40]

The Histosols, a third and rather small group of soils in Iceland, have the highest content of organic material, a very low pH-value and are found in areas with the least aeolian input (low carbon material deposited by wind). The name derives from the Greek word histos, which can be understood as web / tissue. Especially found in boreal, subarctic and arctic regions, they build up from incompletely decomposed plant remains. As shallow groundwater and/ or a high precipitation-evapotranspiration ratio seals off oxygen, these felt-like soils can develop.[41]

To summarize it can be said, that three major groups of soils can be found in Iceland - Histosols, Andosols and Vitrisols. The two major influencing factors are the water content in the ground as well as the aeolian input. As revealed by soil maps,[42] a gradual variation can be observed away from the boundary

39 WRB IUSS WORKING GROUP 2014 p. 146
40 ARNALDS 2015 p. 65
41 WRB IUSS WORKING GROUP 2014 p. 161
42 ARNALDS & ÓSKARSSON 2009

figure 12 - distribution of different soil types throughout iceland

of the tectonic plates, which is leading through Iceland from the south-west to the north east. Close to these areas, hosting most of the volcanic activity, is where dry soils with low organic content are located. With carbon increasing proportionally with distance, soils change from Vitrisols (< 1,5 % C) to Brown Andosols and Gleyic Andosols (< 12 %C), Histic Andosols (12 - 20 %C) all the way to some limited occurrences of Histosols (> 20 % C) in the North and West of Iceland.[43]

43 ARNALDS 2008 p. 411

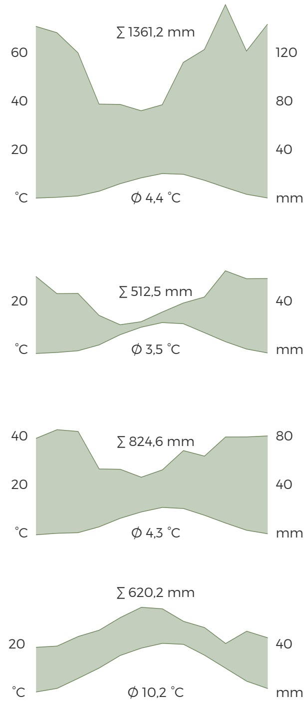


figure 13 - annual mean temperature and precipitation; Hofn, Akureyri, Reykjavik, Vienna

The following paragraph is mainly based on descriptions of the Icelandic climate by EINARSSON.[44] Due to Iceland's position just below the arctic circle, the annual deficit in the balance of energy inflow through sun radiation and outflow through the atmosphere is quite significant. Therefore, heat is transferred up from lower latitudes through oceanic and atmospheric circulations. The fact that Iceland is located at a meeting point of warm and cold ocean currents is influencing its climate extensively. These streams are accompanied by warm and cold air masses that regularly meet close to the island.

A mean low-pressure centre, the Icelandic Low, is not far from its south-western coastline. Travelling cyclones developing there bring precipitation, strong winds and rapid changes of weather with them, which can be seen as typical weather events for Iceland. The climate can in general be seen as maritime, with cool summers and mild winters. Especially in late winter sea ice can occur - and trigger a significant decrease of temperatures in the coastal regions, mostly along the northern and eastern coasts. The annual range of temperature, which is the difference between the average temperature of the warmest and coldest month, is rather small. Despite this and little variation between minimum and maximum temperature within each month, changes within one day can be extensive.

Topography is also of great impact on the weather conditions throughout the country as temperatures vary in relation to height above sea level and its influence on cloudiness and precipitation. Also, the separative effect of mountain ridges may lead to great difference of weather in certain areas.

44 M. Á. EINARSSON 1984

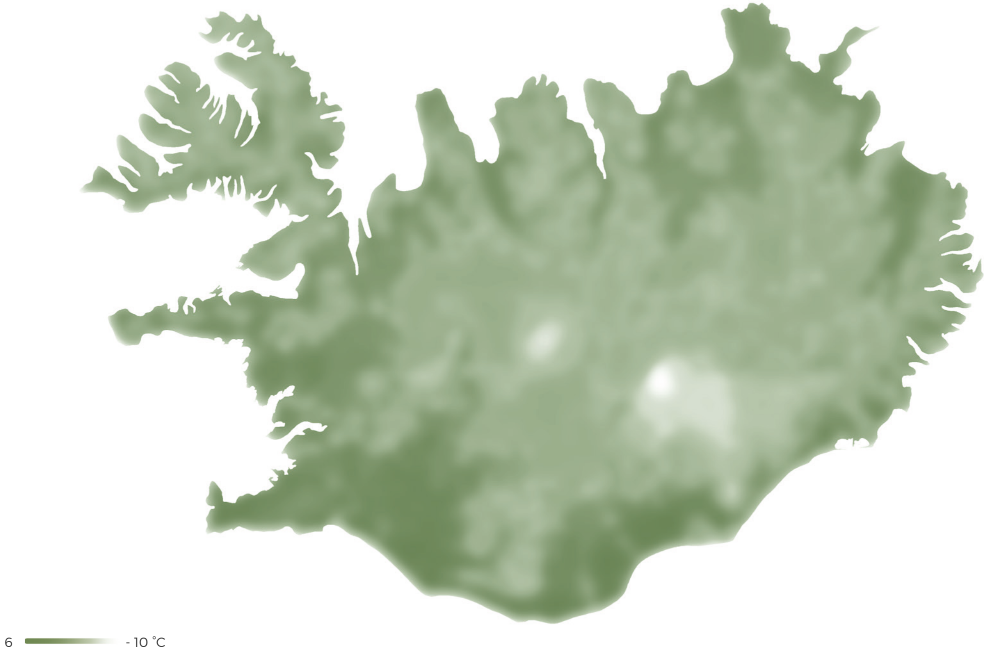


figure 14 - annual mean temperature

With regard to turf buildings, one factor can be of great influence for the structure and needs to be considered – frost. Despite occurring frequently, it usually does not last long, as even in winter thaws are common and can be seen as a peculiarity of Icelandic weather.

Precipitation differs across regions in Iceland, with being highest in the southeast and much lower in the northern area. As mentioned before, the amount of rain and snow also vary with altitude and terrain. In the northern regions more than half the winter precipitation falls in form of snow and leads to a complete cover for weeks or months, while southern regions experience more thaws accompanied by rain that lead to discontinuity. Clear days in Iceland are rare, with the most favourable regions having an average of 3 - 4 days per month.

Even though documentations are between non-existent and unreliable from times of the settlement, analysis of the sagas lead to believe that, before a deterioration to a more unfavourable climate, conditions were at least as favourable as they were in the warmer part of the last century (after 1920).

vegetation

Similar to any other aspect, vegetation in Iceland is vastly influenced by its isolation. As the island spent the last ice age under a giant glacier, it is believed that all or most of the species established there before were eradicated. Compared to continental Europe, to which Icelandic flora shows most similarities, this is believed to be the reason of the limited number of species

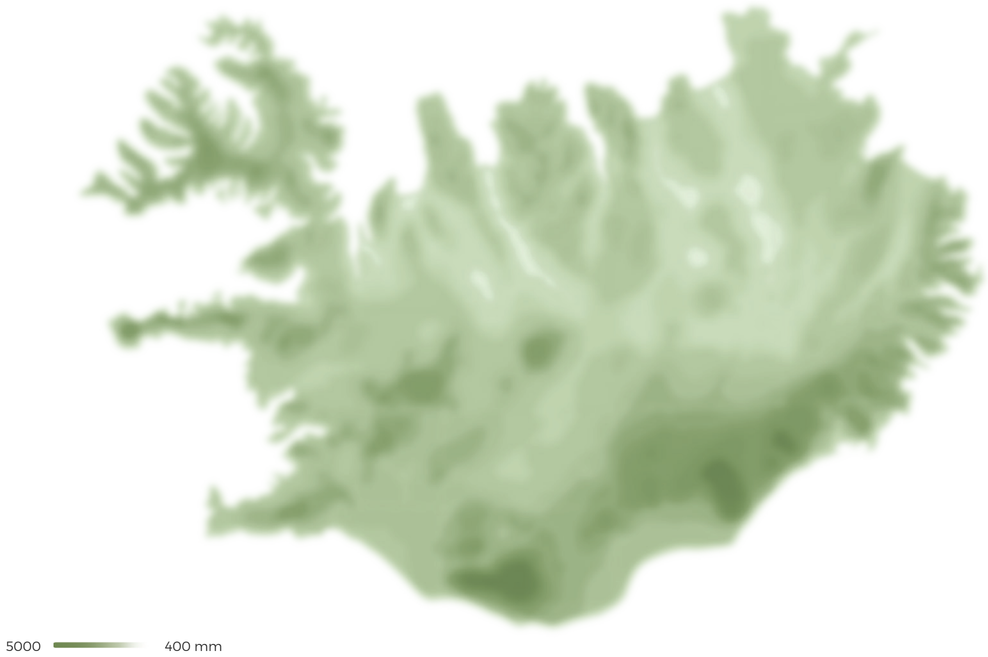


figure 15 - annual mean precipitation

found in Iceland.[45] Various studies suggest, that at the time of the settlement not only forest coverage of the country was much more extensive, but also the productivity of the vegetated ecosystems was considerably larger.[46]

The work of the Agricultural University of Iceland (AUI) on the so-called Nytjaland database (AUI Icelandic Farmland Database) shows that today only around 45 % of all the landmass is covered with vegetation, with that number including moss.[47] The degradation of the ecosystem shows itself in the analysis of various sources (historical records, pollen analyses, old place names, and the current distribution of the woodlands) that indicate historic forest and shrubland areas of around 20 - 30 % or more of Iceland at the time of the settlement.[48] Through clearing and cutting forests for fuel as well as inhibiting regeneration through grazing of farm animals, these are diminished to 1,2 % today. Deserts are estimated to have been less than a third in extent compared to the size they are presently.[49]

Today different government coordinated reforestation projects strive to re-establish native forests, as this could help to slow down desertification and ecosystem degradation and is believed to help rehabilitation of degraded land.[50]

45 E. EINARSSON 2005
46 ARADÓTTIR & ARNALDS 2001 p. 294
47 ARNALDS 2015 p. 37
48 ARADÓTTIR & EYSTEINSSON 2004 p. 197
49 ARNALDS 2000 p. 17
50 ARADÓTTIR & EYSTEINSSON 2004 p. 2014 f

In the case of Iceland, a quite unique comprehensive documentation of its settlement and the people settling is available, documented in Íslendingabók – The Book of the Icelanders by Ari Þorgilsson,[51] written in the first half of the 12th century. Further, there is also Landnámabók – The Book of Settlements, a chronicle list of the names of settlers coming to Iceland and the names of their farms there. Comparing the entries with current places, one can observe that most of the farms can still be found by the same name today. Landnámabók is known in different versions from different times, with its oldest one, suspected to be the work of Ari Þorgilsson as well, unfortunately not being preserved. Still it is quite exceptional what materials there are at hand to give an idea of the development that ultimately led to the Iceland we know today. If not noted otherwise, the following introduction to the Icelandic history is based on the work of Gunnar KARLSSON.[52]

Today when we talk about the settlement of Iceland, we are referring to the extensive and permanent inhabitation of the island by Viking settlers from Scandinavia. This is pointed out since there are several written indications of them not being the first ones on the island, but not enough evidence to paint a clear picture about the situation before their arrival. A description by the Greek explorer Pytheas of Marseille is suspected to be the first mentioning of Iceland. When sailing the Atlantic Ocean around 400 BC he describes to go ashore on an island, six days north of Britain, where the sun can be seen throughout the night around summer solstice. He refers to it as the country Thule. Irish monks are also writing about finding solitude on the uninhabited

51 ÞORGILSSON 1966
52 KARLSSON 2000

island of Thule around the 8th century. But they are said to have moved away when Nordic settlers arrived, since they did not wish to live with heathens.

Versions of Landnámabók differ in the description of who of the Viking explorers found Iceland first, but agree on FLÓKI being the one giving the island the name we know today. It is quite clear to say, that Ingólfr ARNARSON was the one starting the settling period. Peculiar enough, his believe in his gods led him to settle just where the capital Reykjavik is found today. By throwing his high-seat pillars in to the ocean and intending to settle where they were washed ashore[53] he was lead to this place, that transformed through unconnected circumstances centuries later into today's capital. Starting around 870 AD his tour to Iceland was initiating an intensive settling period of about 60 years that was completed around 930 AD. The Book of Settlements is telling about more than 400 original settlers. Including their followers, they are estimated to have brought a total of about 10 000 inhabitants to the Iceland at that time - most of them suspected to have come there from Scandinavian countries.

To govern the country, an annual assembly was established, the so-called alÞing (Althing), bringing together all free males in the country. This procedure of determining and executing law was not an Icelandic invention, as can be seen by several Þing sites that are found throughout Scandinavia.[54] Nevertheless, it is quite astonishing to see such well-documented evidence of an assembly that, contrary to the central European model, was governing a country in absence of one defined leader. It was located at what is today known as þingvellir National Park, in the southwest of Iceland, placed right

53 HJÁLMARSSON 1993 p. 14

54 BRINK 2012 p. 26

on the borderline between the Eurasian and the American continental plate. It was there, where important decisions concerning the country were made, like the Christianisation around the year 1000 or the allegiance to the Norwegian King in 1262 and with it the end of the Icelandic commonwealth.

The centuries under foreign rule were not easy ones for Iceland. Various passive-aggressive trade wars were attempting to strengthen foreign interests in the area. As German, English and Danish fishermen and merchants tried to gain ascendancy over each other, most of the time Icelanders were only bystanders and victims of these conflicts. Ravished by the plague in 1402 and raided by pirates from northern Africa in 1627 the people were not just tested by the increasingly hostile climate on the island alone, but its worst century was yet to come and started off with an epidemic of smallpox in 1707 that decimated the population by one quarter. Around 1750 a period of unusually cold weather and wide-spread pack ice lead to the death of large parts of the livestock and famine in the country. If that was not enough, volcanic eruptions near the hillock Laki in 1783 lead to lava streams destroying farms and poisonous ash covering large parts of the country. Followed by a cold winter with little hay in store and some of it proven poisoned by the eruption, hunger was all over Iceland yet again.

The 18th century brought Iceland to the test through a series of disastrous misfortunes. But while being one of the most devastating times for the country, it was also the kick-off for some great change in the country that should prove to reshape life there to what we see today. The idea of modernizing Iceland is closely tied to some key figures. One of them being Niels HORREBOW, a Danish lawyer, who spent two years in Iceland researching its nature, people and their way of living. “Tilforladelige efterretninger om Island”, which could be translated as “reliable news about Iceland” was first published in Danish 1752, followed by various translations in the following years.[55] It was not just this publication that resulted from his work, as during his time in Iceland he came to meet Skúli MAGNÚSSON. Both dedicated in inducing change to Iceland, they managed to raise widespread financial and political support for their idea of a more industrialized production in Iceland. What at the time was called "de nye Indretninger" in Danish or "Innréttingar" in Icelandic, can be translated as "the new enterprises". With support of the Danish crown as well as important figures in Iceland, they introduced a series of novelties, some of them quite common in continental Europe but still new to this remote island. There is no evidence that the place they chose for their business was in any way informed by the first settlement of Ingólfr ARNARSON, but again this movement gave importance to the location that later came to be the capital city. Along Aðalstræti, a street in today's centre of Reykjavik, a series of timber houses was erected, housing a wool processing factory, workshops and worker's residences. Further, two decked fishing vessels were acquired, Norwegian farmers were brought in to teach Icelanders how to grow grain and a water mill was established in the vicinity. Unfortunately, these businesses were never successful. Unable to compete with the highly industrialized production in Europe, they came to lose more and more in significance and in the end were not able to introduce the modernization their architects were hoping for.

It was also at the end of this disastrous 18th century that trade, run by the Danish crown at the time, had to face its bankruptcy, leading to a sudden abolishment of the trade monopoly in the years between 1786 and 1788. After 186 years, trade was open to all subjects of the Danish king, giving Icelanders the opportunity to participate in trade themselves. This could be seen as the

---

55 see HORREBOW 1753

first achievement of Iceland's continuous struggle to free itself from centuries of foreign rule. After Absolutism came to an end in Denmark, it was finally time, at the 1000-year anniversary of settlements in Iceland, that King Christian IX gave Iceland its first constitution in 1874, handing legislative power back to the people. It was not until December 1st, 1918 though, that Iceland gained full independence as a separate state, leading it into a century of a substantial reshape of the country. Combustion engines further industrialized fishing and roads spread out all through the country connecting continuously growing urban settlements. People increasingly shifted away from a more than 1000-year-old tradition of living in turf houses and replaced them with buildings constructed out of concrete or timber. While throughout centuries a very limited amount of homes in Iceland were not made from turf, around the year 1940 only about 23% of people were still living in such homes.

In the 20th century Iceland mostly got spared by the hostilities of wars but, due to its strategical position in the North Atlantic, it had to endure a precautionary occupation, first by the British and then by the United States of America. While these forces were well-disposed towards the Icelandic nation and did not confine its sovereignty, they still came to be stationed without the government's approval or any notice. While especially the economy largely benefitted from the need of workforce and the infrastructure established, many people were not happy with this imposition on their neutrality. Forces stayed throughout the cold war and until 2006, when the last troops left Icelandic territory.
In 2008 the Icelandic banking system collapsed leading to the greatest wave of migration since the 19th century and a severe economic depression. Today Iceland is a member of the European Economic Area (EEA) and, despite various disputes with the United Kingdom and Western Germany concerning fishing rights, still member of NATO.

2.2 the material turf

In previous chapters an introduction into the soil types of Iceland was already laid out, explaining the occurrence and origin of Vitrisols, Andosols and Histosols. In the context of turf building in Iceland, it is especially Histosols and some Andosols that seem to deliver the specifications needed for harvesting a high-quality building material. It is the incompletely decomposed plant residue that forms a web like structure, making this soil special and leading to the material specifications favourable for construction use.

science and heritage

Icelanders sometimes name turf by its plant cover. They distinguish between lyngtorf (= heathland-turf), valllendistorf (= grassland-turf), and mýrartorf (= wetland-turf) and understand the different characteristics that come with material from different places. Turf builders know that the mineral content of the material changes its attributes.[56] Having a small amount of loam

56 STEFÁNSSON 2013 p. 17 f

figure 16 - cutting a piece of turf from the ground

minerals in the material increases its solidity after drying and makes the walls stronger, while having layers of sand in the profile can lead to the cut blocks breaking apart along those. Furthermore, a too extensive mineral content can be washed out by rain and wind, making constructions instable and less long-lasting.[57] When searching for good building material, different scientific sources are available. In his soil map from 1960, JÓHANNESSON already pointed out areas,

57 SIGURÐSSON personal communication May 26th – 28th, 2017

where turf or peat could be found.[58] As he does not distinguish between various types of peat according to their composition, but to other layers and associating materials, it is harder to understand the specifics of the material found in certain areas. In his 1978 submitted doctorate thesis, GUDMUNDSSON analyses peat from two different, specifically chosen sites, down to the very detail, allowing a good understanding of what material is found at those two sites, but only those two.[59] It is the continuous and ongoing work of the Agricultural University of Iceland, especially the work of ARNALDS in mapping the soil types according to international standards and the WRB, that seem to offer the possibility of linking inherited knowledge to science.[60] An attempt was made to cross-reference the mentioned soil map with the also available map of vegetation classes, the Nytjaland database,[61] to gain an understanding of which type of flora correlates most with which soil type. Due to the fact, that both maps rely on the same data to some extent, this proved to deliver no significant outcome and was dismissed upon beginning.[62]

plant to turf

The fact that turf is formed by incompletely decomposed plants makes the traditional differentiation by its vegetation cover self-evident. Different types of plants lead to different characteristics of the resulting peat. What in soil classification is considered as organic content, can therefore, in the identification of turf as building material, be seen as another variable. Adding this to

58 JÓHANESSON 1960
59 GUDMUNDSSON 1978
60 ARNALDS & ÓSKARSSON 2009
61 GÍSLADÓTTIR, BRINK & ARNALDS 2014
62 ARNALDS personal communication December 16th, 2017

what we know from soil types, three major factors in the characterisation of turf can be determined - water content in the ground, aeolian input and plant species. While water in the ground and the type of vegetation are essential in the process of turf developing, non-organic particles added by wind could be considered an additive, changing the characteristics of the material to the better or worse, depending on the composition and amount of the input.

As mýrartorf is described to be the most suitable kind of turf for building, STEFÁNSSON further elaborates in his work that scholars studying vegetation distinguish between "flóa, gulstararmýrar og starungsmýrar" [63] (no direct translation available, but the last two seem to refer to plant species; mýri=bogland, swamp; flóa=flow over). Moreover it is mentioned that "gulstarmýrar" are favourable for harvesting building turf. The publication of Náttúrfræðistofnun Íslands (= Icelandic Institute of Natural History) shows a large overview of natural habitats over Iceland, using almost the same terminology for some of the wetlands listed.[64] A closer look at the specifics give insight why Gulstararfloávist, or Icelandic Carex lyngbyei fen, might be ideal. On a side note, the publication translates the names of the habitats into English without differentiating wetlands as Icelandic does - "mire" and "fen" are both used for "flói" or "flóavist" (literally flóa=flow over, vist=place[65]), a level surface that is flooded, and "mýri" a slope with ground water seeping downwards through the area.[66]

While being quite common in terms of occurrence, areas specified as Gulstararfloávist stand out in some ways. With Gulstör or Carex lyngbyei being

---

63 STEFÁNSSON 2013 p. 18

64 OTTÓSON, SVEINSDÓTTIR & HARÐARDÓTTIR 2016

65 UWDC ICELANDIC ONLINE DICTIONARY web page visited January 23rd, 2018

66 Þ. EINARSSON 1968 as cited in ARNALDS 2015 p. 64

figure 17 - carrying material from the extraction to the site

the dominant plant species (approximately 40 % of plants), an average vegetation height of 38,7 cm is observed (n=20), marking the highest standing flora of all habitats listed in this report, excluding forests. Further, with more than 75 % of the examined areas (n=160) having soil moisture classified as very wet and almost the complete rest being wet, these are one of the wetlands with the highest water content. With a high average soil carbon of 19,4 % (n=19) and low pH at 5,4 (n=19), the ground in these areas could be classified as Histic Andosol, just on the edge to Histosol (> 20 %C).[67] It suggests itself, that the vegetation with large height is a factor favourable of becoming a very strong weave of turf. In this sense it needs to be considered, that the value of the average does not represent this effect enough, as can be discovered when taking a look at the dominant species, Carex lyngbyei. These sedges can grow up to a height of 25 to 125 cm, largely exceeding the average value.[68]

In the listing by Náttúrfræðistofnun Íslands, a series of other habitats with similar indicator values can be found, allowing the assumption, that good quality of building material can be found there as well. With Runnamýravist (Boreal black sedge-brown moss fens), Rimamýravist (Aapa mires), Starungsmýravist/ Starungsflóavist (Icelandic black sedge-brown moss fens), Brokflóavist (Common cotton-grass fens) and Tjarnastararflóavist (Basicline bottle sedge quaking mires) many of the wetlands described show these indications. Missing connection of soil and vegetation research and the number of different variables working together in describing these classifications as well as the lack of clear evidence of the influence of each of the characterising values limits the possible outcome of this chapter to informed assumptions. Further research would be needed to learn about the ideal conditions for building turf evolving.

---

67 OTTÓSON et al. 2016 p. 110 f

68 KRISTINSSON 1987 p. 348

3 construction


figure 18 - turf building workshop

3.1 tools of construction

With assembling a structure out of a large number of smaller units of material, turf construction could be considered a type of masonry. Like with any other construction method, the way the material is used largely depends on the tools that are available and come to use. In contrast to ways of forming buildings with masonry common in western Europe, turf is in most of the cases not shaped into cubical blocks but is used in various other forms. To understand the different techniques, tools that historically came to use as well as tools applied today will be examined. Further comparison with other cultures of the ways to form a wall will be discussed in section 4 – comparision.

The following chapters concerning construction methods are in general based on knowledge obtained at the turf building workshop the author participated in[69] as well as personal communication with professionals,[70] reconfirmed and complemented with information from available literature.[71] As written

69 SIGURÐSSON personal communication May 26th -28th, 2017

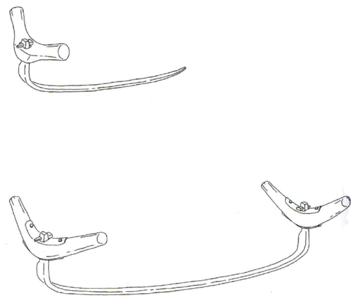
70 KRISTINSSON personal communication June 10th, 2017;
LÁRUSSON personal communication June 11th, 2017

71 ÁGÚSTSSON 1998a; HANNESSON 1942; S. SIGURÐARDÓTTIR 2008; STEFÁNSSON 2013

sources and personal workshop experience coincide in most cases, individual citations will only be added to information that is unique to one source.

Torfljár: the turf-scythe

The tool that is essential and most specific to turf building would be the turf-scythe. Just like its name is suggesting, this tool is a scythe-like blade, specifically made for turf cutting. Unlike a scythe for cutting grass, it is guided with a short V-shaped handle, called Skammorf (=short snath, with snath being the handle of a regular scythe), perpendicular to the blade right at its end.



There are two versions of this tool, named after the number of incisions that need to be done to get one piece of torfa. The “Einskeri” (= one-cutter) is therefore equipped with two handles, making it possible for the two people operating the tool, to cut out a strip-like piece of turf in one workflow. The “Tvískeri” (=two-cutter) on the other hand demands at least two cuts for the same result, but can be operated by a single person. The Tvískeri is also necessary for not only the gathering of the building material but also for many other steps in the process of constructing a turf building. It is used to even out the top of one layer as a base for the next one, to smoothen the surface of the finished wall as well as many other small adjustments that need to be taken to assure a tight fit between the individual pieces of turf.

figure 19 - Tvískeri and Einskeri

When extracting turf with a turf-scythe, for both Einskeri and Tvískeri, the width of the pieces taken from the ground is defined by the length of the blade. Usually the blade of a Einskeri is about twice as long as the blade of a Tvískeri. It is imperative that the blade of the tool is sharp enough to cut though the dense weave of fibre and therefore it needs constant whetting.

This matter gives further significance to the composition of the material available, as increased mineral content is blunting the tool even faster.

The use of the Torfljár can best be compared to the way meat is filleted. The blade cannot be jabbed into the ground but must be lead in with a pulling motion from the surface. As still a considerable amount of force needs to be applied and the process is quite exhausting, a refinement of technique is advisable. Like with any other work with a sharp blade, it is important to not just push the blade against the material but also to allow the sharp edge to cut through in an angled pulling motion.

Páll: the turf-spade

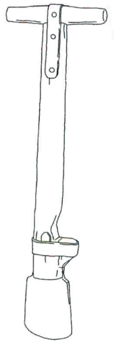


figure 20 - Páll

While the turf-scythe explained in the previous chapter was used to get strip-like pieces of turf, the Páll, a tool similar to a spade, was designed to cut blocks. In contrast to modern shovels, the blade of the Páll is a flat piece of metal, allowing a straight cut into the soil of about 30 cm down, but demanding a thicker and heavier format. At the socket, where handle and blade meet, the tool has a metal or wooden bar to the side to step on it and use the worker's body weight for the incision. After more factory-produced spades were shipped to Iceland, the Páll continuously lost significance and was mostly abandoned after the 19th century.[72]

During the turf building workshop, only modern spades were used. Not just to gather material from the ground but also as a cutting tool for finishing touches in the building process. To make this more efficient, it was constant-

72 STEFÁNSSON 2013 p. 23

ly resharpened with a power tool. It was observed that, contrary to the Páll, the bent blade of the spade can be of some obstruction. As the sides of blocks should be as flat as possible to guarantee a good fit between the single elements of a wall, a straight cut is naturally better achieved with a straight tool.

Undirristuspaði: the undercut-spade

After vertical cuts into the soil are made with a Páll or spade, the blocks need to be loosened from the ground underneath. The tool that comes to hand for this purpose is the Undirristuspaði (=undercutting-spade). As its name describes quite well, it is used to cut in horizontally from the side and through the dense weave of roots and turf, to get the block out of the ground with clearly defined edges. Failing to do this step properly and ripping the material off the ground leads to several disadvantages. Not only is the process exceedingly more energy-sapping, but the unclear sides and edges of the building elements need to be recut, requiring another step of procedure as well as leaving the offcut as labour-intensively earned but only being for subordinate use as backfill.

The undercutting-spade consists of a flat piece of metal with a V-shaped front. The shaft, with which the handle is attached, is placed in an angle to the blade to allow a horizontal cut in a more upstanding position of the worker. Just like the spade, during the turf workshop this tool was constantly re-sharpened with power tools to assure higher efficiency and reduce the manual force that needs to be applied in the process. Unlike the regular spade, there is no stepping bar helping to apply force with one's foot, and, as body weight can be applied less efficiently for the horizontal cuts, the work is considerably more energy-sapping and one of the most exhausting tasks in turf building.

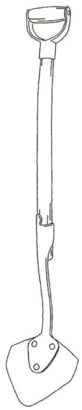


figure 21 - Undirristuspaði

The tool is also used for removing Thufur (= hummocks) from land for agricultural use.[73] These are mounds that originate in cold climates from a combination of water in the soil and frost and are a prominent landscape feature all over Iceland.[74]

turf cutter: engine-powered turf cutting

Since today machines for turf cutting are available, those are used as well. Powered by a combustion engine, a blade shimmies back and forth at a high velocity cutting into the ground at a defined depth a little further with each motion. Blade depth, advance of the machine as well as cut-off length of the strips can be adjusted. The width of the pieces is defined by the length of the blade, usually somewhere around 30 to 60 cm. In contrary to Torfa or Strengur, the strips have the same thickness for the whole width and also have a straight cut-off on their short sides.

---

73 S. SIGURÐARDÓTTIR 2008 p. 9
74 ARNALDS 2015 p. 125

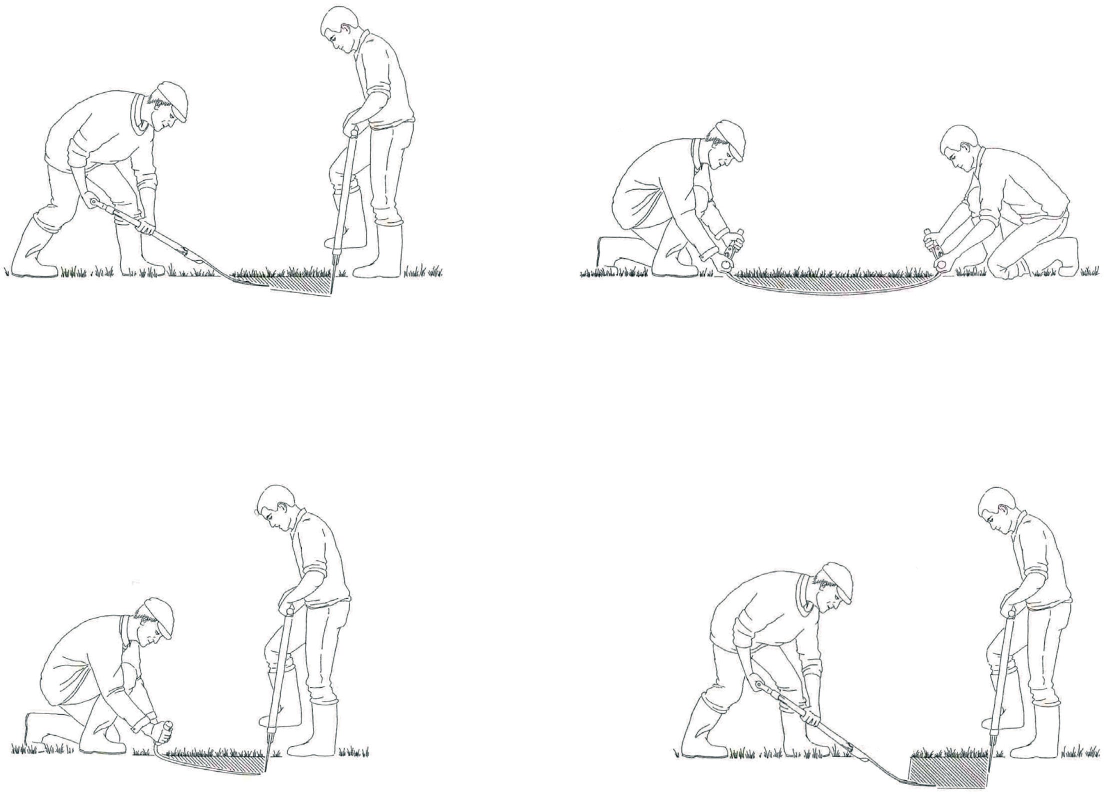


figure 22 - various application of tools cutting Strengur, Torfa and Klömbruhnaus

3.2 turf masonry and cutting patterns

In turf building, there are various ways to split up the material in the ground into handy elements, lift them out and put them back together as a wall. In most cases not only one shape or cutting pattern comes to use, but a combination of several, utilizing the advantages of each of them. Further, bonds are not only varying within one structure, but also differences from one to another can be observed as a reaction to local conditions, regional habits or even personal preferences of the builder.

In general cutting patterns can be categorized into two groups: strips and blocks. While strips have their advantages and are necessary for some applications in turf building, blocks make use of the land more efficiently. As pieces are usually only cut from the top layer of soil, using the deeper cut blocks reduces the amount of ground damaged by turf-cutting by up to 75 %.[75] After the turf is cut, it is lifted from the ground and laid out to drain off most of its water content before construction. It is important to let it dry for the right amount of time, for a wall built with turf that is too wet might

75 WALKER 2006 p. 66

figure 23 - Front facade of Tyrfingstaðir turf farm

settle too much or even rot because of the humidity in the material. On the other hand, turf that is too dry is hard to work with and looses its plasticity and ability to readjust to the shape of its neighbouring block. The right amount of time depends strongly on weather conditions but takes at least two weeks.[76]

In most cases in Iceland turf is used to construct a face shell, which is filled up with a core of rammed earth and offcut. Walls can be double-faced, when standing freely, or single-faced, when dug into the ground or built into a hill. The core is filled in a continuous process with every course of turf face. The higher the compression of the beaten earth is, the stronger the wall will be and the longer it will last.[77]

Torfa and Strengur: Strips of turf

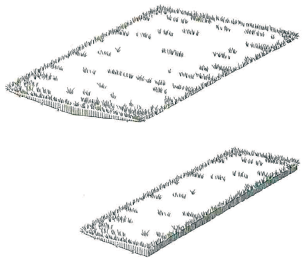


figure 24 - Torfa and Strengur

Shapes of turf that can be found in almost every turf construction in Iceland are Torfa and Strengur. These long and plane flat pieces are usually cut with a turf-scythe and about 5 - 10 cm thick and 1 - 2 m long. Depending whether a one-cutter or a two-cutter is applied, Torfa has the cross-section of a triangle or segment of a circle, with the width of approximately 50 - 60 cm – depending on the size of the tool at use. As Torfa is phasing out in thickness on all sides, it is not used to construct the face of a wall, but to bind inner and outer shell together. Much like headers in brick masonry, a row of Torfa is therefore laid crosswise over the wall every few courses.

---

76 S. SIGURÐARDÓTTIR 2008 p. 9

77 STEFÁNSSON 2013 p. 28

A piece of Strengur, in the shape of Torfa cut in half along its length, can be used for this as well, but its main application lies somewhere else. With its wedge shape, Strengur has one edge with full thickness that can be forming a wall face. It is therefore laid out in the direction of the wall, binding blocks together lengthwise, much like stretchers in brick masonry. Usually Strengur is found in a wall of blocks every second or third course. Further it is used as a substitute for mortar in stone walls. In some cases, walls are constructed entirely without blocks, with Strengur forming the shells and Torfa binding them together.
A special type of Strengur can be found in southeast Iceland.[78] It is cut with a spade and thicker than regular Strengur (about 15 cm in total), and one of the cases of walls constructed entirely without blocks.

Klömbruhnaus (Klambra) and Kvíahnaus: blocks of turf

It was mentioned before, that cutting turf in the shape of Torfa or Strengur is not very efficient in terms of land use. In most buildings walls are therefore constructed with the use of blocks. When talking about blocks the impression could emerge that rectangular pieces, much like bricks, are used. But this only makes a small portion of the material.

The type of block that is found in most constructions is also the one forming the most iconic patterns on turf walls. In its shape Klömbruhnaus or Klambra is the most sophisticated, as each of its little peculiarities appear to serve a special purpose. In a simplified version the block ready for construction could be described as the wedge one gets, when splitting a grass

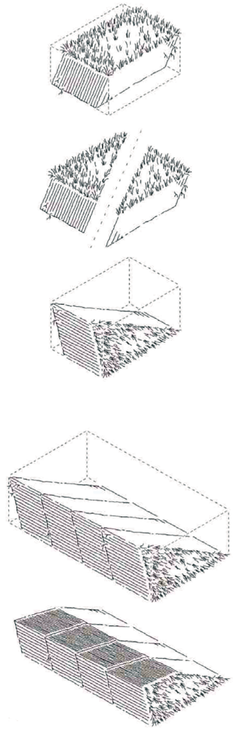


figure 25 - cutting a piece of Klöbruhnaus

78 STEFÁNSSON 2013 p. 23

figure 26 - gable constructed from Klömbruhnaus at Glaumbær turf farm

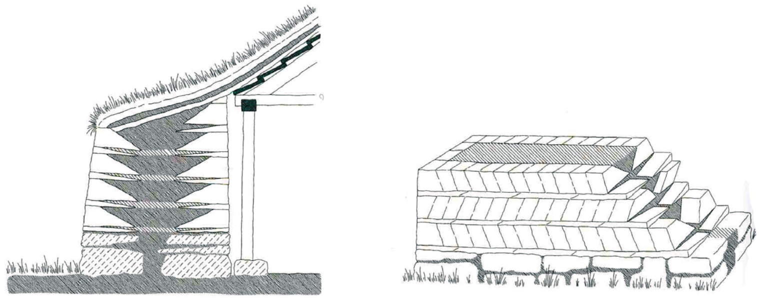


figure 27 - construction principle of a wall with Klömbruhnaus

side up cuboid of about 30 x 60 and 30 cm of height into half along its diagonal. The block is placed into the bond, so that the smaller rectangular side of the wedge is part of the face (called neck) and thickness decreases into the wall down to zero (called tail). The block and its diagonal are cut with an angle of about 30 degrees off the vertical, making it lean to the side within the bond. As a result of this, the visible side has the shape of a parallelogram, forming a characteristic herringbone pattern. This angular cut has not only aesthetic qualities but also some practical advantages.

First off, cutting like this comes more natural for the worker. Standing one step away from the incision, the spade leaning towards oneself when stepping on it is the more intuitive way of doing this work step. Further, the blocks leaning onto each other in the bond leads to a closing of the gaps in between when the weight of the next courses is applied. As each half of a divided cuboid is leaning in a different direction, the sides towards which the pieces are leaning are alternated from course to course. This makes use of all the blocks and prevents the wall pushing in one direction. A layer of Strengur is usually found after every or every second course.

A variation of Klömbruhnaus can be found at the site of Glaumbær. Instead of wedge-shaped blocks forming shells on two sides and an earth-core, walls are constructed of turf through and through. Blocks as long as the intended wall thickness are therefore cut from the ground with a spade. Laid out crosswise, the ends of these long pieces later form the face of the wall. As the blocks are also cut in an angle, the same herringbone pattern as with Klambra can be seen, with the difference that the grass-side is upwards or downwards and not facing the neighbouring block. Layers of Strengur and Torfa are used analogue to walls of Klömbruhnaus. As structures like these found extensive use in the well-preserved turf house of Glaumbær, they are referred to as Glaumbæjarhnaus.[79]

The principle of angled cuts is also found with Kvíahnaus. While these are in the shape of a cuboid, they still have their sides cut in an angle, to have gaps closing. With these bigger blocks, layers of Strengur in between become obsolete, as long as gaps are overlapped within the next course. To achieve a better interlocking with the core of the wall, the blocks are often laid out alternating as headers and stretchers.

To construct a rectangular end of a wall or corners, blocks with vertical sides are cut. These rectangular cuboids of turf are cut to a size of about 30 x 60 cm and 30 cm in height and applied to almost all types of wall structures.

---

79 S. SIGURÐARDÓTTIR 2008 p. 15

Snidda: diamond-shaped turf

In contrary to other cuts of turf, Snidda is one that is designed to grow back together and keep the grass in the turf alive. This results in a strong bond between the individual pieces within the wall and is used in areas, where extensive rain is eroding walls faster (mostly in the southern parts of Iceland). Snidda is cut with a spade and its size is strongly influenced by the width of the shovel blade. Usually sides are approximately 20 - 30 cm long. Compared to blocks of turf, Snidda are much smaller and lighter. It is therefore easier to handle them, but naturally more individual parts have to be lifted and placed to form the same wall. As a result of the diamond shape, the bedding of each piece is inclined to two sides like a V. A wall constructed of Snidda thereforee provides the unique quality of closing all gaps, that might open up through settling, just by its own weight.

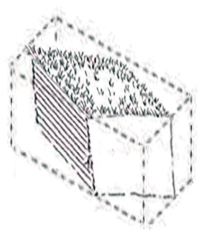


figure 28 - a piece of Snidda

Stones within turf structures

While stone buildings are a rare thing to find in Iceland, the use of stone within turf buildings is quite common. One example that can be seen in many structures is the use as a foundation of turf walls. It was not until the 19th century that educated people in Iceland started to engage in theories of how to improve their building tradition and introduced several layers of stones underneath the turf walls. The absence of archaeological evidence showing otherwise suggests that before that most walls were built directly on the soil.[80]

80 STEFÁNSSON 2013 p. 29 f

But even these structures made of stone can be considered as part of the turf building tradition, as they are not erected as a dry-wall or with the help of some kind of mortar. Instead joints were filled with strips of turf, Strengur to be precise, which not only closed that gaps between stones to hold back the core of beaten earth but also held the stones in place like a mortar would. In a wet or humid state, turf allows a certain plastic deformation that helps adjusting to the shape of the stones and keeps that shape when drying, holding them in place.

Besides applying this technique as foundation for turf walls, it can further be observed in structures with animals, as they tend to scratch themselves on the walls or even try to eat the soft turf away. It can therefore be seen that barns use stone walls half way up or at the side of the room, where animals were standing at, to make them more resistant to abrasions. For several reasons it seems clear that the use of stone was limited to areas of actual necessity and continuing in turf when possible. Leaving the factor of material availability aside, not only did stone walls require heavier lifting for the same amount of wall surface but, as it can easily be shaped to a good fit, turf is naturally easier to work with.

Þaksnidda: roof blocks of turf

In a traditional Icelandic turf building even the roof was using turf to make it waterproof. Similar to the use of Snidda in rainy regions, it was intended that the vegetation of the cut turf stays alive and is growing back together. Forming one conjoined layer, this made the roof more resistant to precipitation and wind. Carried by a timber structure, a sub-roof is applied first to protect the wooden parts from the roots of the vegetation and humidity. This can consist of dry turf, birch shrubs or other materials. Blocks of turf are cut from the ground, not unlike Glaumbæjarhnaus, and laid out on the sub-roof, grass side up. Just like Klambra the blocks are approximately 30 cm or one shove depth thick and provide ample and undisturbed soil structure for the grass to grow.

Further, roofs can be made from Torfa, which is laid out along the length of the surface. Overlapping each other with the grass side up, they also grow back together quickly to form one conjoined layer. To provide enough soil for the grass to grow, a layer of earth and manure is applied between sub-roof and Torfa. Pieces of turf should not dry out in the process before growing back together. Otherwise they might erode quickly or even be blown off by wind.[81]

Heytorf and Reiðingur: turf for other purposes

Not only was turf the main building material in Iceland for centuries, but it was also used for other purposes like mattresses, fuel and others. One application is very similar to its use of waterproofing a roof. Icelanders used to store their hay for the winter not in a barn or house of some kind, but it was piled up and covered with layers of turf as a rain cover. Pieces of Torfa were cut as long as they could be handled and stretched over the hay, overlapping each other. Ideally each strip would reach over the whole stack in one piece, to make the cover as waterproof as possible.

To protect a horse's back when carrying a pack saddle, Reiðingur (að riða = to ride) was used. Strips of turf were laid underneath the wooden rack as damper to soften the pressure. Dry pieces were used with as little mineral content as possible, to reduce the danger of friction burn.[82]

---

81 S. SIGURÐARDÓTTIR 2008 p. 16

82 STEFÁNSSON 2013 p. 27

3.3 timber structure

The scarcity of wood within Iceland lead it to be a material worth preserving. As most of it was thrift wood or imported, it was necessary to take measures to bring it to use in the longest-lasting way possible. This can clearly be seen in the way timber constructions within turf buildings are designed. With humidity and precipitation omnipresent in this environment, measures, of what is called technical wood preservation, are taken to first, keep the wood dry and second, if exposed to wetness, allow the structure to dry out as quick as possible. One basic principle to achieve this is the strict separation of wood and turf. The humidity stored within the sponge-like peat would accelerate the decay of timber extensively, contact should therefore be avoided. In most cases roof structures are therefore carried by columns instead of being supported by the turf walls. Further, these columns are placed with a distance to the wall face to have at least a few centimetres of air between turf and wood. Said columns are then placed on a plinth of stone to avoid contact with the humid ground.

One critical point is definitely the roof cover. While turf roofs manage to keep off most of the rain and snow, they are, in the absence of a modern waterproofing or at least a layer of tree bark (often birk), quite leaky. The layer above the rafters of the roof, in Icelandic called árefti (raftari = rafters; á = on), was therefore one that was usually exposed to water to some extent. It was not uncommon to have less valuable, for example reused, pieces of wood and shrubs there, as decay had the strongest impact on these parts of the construction.[83]

types of construction

Assumably because of the lack of quality wood available for most constructions, timber structures found within turf buildings tend to be quite simplistic but practical. Just like in many other cultures, the design follows the purpose of the void it is surrounding. As in Iceland these load-bearing structures always reach to the ground level of the building, and therefore affect the whole effective area even stronger, the type of construction is strongly influenced by the function of the room. Especially the layout of columns carrying the roofwork needs careful consideration. In many cases the wooden framework of the building is already part of the built-in furniture or appliances of the room.

Similar to other cultural areas, a variety of purlin-framing as well as rafter-framing can be found in traditional Icelandic buildings. AGÚSTSSON states that purlin-structures can be considered older and more primitive in Iceland.[84] While they seem quite rudimental, differences can still be found that often reflect a close reaction to the purpose of the room they are spanning. In Icelandic there is a differentiation between einása-, tvíása- og þríasaþak (one/

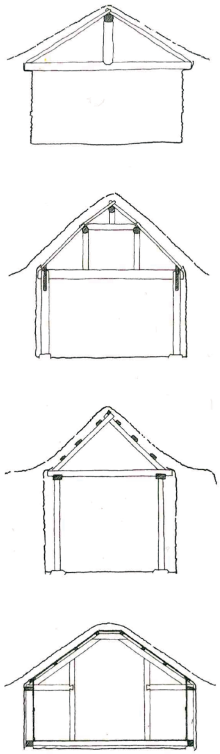


figure 29 - einása, þríasaþak, rafter roof and Kálfasperruþak

83 S. SIGURÐARDÓTTIR 2008 p. 24
84 ÁGÚSTSSON 1998a p. 65

two/three; ása = axes, purlin; þak = roof).[85] With the upper purlins carried by king and/or queen posts, these constructions are comparable to what is found in other cultures. What appears special are roof works with tie beams absent and mentioned posts reaching down all the way to the ground level as separate columns carrying the roof. A typical application of this would be with the queen posts, not far apart from each other, enclosing a central, sometimes elevated, walkway, from which animals to the left and right were fed.

Another type of frame, that seems common when observing sections of Viking longhouses and found application in later turf farms, is the þríasaþak with queen posts reaching down to the floor and a king post resting on a tie beam on top of them. In longhouses from the time of the settlement, built-in platforms were installed on the sides between those queen post columns, serving as a sitting bench as well as a sleeping area and an individual space of residents.[86]

Similar partitioning of the interior by the load-bearing structure can still be seen in later Baðstofas, though often with a more advanced type of rafter frames. In particular this would be the Kálfasperruþak (kálfur = calf; sperra/raftari = rafters; þak = roof), with a discontinuous rafter tie and rafters not meeting at the roof ridge. Instead they are jointed with a kind of collar tie, called Kálfur, placed at a very high position and ending after that. The horizontal forces appearing in this structure are diverted through posts/columns downwards, where they are absorbed by a girt underneath the floorboards. This leaves more volume in the centre of the room without any tie beams in the way.

85 ÁGÚSTSSON 1998a p. 62
86 STEFÁNSSON 2013 p. 40 f

The biggest peculiarity of wooden structures within turf buildings might be the absence of struts and braces. While this is a common feature to reinforce most frame constructions, it is observed that they are barely found within this Icelandic context. It is uncertain whether they are not in use because they are obsolete in a turf structure that has enough mass to absorb all horizontal forces or if this is a specific design choice to make the structure more resilient to earthquakes. With the geological conditions and Iceland's position on the mid-Atlantic ridge this is a regular occurrence. Allowing a certain movement of the construction could reduce the danger of damage by these horizontal forces effecting the building. This would further give additional meaning to the design of the column's footing, standing loosely on a plinth.

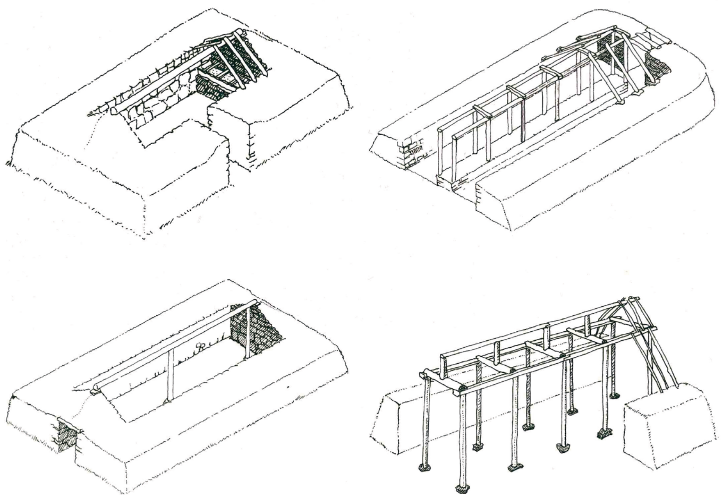


figure 30 - roofworks with one, two or three purlins as common in turf buildings

3.4 layout and development of turf farms

Like any other typology, turf buildings in Iceland went through a continuous change and adaption throughout centuries. It is clear today that when Iceland was settled the predominant type of structure used to be the longhouse, imported by the Viking settlers from their countries of origin in Scandinavia. While there are discussions on a more precise definition of where they came from and if the same materials were at use there, it is fair to say, that the typology in general was imported to Iceland.[87] As climatic conditions worsened after the settlement[88] and forest and shrubland areas decreased,[89] architecture adapted to these changing circumstances. Due to Iceland's isolated position and very limited influence of foreign building culture up until the 19th century, connections of this development to its prototype can be seen quite clear throughout centuries. By making use of an organic material with relatively fast degradation, a turf building always demands rebuilding after a certain amount of time. The necessity of replacing parts of the structures in a periodic rejuvenation can therefore be seen as a catalyst for constant development.

---

87 B. F. EINARSSON 1995 p. 140

88 M. Á. EINARSSON 1984 p. 679

89 ARADÓTTIR & EYSTEINSSON 2004 p. 197

functional units of a turf farm

Skáli – Describing the main room of the long house,[90] the Skáli (= lodge, cabin) can be considered the stem cell of turf farms. First being a single hall with a variety of different functions, they are progressively moved to separate units. After loosing all defined purpose and even its characteristic structure, the Skáli maintains its place in a turf house and can still be seen in many late stages of development.

Stofa – One of the early annexes to the Skáli can be seen in form of the Stofa (= living room). While Skáli and later Baðstofa were not only used asbedrooms but also gave room for activities in daily life, the Stofa could be considered a more formal living room. For that purpose, it is found throughout many turf buildings in a variety of forms.

Eldhús – In today's Icelandic language merely describing a regular kitchen, the Eldhús (eldur = fire; hús = house) earlier had a broader spectrum of tasks. While being mainly used for food preparation, like cooking and smoking, the scarcity of fuel turned it to be the only room with a fireplace for centuries.[91]

Baðstofa – Theories on the origin of the Baðstofa (baða sig = to bathe oneself) vary and discussed in a following chapter. In later turf buildings this was the main sleeping room, that was also a place for daily activities such as eating and working on chores. It is often found as the innermost unit of a turf farm.[92]

---

90 SIGURÐARSON, ZOËGA & SIGURÐARDÓTTIR 2017 p. 12

91 SACHER 1938 p. 12

92 STEFÁNSSON 2013 p. 70

figure 31 - inside a Skemma of Glaumbær turf farm

Útihús – A general term for various stables and sheds. Barns for animals often in form of a Garðahús, with a central walkway along the long axis of the building and pens to both sides. Separate entrances for men and animal, sometimes attached to a hay storage.

Búr – This room is used as a cold pantry to store various foods.

Skemma – Storage rooms of various kinds are named with the collecitve term Skemma.

evolution theory: stages and variations

It is clear, that turf buildings developed throughout the more than 1000 years of history after the settlement of Iceland. Reasons for these adaptions varied and are not always clearly traceable. While AGUSTSSON tries to define different types that he attests varying popularity and occurrence according to regions,[93] STEFANSSON merely mentions certain milestones we know of from different times, but also states that not enough evidence is excavated and researched for a clear determination of the process.[94] He also testifies that many turf buildings that are preserved until today mostly represent a type sustained by a wealthier minority of Icelanders and was chosen in a romanticizing tendency as a representation of this tradition.[95]

This claim is supported by HAFSTEINSSON saying:

> "The majority of those turf-houses are themselves from affluent farmsteads, rather than the modest turf-houses in which the majority of the population had lived for centuries."[96]

The first farms in Iceland are said to be longhouses as they were known in many parts of Scandinavia and other areas settled by Viking sailors. Reviewing existing archaeological excavations EINARSSON concludes that, while some of them might be singular buildings without annexes, excavations

---

93 ÁGÚSTSSON 1998a p. 31 ff

94 STEFÁNSSON 2013 p. 53 ff

95 STEFÁNSSON 2013 p. 53

96 HAFSTEINSSON 2010 p. 267

found in other areas of Viking settlement suggest that this addition of the singular longhouse, with further buildings attached to them, was already imported to Iceland and did not originate there.[97]

Some of the oldest examples of this type were found on Aðalstræti (= main street), in the very centre of today's capital Reykjavik, from the period of the settlement. While from this time, dated to the 9th century,[98] there are only fragments left, a later form built in two stages, both originating approximately between 950 and 1050 A.D., is traceable in its extent and layout. The longhouses have a convex shape, with outside walls bent, and can vary in size. While mentioned buildings at Aðalstræti (internally) measure 16,70 m x 3,7-5,8 m in phase 2a, and 11 m x 4,7 m in phase 2b,[99] a complex of longhouses found at Hofstaðir, near lake Mývatn, had a total length of about 45 m.[100]

figure 32 - interpretive plan of the Aðalstræti excavations

Single or multiple entrances are usually found on the long side and are positioned asymmetrically towards one end of the structure. Inside the so called Skáli there usually was a longish fireplace in the centre of the room. Interpretations of excavations suggest, that the space around the long axis of the room was an open area to move, while on the sides there were different fixtures of wood. It is believed that for sitting and sleeping of residents there were wooden platforms, divided into bed-like partitions in accordance with the main structure of the building. It is assumed that animals were found in the same room in stalls, sharing the warmth of the room with humans.[101]

97 B. F. EINARSSON 1995 p. 116 f

98 GRÓNVOLD et al. 1995 p. 9+24; NORDAHL 1988 as cited in ROBERTS et al. 2001 p. 38

99 ROBERTS et al. 2001 pp. 41+47

100 LUCAS & BATEY 2009

101 ROBERTS et al. 2004 p. 97

The farm Gröf í Öræfum, in the south of Iceland, south of Vatnajökull glacier, is believed to be covered with ashes by the eruption of Öræfajökli in 1362 and therefore dated before that time.[102] Comparing its layout with the farm Stöng í Þjórsárdal, which is believed to have been abandoned earlier, during the early 13th century,[103] a transformation is visible. While the excavations in Stöng show annexes in different corners of the structure,[104] Gröf already presents a trend that should prevail in Icelandic turf building for a long time – a central vestibule or hallway, from which different parts of the bær are accessed. Further, it appears that cells of the cluster follow a more rectangular manner in shape and layout, in contrast to a radial positioning of annexes as seen in Stöng.

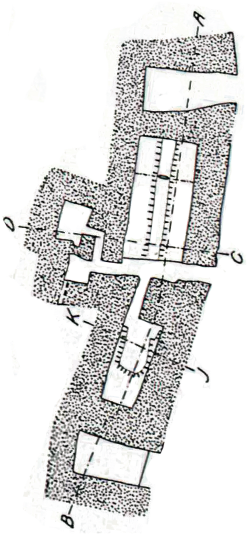


figure 33 - floorplan Gröf í Öræfum

With Gröf í Öræfum being the oldest known example of what is called the gangbær-type (= hallway-farm-type), it is setting a marker for a development of turf buildings that in its essence can be observed until the 19th century.[105] A look at the remains of Kúabót í Álftaveri, which is believed to be destroyed much later in the 15th century by a sudden glacial runoff from Katla,[106] called Jökulhlaup (= glacial run), reveals that while these ruins are from a later time, the layout with its distinctive central hallway is very similar.

As it is custom and necessity to the Icelandic turf building tradition to build and rebuild structures according to changing needs and signs of decay, most farms that were not abandoned due to outside influences do not show their original state, in which they were first built, anymore.

102 GESTSSON 1959 p. 44
103 CHRISTENSEN & VILHJÁLMSSON 1989 p. 97
104 STENBERGER, ROUSSELL & STEFFENSEN 1943
105 ÓLAFSSON 2004 p. 135
106 ÁRNADÓTTIR, GESTSSON & SVEINBJÖRNSDÓTTIR 1986 p. 98

figure 34 - front facade of Laufás turf farm

The second Volume of Hörður ÁGÚSTSSON's Íslensk byggingararfleifð gives a closer idea on how the development described to this point continues.[107] In the absence of archaeological evidence or lacking accessibility, he found another method to reconstruct the state of turf farms before our time. For centuries Icelandic clergyman came to enjoy a certain independence in drawing up the budget of the feud in their care and keep house there, but also had to take responsibility for the condition of all buildings of possessions. There-

107 ÁGÚSTSSON 1998b

fore, a report was drafted for every succession. These reports are dating back to the 16th and 17th century and are detailed enough to allow ÁGÚSTSSON to draw conclusions about the layout of the farm throughout time.

Starting at the oldest reconstructed state of 1616 a structural similarity with the before mentioned farms Gröf and Kúabót is visible. The central passageway, although much longer than the ones in the examples before, serves as a main connection of individual functional units. It is presumable that today's strong rectangularity of the layout could already be seen, as with rooms tightly docked onto each other sharing the wall in between, this is naturally the easiest way to arrange them. Stofa and Skáli are oriented transversal towards a vestibule area and perpendicular to the axis of the hallway. It is presumed that the entrance was emphasized with a separate gable, as it is seen in other cases. One of them being the southern farm Keldur, a vestibule like this can still be seen there today.

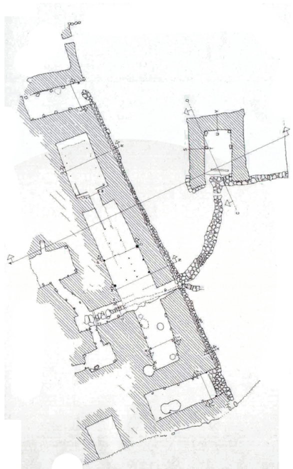


figure 35 - floorplan Kúabót i Álftaveri

The next major typological change is visible in the reconstruction drawing of 1768. Like other farms it is believed that at this time Laufás was transformed into what ÁGÚSTSSON refers to as Mælifell-type.[108] Named after a farm from that time, it is characterized by the Stofa turning 90 degrees, orienting towards the outside with a gabled wooden façade, while Skáli remains in its traversing position.

Before the turn to the 20th century, another transformation appeared that in terms of layout changed Laufás into the state that in its essence can still be seen there today. The Skáli is rotated in the same manner as the Stofa before,

108 ÁGÚSTSSON 1998a p. 33

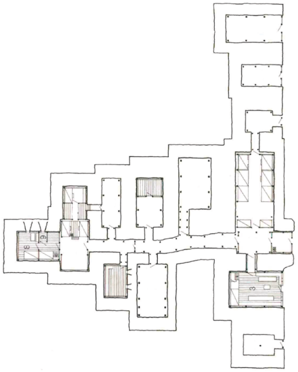


figure 36 - floorplan
Laufás 1768

also being equipped with its own wooden gable.[109] With all rooms in the front now facing the yard, presenting themselves with a wooden gable, this is what ÁGÚSTSSON defines as the northern type.[110] STEFÁNSSON titles this type of structure with the term Burstabær (= brush-farm).[111]

But not all farms developed like Laufás in northern Iceland. Other influences in other regions lead to different transformations. Some bærs were shaped following the ideas of Guðlaugur SVEINSSON, a clergyman from Vatnsfirði in the Westfjords, in the intention of improving the unhealthy housing situation in Icelandic farms. This type, with all units under in a single row, each facing the yard, was described by ÁGÚSTSSON as the southern type, as it appears it established itself in this part of Iceland the most.[112]

It is clear, that archaeological evidence is not available in sufficient extent to draw a clear picture of the development of turf farms. Also, the material and methodology available through the extensive typological research of Hörður ÁGÚSTSSON is limited to the, usually wealthy, farms of the church feuds that were documented in before mentioned status reports. But while not being able to show one clear line of evolution, it appears that the connections from functional units in the last generation turf farms with their origin, the long-house are traceable. Comparing the evidence at hand can help to point out some transformations that lead to the farms we can see today.

As an additional observation it seems apparent that the same sense of national identity that established itself in many countries during the industrial era

---

109 ÁGÚSTSSON 1998b p. 320
110 ÁGÚSTSSON 1998a p. 40
111 STEFÁNSSON 2013 p. 53
112 ÁGÚSTSSON 1998a p. 40

figure 37 - black gables of Keldur turf farm

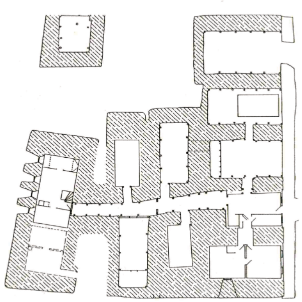


figure 38 - floorplan Laufás
current state

lead to more representational arrangements of architecture in Iceland as well. While in medieval times turf buildings seem to have developed in a natural logic of self-preservation, 19th century shows rows of gabled façades materializing an Icelandic identity.

Ultimately, these iconic fronts came to be an image of national pride, which lead to the preservation of the farms with the most impressive fronts, while small farms, the backbone of Iceland for centuries, got abandoned and in large numbers replaced by internationally influenced concrete and timber buildings.

from Skáli to Baðstofa – retreat within a cluster

The previous chapter mainly dealt with the development of two main units in the transition from Skáli to Burstabær. But another major change in the layout of a turf farm can be observed. Functions that used to be incorporated in the Skáli were moved to the back of the house. The peculiarity of this case comes from the fact, that one unit within the cluster is gradually stripped of its purpose, including the supporting furniture that was incorporated in the structure, and moved to a different unit – all that while the naming of the changing rooms remains the same.

Typical interiors within the Skáli included wooden fixtures on the long sides with the central area as open space.[113] These were fitted within the main timberwork carrying the roof and therefore dependent on the iterant distance of frame units of about 1,3 – 1,9 m, called stafgólf (stafur = stick; golf = floor).[114]

113 ROBERTS et al. 2004 p. 97

114 STEFÁNSSON 2013 p. 72

Wooden platforms, for sitting and sleeping, as one of those fixtures, seem to be the ones maintaining a role within the Skáli throughout the development of turf houses the longest. In various examples these bed-like platforms were still documented at times when many other functions were already moved to other units of the Gangbær. Starting during the 17th or 18th century, all the examples listed by ÁGÚSTSSON show a gradual movement of sleeping arrangements to the back of the house.[115]

In his article from 2014, LÁRUSSON argues that sources indicate the existance of bathing facilities at the end of the Gangbærs hallway in multiple cases,[116] and although no intact ovens have been excavated in these locations, archaeological evidence suggests their occurrence.[117] It is just this place that is taken over by the functions that used to be implemented within the Skáli. Theories on the reasons for the ignition of this development are various, but it is suggested that it has to do with colder temperatures and a deterioration heating situation, due to the scarcity of firewood.[118]

It is possible that the bathing facilities might have been located in the back of the cluster for reasons of heat preservation as well. And while this could also explain a use of this positive effect for sleeping arrangements in times of fuel shortage, the question of whether a social component took a part in this as well remains.

---

115 ÁGÚSTSSON 1998b p. 85 / 104 / 111 / 115

116 GUÐMUNDSSON 1889 pp. 240-244; A. SIGURÐARDÓTTIR 1966 pp. 69-79 as cited in LÁRUSSON 2014 p. 18

117 HALLGRÍMSDÓTTIR 1993 as cited in LÁRUSSON 2014 p. 19

118 ÁGÚSTSSON 1998a p. 33; LÁRUSSON 2014 p. 19 f

Turning the Stofa towards the yard and equipping it with a wooden gable is a transformation that increases the deficit of warmth through thermal transmission. Therefore, it stands contrary to the suggested intentions of increasing energy management and, in this sense, ultimately moving quarters to the back of the complex. However, emphasizing Stofa and later Skáli with a wooden façade could be interpreted as a tendency to a more representational character of the front. A movement of the most private functions of the farm to a less accessible part of the house could therefore also be understood as an effort to increase intimacy.

While these explanations can not be verified at this point, the fact remains that room terminology of the turf farm changed as a function, including supporting built-in furniture, was shifted to another unit of the cluster. Skáli remains in the front, Baðstofa becomes the new living, working and sleeping quarter.

figure 39 - Baðstofa of Glaumbær turf farm

4

comparision


figure 40 - Kirkjufell mountain

4.1 building conservation

It was mentioned before that the degradation of turf demands periodic reconstruction of buildings or parts of it. Originating from that, it has been the Icelandic tradition for centuries to tear down damaged structures and rebuild them using fresh cut turf and reusing stone and wooden parts that are still intact. A traditional turf house is therefore always a living organism. Likewise, preserving them is an ongoing process that never stops.[119]

authenticity

In 1964 the 2nd International Congress of Architects and Technicians of Historic Monuments meeting in Venice released the Charter of Venice, defining the principles for preservation and restoration of historic buildings. Based on the principles of this Charter, ICOMOS (International Council on Monuments and Sites) was founded. In 1972 the UNESCO World Heritage Convention installed the World Heritage Committee, an intergovernmental panel and deciding entity for the World Heritage List and assigned ICOMOS

119 STEFÁNSSON 2013 p. 43

as advisory body for cultural heritage. For consideration of an object to the World Heritage List, as defined by Article 1 in the World Heritage Convention,[120] the Operational Guidelines for the Implementation of the World Heritage Convention, drafted in 1977, ask for a "test of authenticity in design, materials, workmanship and setting" to be met.[121] This test of authenticity is first defined in the Management guidelines for World Cultural Heritage by ICCROM (International Centre for the Study of the Preservation and Restoration of Cultural Property) as a "test of authenticity in materials", stating that the historical substance cannot be replaced and is "a primary criterion for authenticity in design and in workmanship".[122]

It is not until the year of 1994 that this understanding of authenticity is challenged by Japan that recently ratified the World Heritage Convention. Due to measures practiced on their cultural sites that do not correspond with the Charter of Venice[123] it was worried that its own cultural heritage cannot meet the criteria of the World Heritage List. The discussion of terminology and the primal definition of authenticity in cultural heritage ultimately lead to the Nara Document on Authenticity.

> "It is thus not possible to base judgements of values and authenticity within fixed criteria. On the contrary, the respect due to all cultures requires that heritage properties must be considered and judged within the cultural contexts to which they belong."[124]

---

120 UNESCO 1972 p. 2
121 UNESCO 1977 p. 3
122 FEILDEN & JOKILEHTO 1993 p. 17
123 MAGER 2016 p. 115
124 ICOMOS 1994 p. 47

Implemented in the Operational Guidelines for the Implementation of the World Heritage Convention of 2005 in a separate chapter concerning authenticity, this is now expressed as:

> "Depending on the type of cultural heritage, and its cultural context, properties may be understood to meet the conditions of authenticity if their cultural value (as recognized in the nomination criteria proposed) are truthfully and credibly expressed through a variety of attributes including: form and design; materials and substance; use and function; traditions, techniques and management systems; location and setting; language, and other forms of intangible heritage; spirit and feeling; and other internal and external factors."[125]

The chosen phrasing shifts focus away from mere presence of historic substance and now asks for evidence proofing the credibility of individual attributes of a monument, based on a cultural context.

periodic reconstruction

One example frequently mentioned when discussing the changing definition of authenticity is the Ise-shrine in the Mie prefecture in Japan, about 100 km south-east of Kyoto. The complex is believed to be constructed in the 4th - 5th century and houses one of the Imperial Regalia of the Japan, the sacred mirror Yata no Kagami.[126] It consists of various individual buildings that

125 UNESCO 2005 p. 21
126 MAGER 2016 p. 146

figure 41 - Baðstofa of Laufás turf farm stripped of its turf walls

are almost exclusively constructed out of wood and access is only granted to a very limited group of people. It is reported that empress Jito ordered, that the shrine is to be rebuilt regularly.[127] Not only to ensure the materialistic continuance of the shrine, but to emphasize its importance in strengthening the emperor's power.[128] Initially these were not the only buildings of their kind experiencing this periodical reconstruction but, due to the extensive effort necessary, they are one of the very few where this tradition is still practiced.

127 KAWAZOE 1965 p. 200 as cited in MAGER 2016 p. 154

128 WATANABE 1974 p. 11 as cited in MAGER 2016 p. 154

In this continuous tradition of building and rebuilding some similarities to Icelandic turf farms can be found. While the motivation to do so is clearly differing between the two cases, the end result is similar. Without keeping the tradition alive, it is impossible to preserve the cultural heritage. Decay of substance is part of the tradition and altering that factor would obscure an essential part of it. It is unclear if there is a connection between the Nara Document on Authenticity and the ratification of the UNESCO World Heritage Convention by Iceland the year after, in 1995,[129] but it appears possible that this change in the understanding of authenticity cleared the way for Iceland accepting this convention and opening up to the possibility of having its building tradition becoming part of the UNESCO cultural heritage list.

In the year 2011 The Turf Building Tradition was submitted by the National Museum of Iceland to the Tentative list of UNESCO World Heritage List, a step necessary prior to becoming part of the heritage list itself.[130] Further, turf buildings, and Keldur in specific, are listed in the ICOMOS Heritage at risk report from 2000.[131]

national practice

It is pointed out in both the 2000 Heritage at risk report as well as the 2011 Tentative list submission that turf buildings require extensive care and continuous restoration. And while it is stated that "the maintenance of a turf-

129 WHC.UNESCO.ORG last visited 11.03.2018
130 WHC.UNESCO.ORG web page last visited March 11th, 2018
131 ICOMOS 2000 p. 108 ff

house demands skills in traditional building methods, [...]"[132] it appears that there is a dispute in terms of practice between stakeholders. This is discussed in the 2010 article from HAFSTEINSSON. He claims that local-based private initiatives, like Íslenski Bærinn,[133] the Icelandic Turf-house Project by Hannes LÁRUSSON and Kristín MAGNÚSDÓTTIR, are, despite their willing and continuous effort of participation, excluded from the inscription process to the UNESCO World Heritage List.[134] And while various other private initiatives to enliven the turf house tradition exist[135] and UNESCO encourages state parties to prepare submissions to the Tentative list, "[...] including site managers, local and regional governments, local communities, NGOs and other interested parties and partners",[136] none of them can be found mentioned within the submission. The second cycle of periodic reporting on state parties by UNESCO attests Iceland's preparation of its Tentative List good involvement of government institutions and departments as well as experts. Nevertheless, engagement with local communities, land owners and NGOs is rated as poor.[137]

One particular example described by HAFSTEINSSON appears to give further insight into the origin of this dispute between some turf builders and government authorities. During reconstruction work of Nupstaðir turf-chapel, a Norwegian conservationist was hired as well as a local turf master to assist with his extensive experience in the process. Over a disagreement of practices, the local turf master quit and has never since been part of any construction

132 ICOMOS 2000 p. 109

133 ISLENSKIBAERINN.IS web page last visited March 12th, 2018

134 HAFSTEINSSON 2010 p. 271

135 FORNVERK.IS web page last visited March 12th, 2018; THETURF.NET web page offline, last visited October 18th, 2017

136 WHC.UNESCO.ORG web page last visited March 12th, 2018

137 UNESCO 2013 p. 1

on behalf of the National Museum.[138] While the directed course of action was to rebuild only parts that were necessary on top of intact fragments and even numbering stones, to place them in the exact same position as before, the turf builder argued that this was not according to the traditional ways he had learnt from his ancestors. While it is not specifically stated in HAFSTEINSSON's article, the suggested method by the turf builder would likely mean to tear it down completely and rebuild it with fresh turf, reusing stones from the old construction as is seen fit.

A similar practice was observed in the turf building course the author of this work participated in. Existing walls were retained where possible and supplemented with newly constructed ones. Further, in these newly constructed parts a mixture of turf cutting patterns, that previously existed in these walls, were imitated, even though there was no logical reason to it, but the mere intention of imitating historic substance.

While ICOMOS Iceland, believed to be represented by officials of the National Museum, says "to ensure the maintenance of the few still surviving, they must be accepted as requiring a continuous building process, demanding at the same time the continuation of skills in traditional building methods and the economic means to keep the process going",[139] it appears there is still a desire to hold on to historic substance as long as possible. Despite the turf builder's claim that traditionally the reconstruction of turf buildings is handled differently, a preservation of the as-is state of buildings is hoped to be achieved. This is also visible in the submission to the tentative list, as for

138 HAFSTEINSSON 2010 p. 273
139 ICOMOS 2000 p. 109

every single object "[…] with renewal of turf when necessary, as is part of the tradition […]" or "[…] renewal of materials has been minimal" is used as justification of this practice.[140]

It appears the practice displayed today not only leads to a dispute of stakeholders, as described before, but also reflects an unclear position towards the basic rules of building conservation, like the Charter of Venice. Especially as article 9 says that "[…] any extra work which is indispensable must be distinct from the architectural composition and must bear a contemporary stamp",[141] a fractional reconstruction with traditional methods and especially trying to imitate a previous state as closely as possible might stand in the way of being accepted as part of the World Heritage List.

With the inevitable degrading of turf, it is believed that an approach of justifying the authenticity of a monument similar to the Japanese shrines described in the previous chapter is more suitable. A focus away from materialistic substance and towards the tradition of rebuilding a structure on the same site, with traditional methods and reuse of more durable components when adequate, seems appropriate. Not only would this be more truthful to Icelandic traditions but a lasting justification of its value, able to persist even for future times when all historic turf substance has degraded and therefore been replaced.

140 ÞJÓÐMINJASAFNS ÍSLANDS 2011
141 ICOMOS 1964 p. 2

4.2 do as the romans do

Studying methods of using turf in traditional Icelandic building reveals similarities to a construction method from the very other end of the European cultural area. It is far-fetched to suggest that turf-building in Iceland got inspired by ancient Roman construction methods, but a comparison reveals various parallels.

One of the most fundamental parallels is construction of walls with shell and core. While in Iceland shells were constructed from turf and the core is filled with beaten earth,[142] roman architecture used fronts of natural stone or brick and filled its core with rammed concrete, called opus cementitium.[143] Also the interlinkage between wall faces, usually achieved with Torfa, can be seen in roman walls as layers of bricks reaching through from face to face after several layers of shell and core.[144]

---

142 ÁGÚSTSSON 1998; SIGURÐARDÓTTIR 2008; STEFÁNSSON 2013

143 LAMPRECHT 1987 p. 21

144 LAMPRECHT 1987 p. 30

figure 42 - the decay of mortar reveals the triangle shape of bricks in Roman masonry

Further, Strengur, Klömbruhnaus and sometimes Snidda[145] are cut with decreasing thickness towards the core of the wall to optimize interlinkage with the rammed earth. The same principles are at work within ancient roman shell and core walls. Not only do tuff pieces of opus reticulatum have a pyramid shape with decreasing thickness to the centre of the wall[146] but also the diamond pattern of the front is the same as

145 STEFÁNSSON 2013 p. 27

146 LAMPRECHT 1987 p. 27

with Snidda, although different in size. Bricks within opus testaceum are often broken into the shape of a triangle. With the long side forming the face of the wall and the tip of the triangle pointing into the core, the same principle of maximizing interlinkage is at hand here as well.[147]

The use of this type of masonry in Roman architecture can be dated back to the third century BC and is observed in many constructions.[148] Descriptions of it can also be found in the ten books on architecture by VITRUVIUS, explaining how it consists out of two shells and a core, bound together by stones reaching from face to face after several layers.[149]

While it is documented, that romans adapted turf building techniques to be part of the Antonine[150] and Hadrian's wall[151] and supporting fortifications, it is unclear whether and to what extent their turf structures adopted techniques known from ancient roman masonry. And while it seems likely that Viking raiders invading Northumbria in the year 793 AD[152] were able to see remains of this roman presence, it is also uncertain how much they informed their building methods with what they might have observed there, or if they were using turf in the matter described all along.

---

147 ADAM 1994 p. 293

148 ADAM 1994 p. 250

149 VITRUVIUS POLLIO & FENSTERBUSCH 1987 p. 107

150 WALKER 2006 p. 11 ff

151 BRUCE & BREEZE 2006 p. 58 ff

152 SWANTON 1997

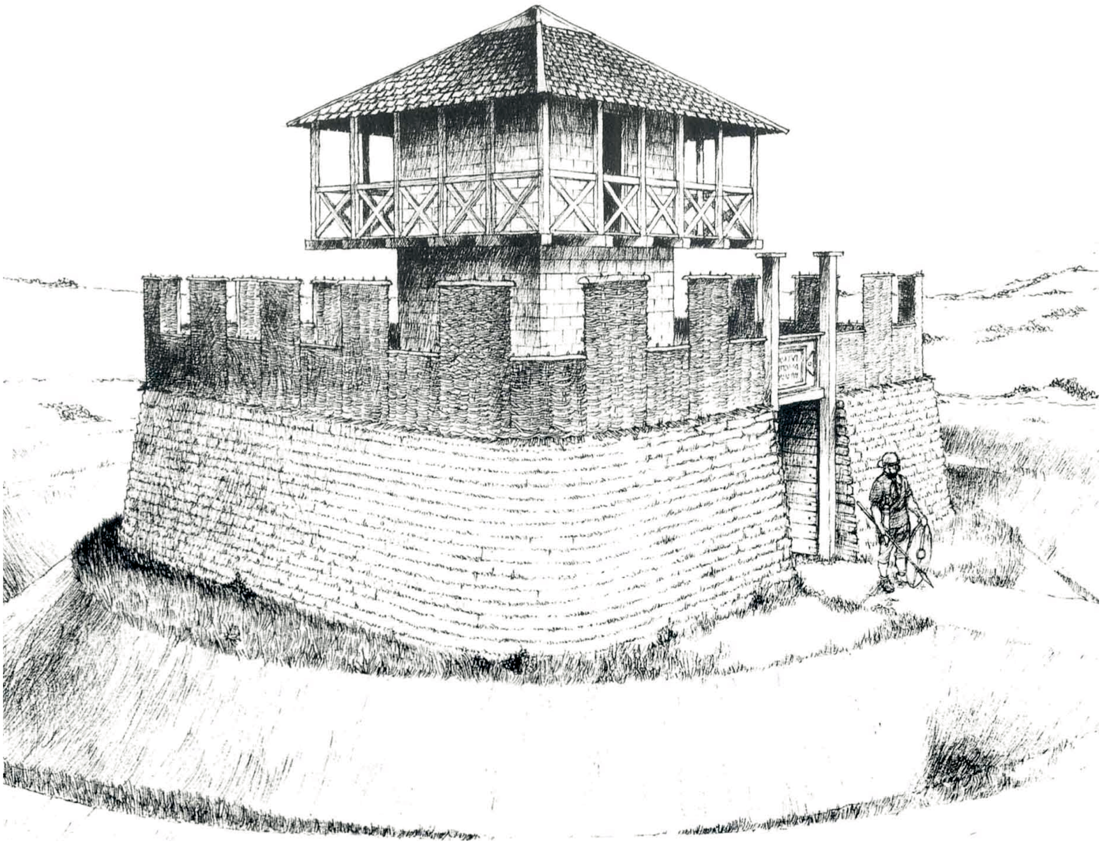


figure 43 - reconstruction of a turf fortification as part of the Antonine wall

4.3 relatives

The use of earth for construction purposes in a cold climate is something that can not only be observed within Iceland. Although the scarcity of wood appears to have established itself particularly strong there, many boreal and arctic regions share a similarity in climate and, strongly influenced by that, vegetation. With peat soils widely spread through the northernmost parts of continents in the northern hemisphere they found application as building material in a variety of cultures.

the Sámi winter huts

One example the bares the potential to be considered influential for turf buildings are the winter huts from the Sámi people. Today considered the online aboriginal ethnic group within the European union, Sámi are believed to be living in Scandinavia at least since the bronze age.[153] The gamme, a turf hut extensively used by Sámi in the coastal regions of northern Norway was constructed to protect against cold winters. Consisting of a timber structure

153 LEHTOLA 2002 pp. 9 + 20

figure 44 - Sámi family in front of the winter hut

clad with pieces of turf for insulation the similarity to Icelandic turf houses is evident.[154] Sharing a land with the people who came to settle Iceland a cultural exchange to some extent is probable. EINARSSON believes that pit houses, as found in Granastaðir, may derive from a Sámi context.[155]

Besides with the Sámi, semi-dugout earth lodges can be found with Selkup and Ostyak people in Siberia or Northern Athapaskans in Northern-America.[156]

154 OLIVER 1998 p. 1395

155 EINARSSON 1995 p. 118

156 OLIVER 1998 pp. 845 ff + 1791

figure 45 - Blackhouse at Skinidin Folk Museum

constructions in Scotland

Although at this day there are no historic examples left in Scotland, structures made from turf almost identical to the ones in Iceland are described to have existed there.[157] Erected with pieces of Fale, equal to Klömbruhnaus, and Divet, Scottish pendant to Strengur, in a shell and core technique, parallels are numerous.[158]

Built in a similar manner, so called Blackhouses were once widely spread in Scotland. Their name derives from the smut settling on the walls in the interior, as ventilation and smoke outlet was minimal in these structures.

Today some examples can still be observed on the Hebrides, islands close to the western shore of the United Kingdom. While having the walls, alike turf houses, made from earth-filled shells, one of the greatest differences is the dry-stone construction that comes to practice. Also, the timberwork for the roof is not carried by pillars but placed onto the head of the wall. After being covered with turf, it is also custom to put on thatch, held in place by ropes weighted down with stones.[159]

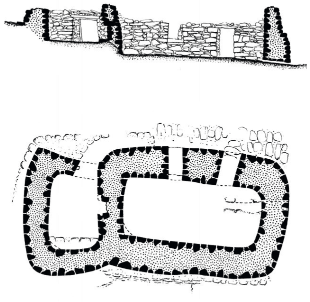


figure 46 - section and floorplan of a Scottish blackhouse

157 WALKER, MCGREGOR & LITTLE 1996 p. 7

158 WALKER 2006 pp. 23 ff

159 see WALKER & MCGREGOR 1996

the Igloo of arctic regions

No similarities in construction are apparent when comparing igloos to Icelandic turf houses. Nevertheless, a closer look at the traditional snow constructions of Inuit tribes shows some parallels in terms of layout and section. With the sleeping space placed furthest in the back, connected by a narrow tunnel or pathway to the entrance point, and raising said area higher from the ground than the rest of the building, warmth inside the structure is used most efficiently. Entranceways in Inuit snow buildings often consist of a row of two or three domes forming the hallway.[160] The narrow hallways of a gangbær and the raised level of Baðstofa could therefore be seen as relative in its long section.

In the case of Igloos, it is not turf that is cut from the ground, but compact snow. With its insulating properties temperature levels inside of up to 36°C warmer than the outside can be achieved, up to 15°C room temperature with the help of an interior lining.[161] Further analogy could be seen in the volatileness of the construction. A practiced team could finish an Igloo in about one hour, material is gathered from the ground, therefore a certain expandability of material is given. In a climate where environmental conditions are inevitably eroding man-made structures decay is accepted and compensated with easy reconstruction.

160 BOAS 1888 p. 541
161 COOK 1996 p. 280

figure 47 - Inuit constructing an igloo with blocks of snow

4.4 contemporary examples

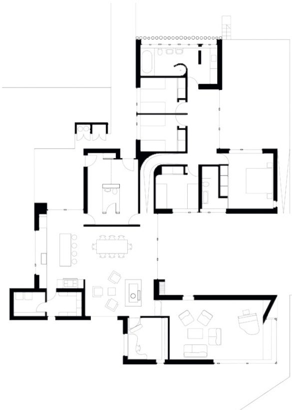


figure 48 - floorplan
Hof Residence

Aside from traditional buildings and constructions made during the first half of the 20th century, there are very little examples working on a new interpretation of Iceland's building heritage. Some of them only defined as such by international journalism and not in the words of the architects themselves. In a 2017 article of CNN style, presenting the heritage at topic here, some local and international architectural firms are mentioned to "[...] have recently utilized such concepts".[162]

Since 2015, the vacation houses designed by Reykjavik based firm PKdM Arkitektar apply the use of a green roof, sloped down to the ground to achieve a blending with the landscape on one side.[163] Hof residence by Studio Granda, finished in 2007, also works with a green roof and the cluster-like layout could be considered a reference to the organization of the traditional burstabær or brush-farm. Traditional turf constructions of Klömbruhnaus are used for structuring the surrounding landscape and interconnecting

162 CNN.COM 2017 web page last visited March 30th, 2018
163 see DEZEEN.COM 2015; PKDM.IS 2015 web pages last visited March 30th, 2018

figure 49 - Hof residence by Studio Granda

figure 50 - Garður residence by Studio Granda

it with the building but are not applied to the construction of walls.[164] At Garður Residenc, Studio Granda's later project from 2014, landscaping becomes even a stronger design aspect, as the whole building is located in a trench-like formation with the landscape spanning over the roof from the sides. No turf building techniques were applied here, instead earth on the sides of the trench were reinforced with sandbags partially covered with an additional layer of sod.[165]

Besides the green roof, described projects apply some aspects of traditional turf building, but do not approach the very central feature of this architectural heritage – the construction of the wall with this material. And while there are projects that try to apply turf building principles to their walls as well, still this is done in a more decorative manner than in a way of embracing the qualities of the material.

While LÁRUSSON is working on turf construction at Íslenski Bærinn, the construction of the main exhibition hall still applies the use of concrete to carry the pressure of soil piled up against it instead of self-carrying structures held together by the use of turf.[166] Various buildings at Möðrudalur are designed to resemble traditional turf buildings, but the material is mostly just piled up in front of a wooden construction. Perforated corrugated iron sheets are placed between wooden constructions and the turf cover. Therefore, a certain distance is kept between the two materials, protecting the wood from moisture and allowing humidity to stream off. Since outside air is allowed behind the turf cover, this possibly leads to a great loss in the insulation properties but applied differently appears useful for future constructions.

---

164 see ARCHDAILY.COM 2009; STUDIOGRANDA.IS 2007 web pages last visited March 30th, 2018

165 see HOMEDSGN.COM 2017; STUDIOGRANDA.IS 2014 web pages last visited March 30th, 2018

166 LÁRUSSON personal communication June 11th, 2017

vision

5

figure 51 - view on Snæfellsnes peninsula

Up to this point this thesis tried to present the working principles of turf building as well as interpretations of their origin. The real purpose of this work is nevertheless supposed to be an encouragement for everyone interested to engage in a critical discourse about a possible future of the Icelandic turf building technique.

The believe is that while these buildings, in the way they were constructed for centuries, have their faults and weaknesses, they also have a lot of potential that could be made use of for future constructions. A critical analysis can help to determine between principles and techniques that appear useful and compatible with today's expectations of architecture and strip off habits that are practiced in the mere sense of imitating what has already been done. Informing the valuable essence of this tradition with the extensive knowledge and highly developed materials available today could lead to an architecture that for some cases provides the answers one has been looking for.

With increasing communication and trade with the outside world, a transformation of turf farms had already started to take place during the times of the industrialization. While it appears that promising examples could have emerged from that, this trend was abandoned due to ambitions of evolving to a modernistic nation through leaving the old ways behind.

Common living situations in turf farms of the 19th century have lead to illness and widespread tuberculosis among the habitants and the buildings themselves were held responsible for it.[167] Further, a lack of aesthetic quality was ascribed to this tradition, as was stated in a newspaper article of 1936:

---

167 STEFÁNSSON 2013 p. 33

> "A particular architectural style did not emerge in the Icelandic farm or churches. Isolation and poverty prevented people from developing such qualities, and they had to settle for a mere roof over their heads".[168]

These two notions resulted in the conclusion that the traditional turf farms stand in the way of Iceland progressing to a modern nation and must be left behind.

The following chapter aims to revive the discussion on a new interpretation of turf buildings through pointing out specific potentials of aesthetic and technical nature and presenting some situational inspirations as a possible origin for discourse.

168 VISIR 1936 p. 3 as cited in HAFSTEINSSON 2010 p. 267

5.1 architectonic potential

identity: critical regionalism

To promote a transition towards a progressive turf architecture, it is evident that engagement with the traditional ways always needs to be done with a critical mind. The intention cannot be a mere revival of a vernacular style which is clearly not suitable for today's expectations in our habitats, but must be a new style, inspired by local conditions, materials and craft. The architectural theory of critical regionalism tells us to mediate between these regional influences and modern developments that are positive in its essence, like progress, free trade and cosmopolitism. It criticizes abstract and universal architectural solutions and favours local traditions and a self-conscious building culture that directly or indirectly responds to factors like climate, light, colour, material and arrangement – characteristics of a particular place.[169]

Coined by TZONIS' and LEFAIVRE's 1981 article "the grid and the pathway" this theory on regionalism, denoted critical, originates from their analysis of

169 LEY 2017 p. 34

the relation between various states of Greek regionalism and its international pendant of neo-classicism.[170] FRAMPTON writes on the topic:

> "Architecture can only be sustained today as a critical practice if it assumes an arrière-garde position, that is to say, one which distances itself equally from the enlightenment myth of progress and from a reactionary, unrealistic impulse to return to the architectonic forms of the preindustrial past. A critical arrière-garde has to remove itself from both the optimization of advanced technology and the ever-present tendency to regress into nostalgic historicism or the glibly decorative. It is my contention that only an arrière-garde has the capacity to cultivate a resistant, identity-giving culture while at the same time having discreet recourse to universal technique." [171]

It appears evident that any attempt of continuing a tradition of turf building can only be authentic and true in dependence of such principles. Continuing to follow solely progressive forms of architecture will result in foreseeable extinction of abilities and knowledge in craft that enables to transform techniques into something lasting. A struggle to preserve the old ways will only lead to a loss of significance due to missing purpose in imitating what has already been and what is not adequate anymore. Especially in the prospect of dealing with a material affected by such high rates of decay, a tradition that is not continuously cultivated is about to be cleansed from the picture. "What is left after identity is stripped? The Generic?" [172]

---

170 TZONIS & LEFAIVRE 1981
171 FRAMPTON 1987 p. 20
172 SCHRÖDER & SCHNEIDER 2018 p. 19

More than one century after a notion of the Icelandic turf building being a hindrance of the nation's progress, the personal communication with multiple locals without exception appeared to show a change of heart. Statements like "people are not ashamed of their heritage anymore"[173] complement with a comment BJÖRNSSON made in 1910, expressing the believe that the Icelanders renunciation from their tradition strongly results from deprecatory comments of foreigners about their architecture.[174] Suggesting that this outside opinion had such an enduring impact, maybe it is the right time for Icelanders to reclaim their heritage in a self-confident way. Working not solely towards a universal ideal of a progressive nation but also on applying those accomplishments of globalization on a particular Icelandic context could help achieving a next step forward within 1000 years of struggle towards an Icelandic identity.

landscape: blurred lines between house and site

In one of the early scientific reports about Iceland, first published in Danish in 1752, HORREBOW describes that while the buildings are standing above or level with the surrounding terrain, it might appear as if houses were built into the ground, like little hillocks, when they are grown over with grass.[175] The vegetation on Icelandic turf buildings is probably one of the most noticeable features. And while it was just that notion of the nation that lives in earthen cave-like structures, this might just be one aspect of this tradition that bares extensive potential to work with.

---

173 UNKNOWN personal communication June 9th, 2017

174 BJÖRNSSON 1910 p. 69

175 HORREBOW 1753 p. 358

figure 52 - abandoned shed at Buðahraun

Naturally, many examples of vernacular architecture were built from the material available close to the site and therefore often show a strong resemblance of the built structure with the surrounding landscape. Earthen architecture like Dogon-villages in Mali, Ksour und Tighermatin in Marocco or Pueblos in New Mexico, USA[176] perfectly match the colour palette of the surrounding terrain. Stone structures like tuff villages in Italy, castles in the Austrian alps or the fortified villages of Svanetia, western Caucasus,[177] make the border between natural and intentionally placed rock hard to spot. Even wooden architecture like log architecture in Norway, temples and shrines in Japan resembles the character of its surrounding. There are various further cases all around the globe, where this special harmony between man-made structure and landscape through uniformity of material can be observed. Yet as the shapes and lines of architecture become more defined, the distinction between natural and intentionally placed becomes clearer.

A look at the seaside fortifications of Malta's capital Valetta presents an architecture that is far from vernacular. Sacral, military and urban residential architecture exist side by side, but all of it bending in perfectly with colour and texture of the bedrock on the shore. Only the clear defined edges reveal what is shaped by humans. The availability of material appears to have levelled the appearance of the cities architecture to a certain harmony with its site.

In his book from 1923, BUBER describes two different principles of existence. While the attitude of the "I" towards the "It" is one that uses or experiences, in contrast to the attitude of the "I" towards the "Thou" is one that describes a dialogue between the two. This mutual and reciprocal

176 see LEHNER 2016

177 see RUDOFSKY 1964

figure 53 - Erdfunkstelle Aflenz, Austria by Gustav Peichl

relationship[178] is what an architecture of the place should thrive to achieve. As VELENA describes, it engages with the place, without clearing all context out or solely applying the principle of contrast that feeds off the vitality of the counterpart.[179] The appearance of turf structures delivers a design tool that can help to engage in just this dialogue between architecture and site. The ability to camouflage man-made lines and contours through vegetation expands the spectrum between blending in and showing itself even further. Like a dynamic range in music, the ability of delivering an even vaguer piano intensifies the impact of a forte exponentially.

Projects that work with aspects like this often do this in a way of going underground. The radio station Aflenz by Gustav PEICHL, part of the Austria public broadcasting, manages to do so by allowing natural light through two internal courtyards of 30m diameter into the structure.[180]

The advantage of turf construction is, in that prospect, the ability to carry vegetation as part of its own skin. Openings can be broken into the boundary walls for illumination and view. The structure is above ground while it can present itself as part of it. The architecture already provides the nutrient medium and a material that is taken from the landscape and reassembled in a different shape can become part of this landscape once again. Complementing this with facades that do the opposite, standing in contrast to the natural shapes and materials, or placing in openings within a landscape allows the designer to work with these factors and arrange a dialogue between landscape and architecture.

178 BUBER 1923
179 VALENA 2007 p. 32
180 KAISER & ARCHITEKTURZENTRUM WIEN 2006 p. 216

space and light: the wall as a volume

Due to the absence of a binding agent within turf walls a greater thickness of usually more than 1 m is necessary to create a durable structure. In times when settlements around the world are becoming increasingly urbanized this would mean an inefficient ratio of interior space to construction volume. Regarding a rural context and the extensive availability of space in Iceland this can be considered an issue that is easy to neglect. For centuries these thick walls have kept Icelanders alive and protected them from the harsh and hostile environment they found on the island. The thickness of the wall makes it react more latent and less vulnerable to influences like wind, cold or wetness, while thinner constructions made of concrete or wood require a sophisticated combination of layers. Each fulfilling a single purpose, a failure of one can lead to a falling out of the whole system.

But besides these technical attributes, which will be discussed in more detail later, the massive volume of walls in turf buildings are bearing great architectonic potential. To follow the terminology of Leon Battista ALBERTI, an architectonic space is contained by paries – the walls and tectum – the ceilings, in the ground floor alternatively by paries, tectum and area – the site.[181] But as HEIDEGGER states: “A boundary is not that at which something stops but, as the Greeks recognized, the boundary is that from which something begins its presencing.”[182] Therefore, a room does not stop at wall, it actually begins there. The way a wall is usually described as a linear element, they not only define one room, but the boundary of one architectural space is the negative of the neighbouring space or vice versa.

---

181 ALBERTI 1986

182 HEIDEGGER 1971 p. 152

A turf wall is constructed, as analogically described by LAMPRECHT on the matter of Roman masonry[183], of three components – two shells that generate the faces of the wall and a central core of rammed earth, filling the void between the shells. As the core of earth is inexpensive and easily extendable a design approach following the principles of Heidegger more closely appears possible. Design can focus on the boundary of the architectural space, disregarding the necessity of parallelism with the next space.

With that level of massiveness, turf walls themselves become a volume the architect can work with. The thickness of the wall allows the creation of spaces within the wall through subtraction. Niches and openings become appendixes to the main space, extending it, diversifying it, allowing lingering within the massive of the wall. In the sense of MÄCKLER, the possibility to experience of a window opening is enabled through becoming a place instead of a picture[184] - or to return to BUBER once more, it is possible to engage in an attitude of the I towards the Thou and start a dialogue with the wall and the outside.[185]

Light is perceived differently through an opening within a thick structure. As seen at the chapel Notre Dame du Haut in Ronchamp, France by LE CORBUSIER,[186] the light is polarized through the thickness of the wall and refracted by the reveal of the windows. The opening itself turns into a lamp shade for the exterior light, diffusing it, softening it through an increase of the indirect component in lighting, adding another aspect to the architectonic tools a designer can work with, when engaging in turf building.

---

183 LAMPRECHT 1987 p. 21

184 MÄCKLER 2016 p. 43

185 BUBER 1923

186 see ROTH 1955

figure 54 - window detail from Laufás turf farm

5.2 interior and exterior

In order to be able to calculate building physical properties of a construction in a planning stage it is mandatory to have a good idea about the characteristics of materials that are intended to use. On the one hand this is necessary to simulate the given situation to avoid defects and on the other hand to be able to prove the structure complies with building regulations. As turf building is not widely used and construction practices and techniques mostly rely on the experience of the given turf builder, material specifications are quite rare and are mostly available from different fields of research, in this case specifically from soil sciences.

material properties

In his dissertation from 1978, GUDMUNDSSON studies soils from two different sites in northern and western Iceland on their pedological properties. While especially bulk density and shrinkage of turf presented in this study are matters of significance for turf building, he does not deliver information on thermal properties. Also, the study shows that the available values vary greatly between different sample locations and depth of extraction and are therefore of limited expressiveness for anticipating material behaviour within a structure.

What is clearly visible is the importance of allowing turf to drain before placing it within a construction as shrinkage can be extensive. GUDMUNDSSON documents shrinkage, concerning soil depths that are relevant for turf building, between 55,2 % and 75,2 % of the sample's original size.[187] It needs to be noted that these values represent a shrinkage from saturated to air dried state, although temperature and humidity of the air is not specified within the study. Nevertheless, it appears noteworthy that the state this study specifies as air dry shows a very small water content of less than 3 % of the original sample volume. Shrinkage is not expected in this extent within a turf, because weight from the rest of the structure already leads to compression and reduces the amount of shrinkage by withdrawal of water.

With reduction of size further bulk density varies indirectly proportional with water content. While JOHANNESSON documents bulk densities in top layers of 0,2 g/cm^3 (= 200 kg/m^3)[188] and OLAFSSON found a variation between 0,18 and 0,39 g/cm^3 (= 180 – 390 kg/m^3),[189] it seems noteworthy that in GUDMUNDSSON's studies a great variation between the two sample areas can be observed. He reports of 0,22 – 0,38 g/cm^3 (= 220 – 380 kg/m^3) in the top 50 cm for the area in the north and only 0,13 – 0,16 g/cm^3 (= 130 – 160 kg/m^3) for the west. The higher density of the northern sample is believed to be a result to enrichments of volcanic ash within the turf.[190]

---

187 GUDMUNDSSON 1978 pp. 124 ff

188 JÓHANESSON 1960

189 ÓLAFSSON 1974 as cited in GUDMUNDSSON 1978

190 GUDMUNDSSON 1978 p. 136

With no specific research on thermal properties of peat soils in Iceland, the use of data from different regions with similar climatic conditions is pursued. Values of thermal conductivity (λ) for peat soils in boreal regions are compared to provide a basis for building physical simulations in this work.

Similar to fibrous thermal insulation, the thermal conductivity of peat is strongly influenced by water content. Therefore, values presented by KUJALA, SEPPÄLÄ and HOLAPPA appear not applicable for building simulation, as they were testing with a minimum water content of 40 % of the sample Vvolume.[191] BROWN states, that dry peat has a low thermal conductivity of 0,00017 g cal/sec cm^2 °C cm, converted to be 0,071 W/mK, but does not elaborate further.[192]

In their paper of 2013, DISSANAYAKA, HAMAMOTO and KOMATSU are developing a predictive model for thermal conductivity and other properties in peat soils. They describe a linear increase of λ with water content as thermal conductivity of organic matter (0,25 W/mK) is much lower then that of water (0,57 W/mK).[193] Measured values that are used for the performance test of this model were presented a year earlier and are shown in a graph in relation to water content. Considering a water content of 3 % in air dried peat as shown by GUDMUNDSSON, thermal conductivity spans between 0,5 and 1,2 W/mK.[194]

---

191 KUJALA, SEPPÄLÄ & HOLAPPA 2008 p. 411

192 BROWN 1966 p. 21

193 DISSANAYAKA, HAMAMOTO, KOMATSU & KAWAMOTO 2013 p. 29

194 DISSANAYAKA, HAMAMOTO, KAWAMOTO, KOMATSU & MOLDRUP 2012 p. 42

thermal transmission

One of the most significant advantages of turf building is the resistance against harsh climatic conditions. Turf walls are wind proof and of excellent thermal insulation. It is safe to say that the availability of this material was the single thing that enabled people to survive harshening conditions on this island since the settlement. Very much like the wool of their sheep that Icelanders made the majority of their clothes of, the dense weave of fibrous material has the ability to keep the interior at moderate temperatures.

With the availability of fuel decreasing, the turf farms can be considered one of the first zero-energy houses. They were built small and life within was tightly packed. Fire was only lit in the Eldhús, the kitchen, fuelled by dried droppings, spreading a biting smell from its saltpetre content.[195] Still the main energy source for heating was the body warmth of humans and sometimes also animals. STEFÁNSSON estimates that within one stafgólf, the distance between two structural frames, usually four grown persons found room to sleep. In the same area, in a stable underneath, there would probably be room for two cows.

On that basis and assuming the volume for stable and living quarters would be equal, having cows within the house could roughly double the energy input from metabolism within one stafgólf.[196] This is not surprising, as the metabolic rate of mammals is said to be in relation to body mass.[197] Two cows with roughly 500 - 700 kg each (estimation with taking into account the

195 SACHER 1938 p. 3
196 STEFÁNSSON 2013 p. 72
197 see WHITE & SEYMOUR 2003

smaller size of cows in the past) greatly exceed four humans in body mass, and therefore increase energy input in relation to volume severely.

To gain a better understanding of what turf walls are capable of in comparison with modern construction methods, the values of thermal conductivity, as described in the previous chapter, will be applied to an abstract section of a turf wall. The pieces of Klömbruhnaus and Strengur, the principle building materials for this example, are reaching approximately 60 cm from the face to the core of the wall. To consider the reduction of thickness and interlinkage with the earthen core, only 40 cm will be taken into account as solid turf mass. With shells like this on two sides and a core of rammed earth, an abstract composition of 40 cm of turf / 40 cm of earth / 40 cm of turf, 120 cm wall thickness in total, will be taken as a simplified basis for calculations.

Following calculations are according to EN ISO 6946 – Thermal resistance and thermal transmittance – calculation methods.[198] For the earthen core a lambda value of naturally humid sand will be considered, as can be seen as a more disadvantageous case in terms of thermal conductivity.[199] The calculated U-value represents the amount of energy lost through 1 m^2 of wall surface at a difference of temperature between inside and out of 1 Kelvin = 1 °C.

λ (turf) = 0,085 W/mK; λ (sand, naturally humid) = 1,40 W/mK
Rsi (horizontal) = 0,13 m^2K/W; Rse (horizontal) = 0,04 m^2K/W

$$U = 1 / (0{,}13 + 0{,}4 / 0{,}085 + 0{,}4 / 1{,}4 + 0{,}4 / 0{,}085 + 0{,}04) = 0{,}101\ W/m^2K$$

198 see EUROPEAN COMMITTEE FOR STANDARDIZATION 2017
199 MASEA-ESAN.DE web page last visited March 20th, 2018

figure 55 - Sænautasel turf farm in eastern Iceland

The result of this calculation clearly shows the extensive thermal resistance a turf wall can provide. In comparison, maximum values for thermal transmittance necessary for passive house certification, considering Icelandic climate being cold to moderate cold, are 0,12 – 0,15 W/m^2K (arctic climate 0,09 W/m^2K).[200]
To achieve an equal amount of thermal resistance with mineral wool (λ = 0,04 W/mK) on a concrete wall, a layer of about 38 cm insulation would be necessary.[201]

200 PASSIVHAUS INSTITUT 2015 p. 8
201 material specifications from MASEA-ESAN.DE web page last visited March 20th, 2018

cradle to cradle

Cradle to cradle is a design concept developed by Architect Will McDonough and Chemist Prof. Dr. Michael Braungart together with scientists of EPEA Internationale Umweltforschung (= international environmental research). It promotes a conception of production in cycles instead of linear life spans of items. Waste is food. This phrase refers to the idea of a second industrial revolution that is based on the use of materials within two closed and infinitely repeating cycles and the sole use of energy from renewable sources. In the technical cycle a resource is assembled to a product, is used for a certain amount of time, returns to the manufacturer to be disassembled and reuse its components 100 % as a resource for new products. The biological cycle works in a similar way, except, after being used, products, originally made from biological sources, are not disassembled for resources, but returned to nature for bio-degradation to become nutrients for new plants. In designing all production processes to be part of one or both of those cycles, every piece of material is reused instead of becoming the burden of being waste.[202]

In that sense it is possible to imagine turf buildings in Iceland to work according to those principles. While turf takes a long time to accumulate (in Iceland approximately 0,1 - 0,3 mm/year on an average),[203] the abundance of this resource appears large enough to consider buildings constructed from it part of the biological cycle.

Further, with the main load-bearing structure being a wooden skeleton, separated from the envelope of the building, adaptations are much easier. As it

---

202 see BRAUNGART & MCDONOUGH 2015
203 GUDMUNDSSON 1978 p. 207

has been practiced throughout history, parts of a building can be torn down and/or new parts can be added without touching the main structure. In that way a house can react to the changing needs of its inhabitants much easier and commitment to a certain design is less permanent.

With the availability of the material in many parts of the country harvesting can be done locally, reducing transporting distance and bringing production to the countryside. With many people in that context owning their own land it can probably be collected very cost effective in many cases instead of being bought from mass production.

While a conception of a turf building in the idea of cradle to cradle appears possible at this point, many considerations throughout the planning- and construction process still need to be done accordingly. But the use of natural resources to this extent and the separation of functional elements of the structure, instead of using multifunctional composite materials, is believed to be a promising point of origin.

5.3 areas of focus

interior climate

Traditional turf buildings were believed to be very unhealthy for their inhabitants. To keep them warm people lived together very closely. Living quarters like the Baðstofa were designed to have as little volume as possible.[204] STEFÁNSSON speaks of approximately 2,5 – 3 m^2 that were common around the end of the 19th century, with 6 - 9 people in one residence. HORREBOW reports of people sleeping completely naked together in one bed, one with his head where the next one has his feet, only separated by a loose wooden board.[205]

Some sources believe that the unhealthy conditions within Icelandic buildings were part of the reason for widespread epidemics.[206] Not only cold and dampness, but also the dust in turf buildings are said to be responsible for

---

204 SACHER 1938 p. 14
205 HORREBOW 1753 p. 352
206 SACHER 1938 p. 10

wide-spread tuberculosis throughout the population.[207]
Studies have shown that, contrary to initial expectations, indoor biological contaminants induced by the use of turf probably had a minor influence on the health of occupants.[208] With numbers of invertebrates generally small in cold climates[209] even fewer were found due to the saline material surface of turf walls.

Poor hygienic conditions from a combination of various activities in the house appear to have had a much larger impact on the health of inhabitants. Bio effluents from occupants and air pollutants resulting from cooking, drying and smoking fish and meat, the production of ammonia from urine (used for cleaning) can be considered of bad influence.[210]

Further, burning organic material like peat, birch wood, dried droppings, sometimes even dried seaweed, bones and birds[211] in unproperly ventilated conditions naturally lead to poor air quality. Also, the exposure to combustion of these biomass fuels is now known to possibly "[...] lead to lower respiratory infections, chronic obstructive lung disease and lung cancer, and is associated with tuberculosis."[212]

It can therefore be considered that a turf building following today's standards of hygiene will not have any major impact on the occupant's health and can be used for construction in good conscience.

---

207 STEFÁNSSON 2013 p. 33
208 VAN HOOF & VAN DIJKEN 2008 p. 1029
209 VAN BRONSVIJK 1995 as cited in VAN HOOF & VAN DIJKEN 2008
210 VAN HOOF & VAN DIJKEN 2008 p. 1029
211 SACHER 1938 p. 3
212 VAN HOOF & VAN DIJKEN 2008 p. 1029

rainwater drainage and frost

A major issue with turf buildings always was their resistance to precipitation. While a well-constructed roof with all pieces of turf grown back together to a continuous layer was quite waterproof, continuous rainfall still kept wearing them down. SACHER describes, that roofs like this need continuous care, they need to be fertilized and grass needs to be cut to prevent decomposition of the root system. This would allow rain and frost to break the grass layer and the roof becomes leaky. Only with proper care said roof would be able to prevail for 20 - 30 years.[213]

One constructional detail in specific proved to be problematic with turf roofs. At the point where wall and roof meet, it is necessary to assure that water runs of and is not seeping into the wall. The prevention of having water percolating in the structure becomes specifically challenging at the depression between two gabled roofs. Water is ponding there and slowly penetrating the walls.[214] The trenches between the roofs are supposed to let water flow off to the side of the building, but settling of walls allows small pools to emerge. Further, strong rainfall is wearing the earthen structure of the gutter down and contributes to the building's decay.[215]

Moisture and water within the wall are especially a problem when frost occurs. The freezing and thawing leads to movement of expanding and contracting and eroding the wall from the inside.[216] In a country with thaws

213 SACHER 1938 p. 8
214 STEFÁNSSON 2013 p. 32
215 SACHER 1938 p. 10
216 SIGURÐARDÓTTIR 2008 p. 13

figure 56 - depressions between roofs

common in winter, even considered a peculiarity of Icelandic weather,[217] it is indispensable to keep walls as dry as possible. During the turf building course Helgi SIGURÐSSON expressed his observation that this problem appears to be deteriorating, as walls that originally remained frozen in their core throughout the winter are thawing more often, resulting in even stronger deformation.[218]

Besides destruction from within, walls also erode by wind-driven rain. Especially in the southern and south-eastern parts of the country, with larger quantities of precipitation over the year,[219] walls were often designed as evergreen to make them more resistant against this erosion.[220] Although this was helpful against rainfall, the vegetation on the wall also retained water within the turf block and lead to faster rotting of the fibre system.[221]

In general, said larger amounts of precipitation and frost-thaw cycles in the south reduced life expectancy of turf walls to 20 - 25 years, while in the north, with less rain and a more stable frost, walls are said to prevail for 50 - 70 years.[222]

Roof overhangs could help protect the wall underneath from direct impact of rain and help to keep them dry. It is probably in response to the heavy winds and storms that occur in Iceland that these are not a common sight throughout the country. Better possibilities of an adequate footing for the structure

---

217 EINARSSON 1984 p. 683
218 SIGURÐSSON personal communication May 26th, 2017
219 EINARSSON 1984 p. 648
220 WALKER 2006 p. 17
221 LÁRUSSON personal communication June 11th, 2017
222 ÞJÓÐMINJASAFNS ÍSLANDS 2011

are available today that could absorb drag force resulting from wind. Therefore, the introduction of overhanging roofs could be considered a valuable addition for a structural protection of turf walls. At the very least roofs have to be designed to cover the top of the wall and prevent rainwater to seep in there.

To increase impermeability of roofs, Icelanders already introduced corrugated iron to their structures upon availability by the turn of the 20th century.[223] Today flexible membranes could be used for waterproofing the roof and keep water away from living spaces and walls. Also, a collection of water into a gutter could help preserve the turf walls. With adding such layers to the composition of the building, careful considerations of the dangers of condensation needs to be taken into account. Depending on the layering and constructional methods of the roof, additional vapour barriers might have to be added, to prevent condensation within the structure that could lead to mould, rotting and deterioration of insulation properties.

Water vapour resistance of a material is described by the value μ and informs about how many times more vapour resistant a material is, compared to a layer of air with the same thickness. As waterproof membranes have a high vapour resistance of μ = 20000 – 50000, the danger emerges that humid air from the inside of the house gets trapped by these layers and condensates. Ventilated roofs can help to prevent that by adding some distance between insulation and membrane, enabling humid air to stream off. In the case of turf roofs this would lead to a contradiction, as the insulating properties of the turf layer on top would be completely lost, making additional insulation necessary underneath.

---

223 STEFÁNSSON 2013 p. 35; LÁRUSSON 2014 p.13

figure 57 - wall being eaten away by decay

To prevent issues with an unventilated roof, vapour barriers or vapour checks with even larger µ-values than waterproofing membranes are used, preventing humid air to stream into the construction from the inside to begin with. As a general rule it can be considered that vapour resistance of layers within a structure should decrease from the inside to the outside.[224]

Considering the fast increase of thermal conductivity in peat with water content[225] the construction methods of traditional turf roofs are not ideal in terms of insulation. It might therefore be worth considering adding an additional layer of turf that is protected from rain solely for its insulating properties. To prevent damage, it is mandatory that this layer is used under a ventilated roof or went through a mechanical drying process before use to assure that no humidity is trapped between layers of highly vapour-resistant materials.

fire and decay

Traditionally walls of turf were barely covered with a finish of any kind. Patterns on the wall, resulting from the way turf is cut and laid out, are part of the aesthetics and deemed characteristic. Interior panelling and wooden floors were occurring in limited amount and can be considered a sign for status and wealth of a household.[226]

Since most wood needed to be acquired through trade, it was a valuable resource. Often panelling would only be found in the Baðstofa, or not at all.

224 LOHMEYER & POST 2013 p. 298
225 DISSANAYAKA et al. 2013 p. 29
226 ÞJÓÐMINJASAFNS ÍSLANDS 2011

Besides its representational value, the extent of wood within a farm would increase the ability to keep it clean and therefore is deemed more hygienic and healthy.[227]

Great care was taken that the wooden panelling from walls and roofs did not get in contact with pieces of turf, as its humidity would have accelerated rotting greatly. Therefore, a layer of air was always left between turf walls and interior panelling.[228]

The outer face of exterior walls in Icelandic turf houses never had any finishing, except live grass in the case of Snidda. Decay is accepted in a sense of a wear layer of the house that upon necessity can be replaced cheaply as a source for it is usually found within the own land.

Three reasons can be identified that speak for equipping turf walls with a surface coat. First, permanency – Covering the raw wall inside and outside with a protective layer and covering it with a roof, maybe even overhangs, could greatly increase the life span of a construction and postpone the necessity of reconstruction to a certain extent. Although, especially in the case of the exterior skin, this would mean a loss of the characteristic surface of turf buildings.

Second, hygiene – separating the turf construction from the interior of the house would greatly reduce dust and seal a surface that is not only hard to clean but also not very user-friendly in terms of placing furniture in front of it, hanging pictures and so forth. Despite the fact that no considerable health

---

227 STEFÁNSSON 2013 p. 35

228 SACHER 1938 p. 11

risk is expected,[229] still turf walls could lead to mineral and organic residue unwanted within today's living space.

Third, fire safety – as it is expected that a material that is used as fuel as well can impose a certain amount of risk in terms of inflatability, sealing off at least the inside of the wall appears unavoidable. Decisions on the necessity for exterior fire protection need to be taken in accordance with specific circumstances to prevent a leapfrogging of fire.

To achieve said sealing and protection of turf walls an adaption of the already known technique of panelling could be applied both inside and outside. Certain levels of fire protection can be achieved with solid wood or with the use of fire resistant board materials. Various products fulfilling that purpose are available today and can be chosen from.

Another possibility to seal a fibrous and uneven surface, as it is found in turf construction, was discovered to be practiced in straw bale buildings. Layers of plastering can seal the surface and choosing the right type of material can contribute positive properties to the construction. Similar to straw-bale building, cement-based plastering is expected to be unfavourable. Its brittle structure tends to result in cracks from movement in the construction, as it can be expected within turf buildings.[230] To be applied onto the soft and fibrous surface of turf buildings, loam and lime material appears more appropriate. The use of a plaster-base can help to increase the bond with the wall.

---

229 see VAN HOOF & VAN DIJKEN 2008

230 MINKE & KRICK 2014 p. 60

Loam rendering is in general more suitable for interior use. Since it is sensitive to water, its application in the exterior is only recommended on surfaces protected from rain.[231] This sensitivity to precipitation suggests that the material can not be considered as appropriate to resist Icelandic weather conditions. Loam plaster is applied in one or multiple layers, depending on the asperity of a surface.[232] In the case of turf building, it can be expected that an application in two or three layers is suitable to cover the uneven surface. Consistencies and mixtures of the different layers vary to achieve ideal properties.

While primal coatings are allowed to crack upon drying, they guarantee optimal bond with the subsurface. Following layers are composed to result in a homogenous surface.[233] Natural fibres, straw, wood chips or cellulose can be added for reinforcing the material, while casein, curd, urea, flour and other emulsions can influence workability or water- and vapour resistance.[234] Final thicknesses of loam rendering in multiple layers are usually between 3 and 6 cm. With a larger amount of material applied the positive influences on the interior climate increase.[235] Through absorbing and releasing moisture from the air, it balances the humidity and can prevent condensations to some extent. Further, the layer of loam serves as a heat accumulator.[236]

Instructions on the use of this material are available in abundance. As it is a natural resource, mixtures and techniques always should be tested and experimented with, before use on a building to achieve an ideal result.

---

231 VOLHARD & RÖHLEN 2009 p. 78
232 MINKE 2004 p. 110
233 SCHROEDER 2010 p. 123 ff
234 MINKE 2004 p. 107 f
235 MINKE & KRICK 2014 p. 61
236 SCHÖNBURG 2017 p. 90

For an exterior, use lime plaster is more appropriate due to its better water resistance, while maintaining a certain elasticity.[237] Similar to loam, different mixtures can be used to enhance the material. Reinforcement with natural fibres or industrial products are recommended to reduce the danger of cracks on a soft surface,[238] as it can be found with straw bales or turf. Special consideration on the curing time of lime rendering needs to be taken into account. As it is a slow process of reaction with CO2 in the air that takes up to three months to achieve an adequate amount of solidity, this could impose in correlation with Icelandic climate. During this time the plaster is not supposed to dry out entirely and should be protected from frost and driving rain within the first weeks. Adding a limited amount of cement can help reach an initial hardness.[239]

A technique for surface finishing extensively used in Scotland is harling. A thin layer of a slurry lime-based mixture is thrown onto the wall to make the surface more resistant to exterior influences.[240] It is shown as part of a case study that this technique was already applied on a turf wall in Scotland and has proven to be of durance. In mentioned case the harl consisted of a mixture of clay and sand and was finished with a limewash.[241]

Various coats of finish can be applied on both lime and loam plaster to increase water- and mechanical resistance.[242] However, careful consideration needs to be maden on the specific vapour resistance of layers and how they

---

237 MINKE & KRICK 2014 p. 64
238 VOLHARD & RÖHLEN 2009 p. 169
239 MINKE & KRICK 2014 p. 64
240 SCOTTISH LIME CENTRE 2002 p. 4
241 WALKER 2006 p. 60
242 see MINKE 2004 pp. 116 ff

figure 58 - window detail at Tyrfingstaðir turf farm

might be influenced by finishes, to avoid problems with condensation within the structure. Rendering of surfaces greatly increases fire resistance of straw bale constructions. It has been proven by different certified institutions that 30 and even 90 minutes of resisting the fire can be achieved.[243] It is believed that similar qualities can be reached with a turf construction, but equivalent material tests are recommended.

joints and settling

Material research on turf, as well as experience from turf building has shown that extensive shrinking and settling of turf structures can be expected. While measures to protect walls from water from precipitation can help reduce movement in a finished state of the building, an initial settling after construction always needs to be expected. Therefore, joints between turf and other parts of the construction, especially windows and the wooden structure of the roof, need careful consideration to allow a certain movement and still maintaining functionality of water and airtightness. To achieve that, two approaches are considered, interlinking of materials and flexibility of materials.

As the wooden structure is carrying the suggested membranes for sealing the roof from rain, this is the layer that needs connection with the exterior wall to form the envelope of the building. To achieve that, a piece of the roof structure should reach into the wall, to maintain contact with it, even when settling occurs. Further, spaces opening up by settling can be filled with darning wool or similar materials to seal the gap. The parts in contact with the turf construction need to be made from a material able to endure despite humidity.

243 MINKE & KRICK 2014 p. 27 f

Similar principles can be applied with windows and other openings to interlink the sides of the frame with the wall it is placed in. Although in this case especially the top side of the window needs focus. With the walls to the side of the window, the vertical opening shrinks. Therefore, the linter above the window is placed with some space to the frame, filled with a flexible material, to close with increasing settling.[244] Also the opening could fill the whole extent of room the height, from floor to ceiling, with a wooden construction and therefore avoid being influenced by settling.

structure and interior

To make the roof structure of a traditional turf house uninfluenced by settling of turf walls, it was carried by a wooden structure on the inside. This timberwork is separated from the walls as consequently as possible to avoid rooting.[245] Further, this allows rebuilding of the turf envelope without having to disassemble the load-bearing framework. With the skeleton structure therefore being part of the interior space, having built-in furniture and other fixtures integrated within them is common in traditional turf buildings. Platforms that served for sitting and sleeping in longhouses from the time of the settlement[246] evolved into bed-like benches in the Baðstofa of the 19th century, representing one example for the close relationship between structure and interior that is characteristic for Icelandic turf buildings.

---

244 WALKER 2006 p. 38
245 see SACHER 1938
246 ROBERTS et al. 2004 p. 97

As wooden buildings are on the rise in Europe, a large variety of different construction techniques become available and applicable to Icelandic turf houses. As most of the material needs to be imported, frame-constructions might be considered more advantageous to reduce the shipping, but solid wood slabs seem possible too.

To avoid columns blocking the living space, the task of load bearing could be transferred to interior walls. Also, an integration of wooden parts into the inner face of a turf wall could be tested. Materials like perforated corrugated iron or dimpled sheets could be used to maintain a certain distance between turf and wood, allowing moisture to dry and prevent rotting. In the sense of traditional turf buildings, columns could also be used as an integrated part of the interior and serve the functionality of the room. Fixtures between the structure would therefore need to be designed to go hand in hand with the main structure.

footing and floor

To avoid moisture rising from the ground, adequate footing should be constructed underneath the wall. The use of traditional turf and stone layers, might be possible, but a concrete slab with foundations reaching down to freezing depth could have advantages in reducing settling of the wall.

Floors within the building can be constructed in many ways, as they can be completely independent from the turf structure. Preventing capillary action and achieving a certain level of insulation needs to be considered here too. Turf laid out on the ground could possibly serve as insulation of the floor here as well.

6

conclusion


figure 59 - Grafarkirkja á Höfðaströnd

6.1 case study

To test the functionality of some ideas originating from this work and see how they could play together in an architectural sense, two detailed cross-sections are elaborated. Both representing a section of a one story building, with outside walls made from turf, focus is especially given on the connection with the wooden structure.

The two details were developed with the intention of including a broad variety of different approaches and possibilities that appear doable with the given knowledge of the material. Both are based on the principle of minimizing moisture within the core of the turf wall, to limit alterations through frost and reduce the danger of rotting and molding.

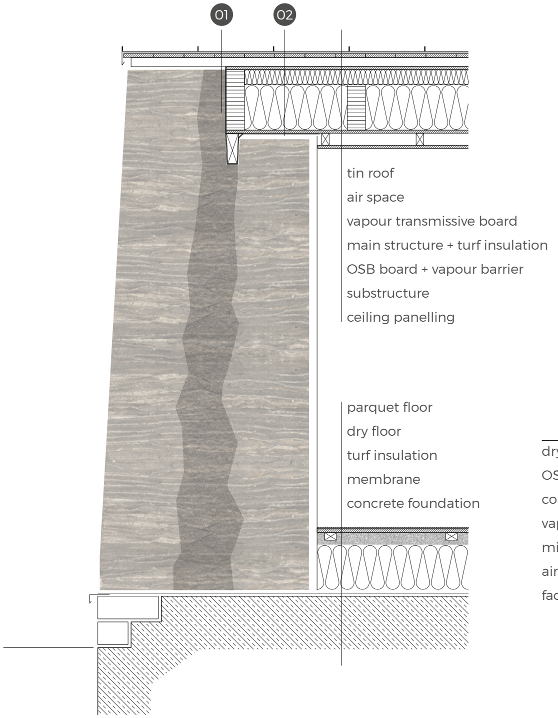
Load-bearing columns are not shown as it is believed they could be shaped in various ways, depending on the requirements of the room. Standing detached in the room, as integrated part of the wall, covered by interior panelling or as part of interior walls appears all possible. Nevertheless, in case of contact between turf and wood, techniques as described before need to be applied to keep separation of the two materials and prevent rotting.

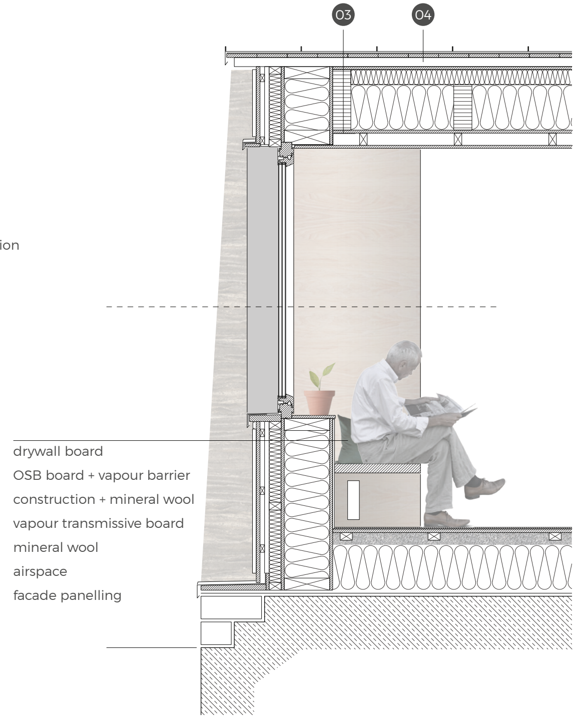
To gather further understanding about the processes of heat and vapour transfer within the elements, a building physical analysis with the software ANTHERM was included. Based on climate data from the last 30 years, as provided by the Icelandic Met Office,[247] a simulation of conditions throughout the year was used to challenge the constructions. In both cases the city of Akureyri, in the north of Iceland, was chosen as location and weather data from there was applied to the design. The knowledge resulting from this gives an idea about the temperature decrease and flux, reveiling the weakest areas in the assembly. Difference of vapour pressure serves as an indicator of points within the structure where condensate might occur. At last vapour flux informs about areas in the detail drawing that allow humidity to stream off.

Nevertheless, all ideas presented in this chapter only serve as a first example of what constructions could look like. As the suggested solutions are not tested in reality and only designed with theoretical knowledge and limited data of material behaviour in these conditions, conclusions drawn from them are very hypothetical. Mock-up constructions based on the ideas presented here and informed by the knowledge of experienced turf builders could give further insight about applicability and points that need further development.

---

247 EN.VEDUR.IS web page last visited April 1st, 2018





01 - front of wooden construction protected by membrane
02 - gap opening up through settling filled with darning wool
03 - vapour-proof connection of window frame to ceiling slab
04 - airspace for ventilation of roof
05 - wooden lamella for interlinking with turf wall

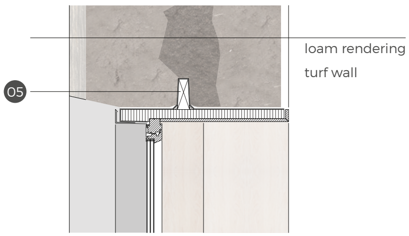


figure 60 - section and floor plan detail 1

figure 61 - elevation detail 1

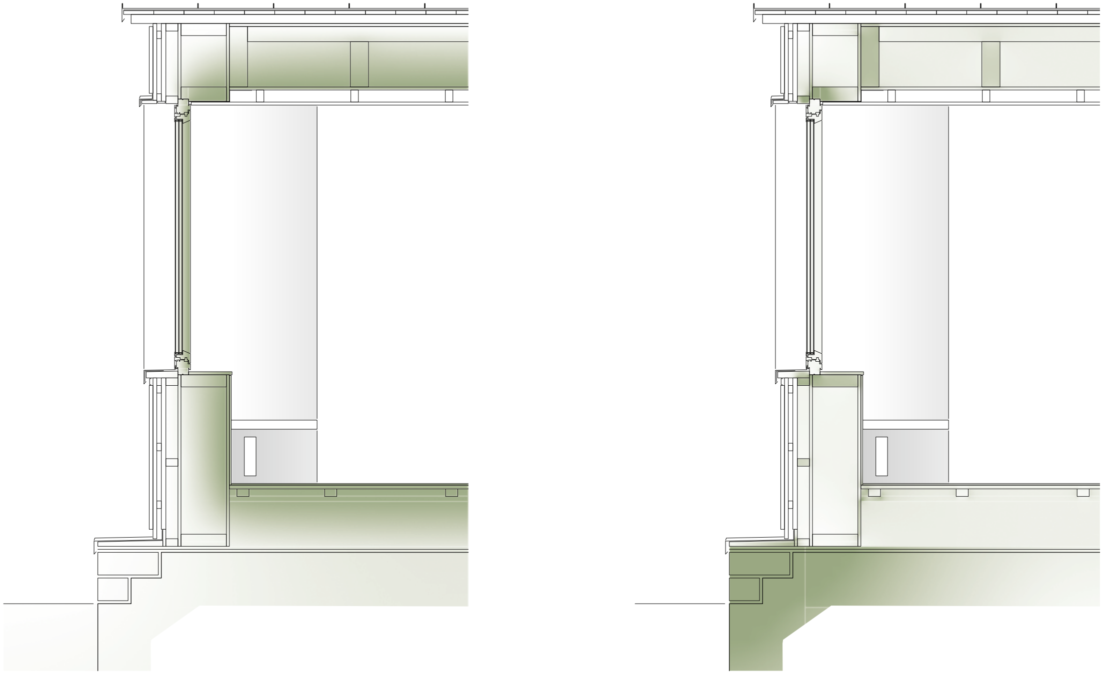


figure 62 - temperature characteristics and heat flux detail 1

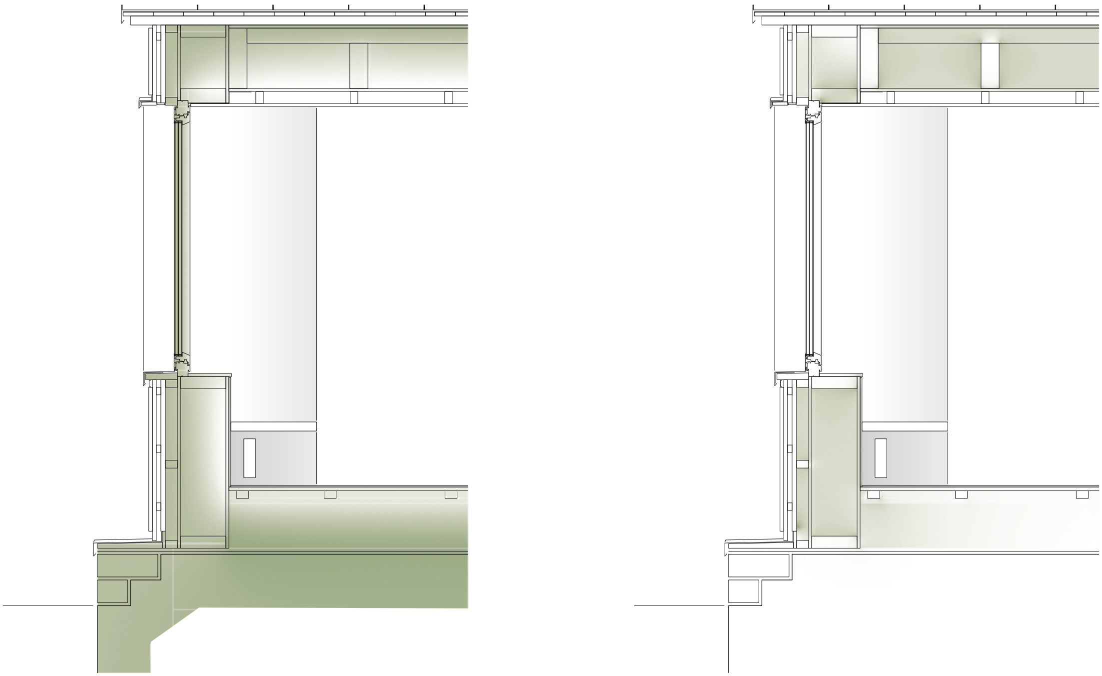


figure 63 - difference of varpour pressure and vapour flux detail 1

detail one

The first of two detail drawings represents a turf wall, in this case made from Strengur alone, in combination with a wooden frame structure. The whole construction is founded on a footing made of concrete with a horizontal membrane to lock out moisture from the ground.

To prevent problems with the window due to settling of turf walls, a whole vertical section of the wall is replaced by a wooden construction, reducing the number of joints between turf and other materials that need to be resilient to settling alterations. As changes in size not only occur as a result from loss of water, but also by own weight, horizontal contact points are exposed to movement more extensively. With the proposed replacement of a whole section for placing an opening, the horizontal joints can be reduced to the meeting point of roof and wall. Further, it simplifies a possible replacement of the turf parts of the house, as the windows can stay in place through the process.

The ventilated roof is designed to be without grass cover in this case. Using green turf roof with a ventilated structure would be questionable, as the insulation value is lost through the airspace and additional insulation needs to be applied underneath. The possible use of locally produced turf insulation within the structure is something that could be considered, as this has been done in earlier days as well.[248] The same could possibly be used in the floor as well, with a dry-floor carried by the turf. Nevertheless, a procedure of drying the turf before usage would need to be developed, as settling of the floor and moisture within the wooden structure should be avoided at all cost.

---

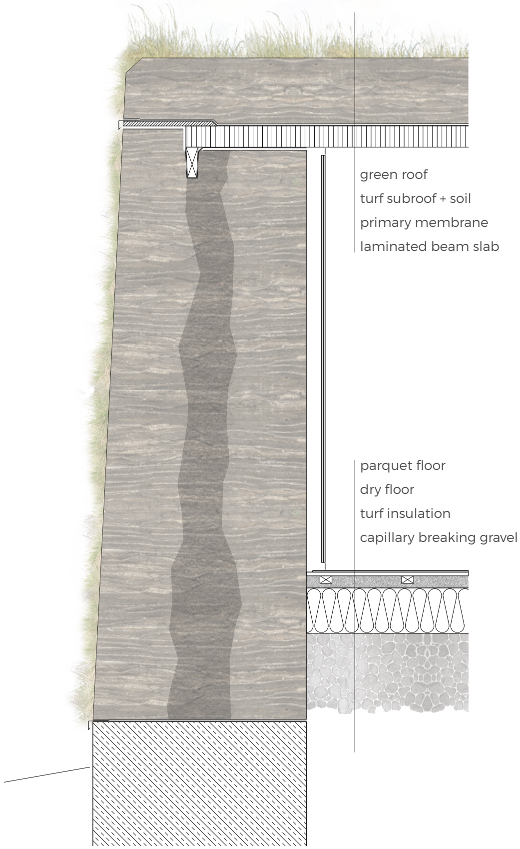
248 DAVIÐSSON & PÁLSSON 1979 as cited in STEFÁNSSON 2013 p. 36

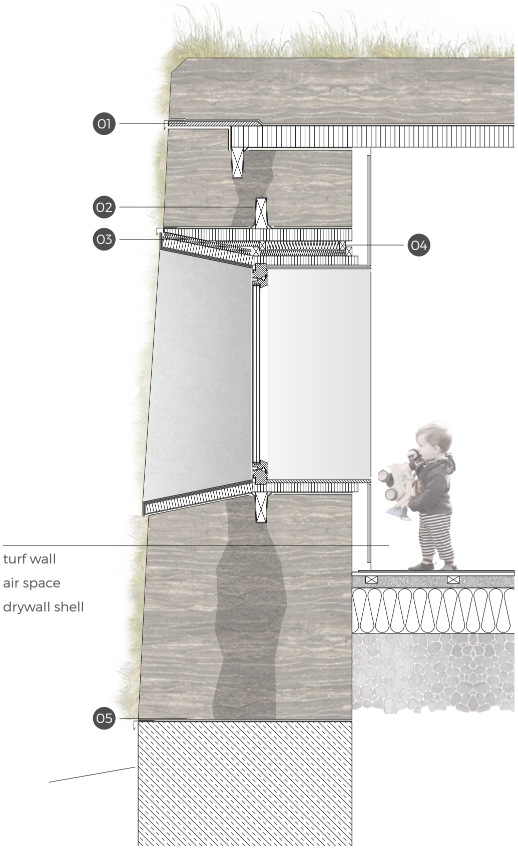
To interlink the wooden roof structure with the wall, lamellas are placed on the side of the wooden elements. Reaching into the turf wall these should help avoid open jointing with alterations of size and settling and extend the length of the seam. Contact points of wood and turf are protected from moisture by a membrane, while still considering the ability for moisture to stream off and not be trapped within the element. Gaps opening up in the initial drying process of the material can be filled with flexible materials such as darning wool or even pieces of turf. Walls on the inside are sealed with a rendering of loam plaster and left in raw turf on the outside.

The example should further illustrate atmospheric characteristics of massive walls like this. The opening of the window becomes a spatial element one is able to interact with instead of reducing it to its mere picture-like functionality of providing light, air and view to the room.

Analysis with ANTHERM shows the typical weak spots occurring with the wooden parts of the construction, where insulation is interrupted. Therefore, a second layer is applied crosswise, as is common. Further, contact points of windows and wall are heat bridges. Having the concrete slab underneath the building in contact with outside air proves itself disadvantageous, a thermal separation in the axis of the wall could lead to improvement. Simulation shows no immanent dangers of condensation within the structure, as would be represented by dark areas in the difference of vapour pressure.

Mould is not expected on the inside, with the coldest point of the section around the lintel being warm enough to not have moisture condensing, according to calculations.





01 - main membrane covering the top of the wall
02 - wooden lamella for interlinking with turf wall
03 - space for vertikal movement filled with darning wool
04 - wooden latches overlapping each other
05 - vertical barriar to block moisture from the ground

figure 64 - section and floor plan detail 2

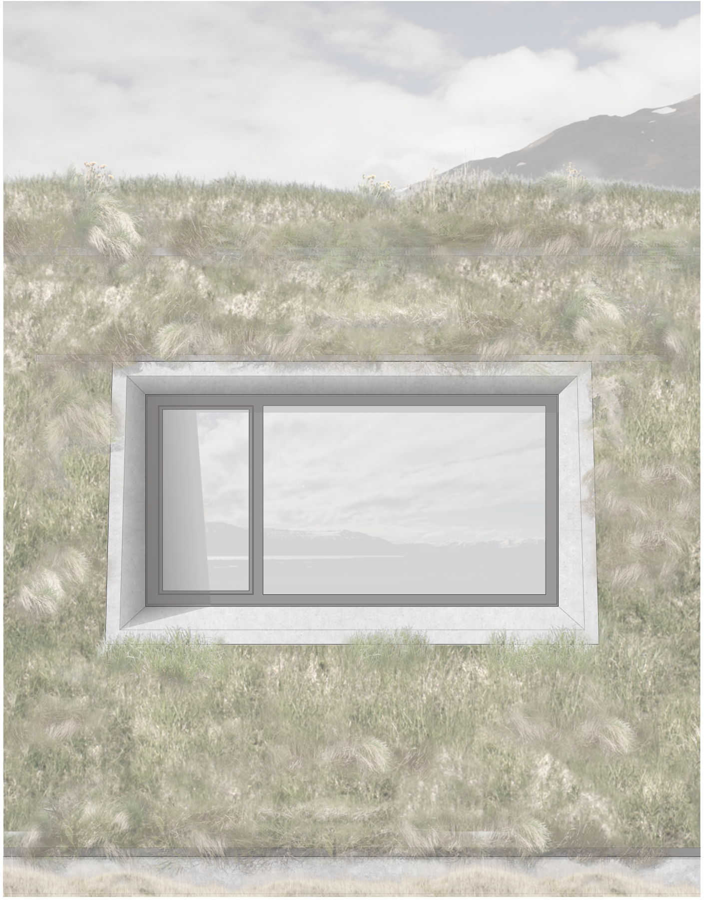


figure 65 - elevation detail 2

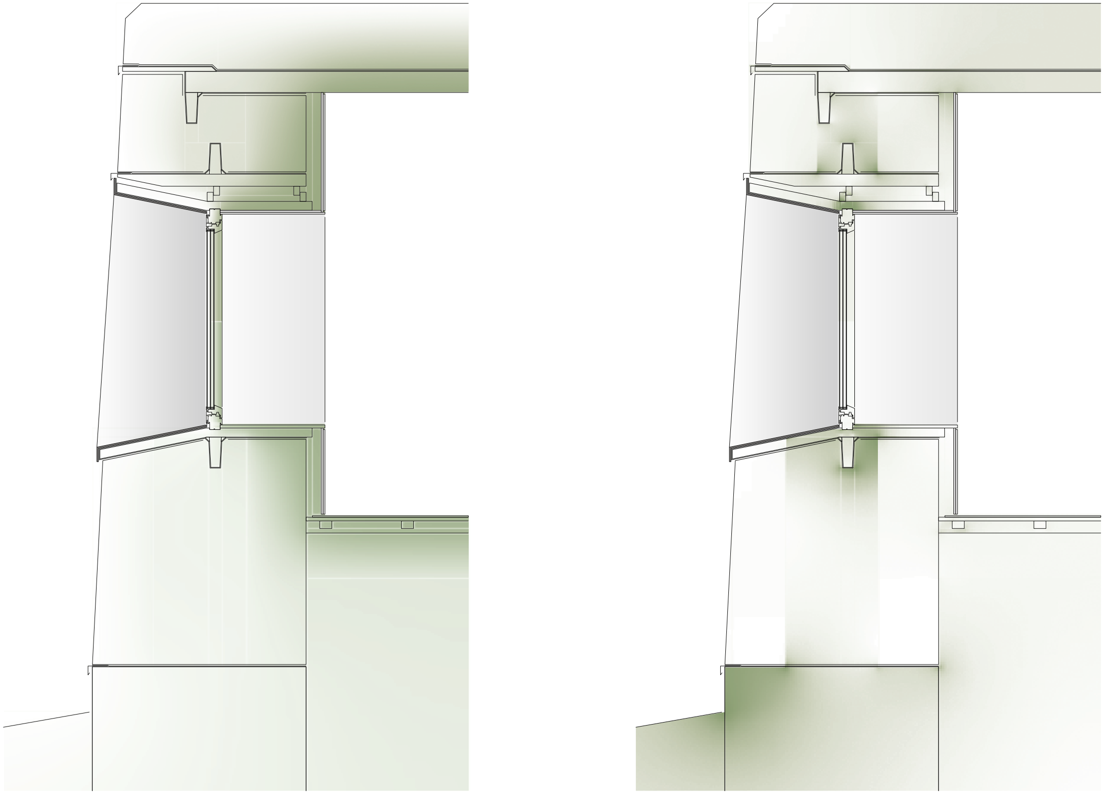


figure 66 - temperature characteristics and heat flux detail 2

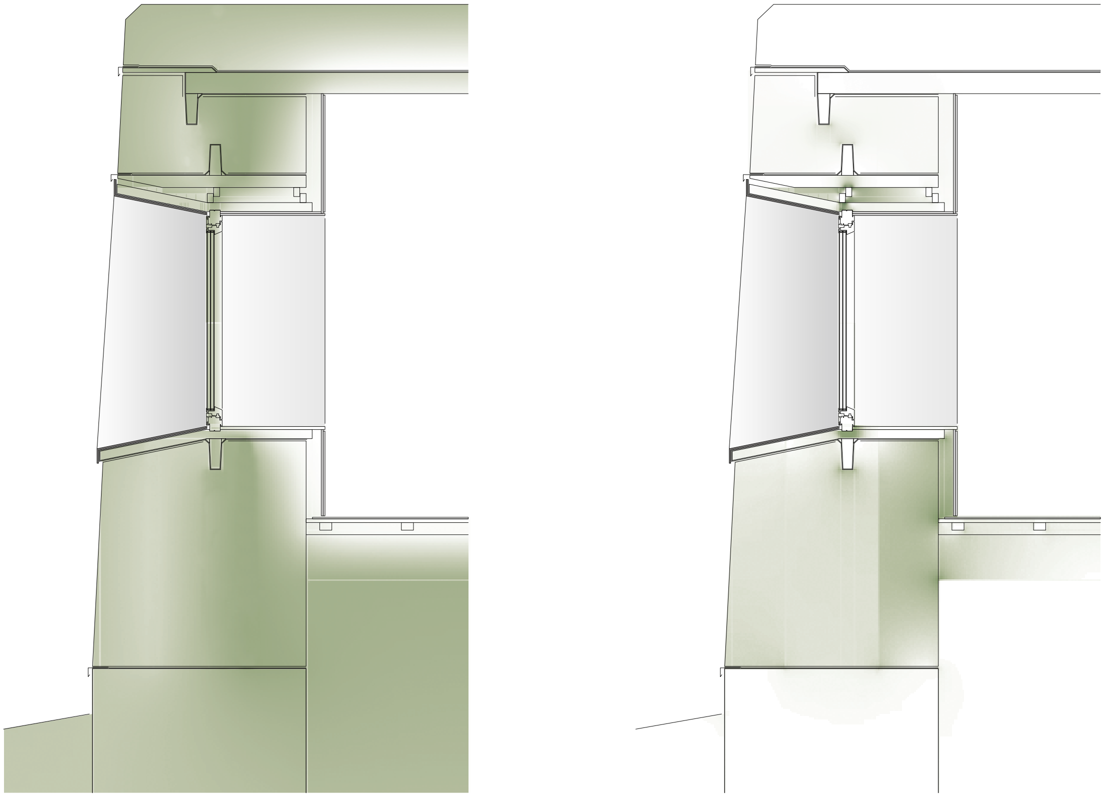


figure 67 - difference of varpour pressure and vapour flux detail 2

detail two

The second detail-drawing shows a wall made from Snidda with a green roof carried by a laminated beam slab. With this building technique the grass cover is turned to the outside of the wall and will stay alive. This results in green walls, that are here complemented with a green roof. The concrete footing is only underneath the turf wall in this case.

The window is installed within the turf wall in this case. To distribute the weight of the window onto the wall as evenly as possible it is places within a wooden box that spans the whole thickness of the construction. As literature on Scottish turf building suggests, the linter of the window is placed with some distance to the box frame to allow some settling of the walls.[249] Interlinking wooden pieces keep the frame in place horizontally, while the wool filled space between linter and box allows movement of about 5 cm.

The ceiling slab as well as the window box are reaching into the turf wall with the same wooden lamellas as in detail one, packed by a membrane to avoid rotting. To avoid rainwater seeping into the wall, the main membrane reaches out to the face of the wall. To improve insulation and to protect the main slab from outside conditions, this is done with an additional board material. Also, this allows minimal profile one the front side, to preserve the look of merging wall and roof.

On the inside turf walls and the construction are covered by a drywall shell, positioned with some distance to the turf wall to allow air circulation. On the round a dry-floor is places within gravel on turf insulation.

---

249 WALKER 2006 p. 38

This is example is aimed to show some of the architectural possibilities in combining the natural grass surface of a turf wall with contrast to boxed windows, diffuse and straight lines complementing each other, the idea of a building or parts of it completely blending with the landscape.

For the ANTHERM analysis the same constructional principle was applied as earlier with the calculation of the U-value. To take the earthen core and its interlinkage with the turf pieces into account, a shell thickness of 40 cm massive turf is assumed as base for calculations. Again, despite some points within the turf wall already have a low difference of vapour pressure, no condensation is expected. As is the coldest point on the inside calculated to be of no danger to moulding.

As rainwater would reduce the insulation properties of the turf on the roof, an additional layer of water protected insulation could be considered to reduce thermal losses through the ceiling. If doing so, a vapour barrier probably needs to be introduced to avoid trapping moisture within the construction.

6.2 conclusion

In search of an architecture that embraces the atmosphere of the Nordic regions the quality and potential of Icelandic turf buildings was discovered. It was the aim of this work to collect and link knowledge that is available to investigate a possible reignition of this tradition and the challenges of an implementation in current architecture.

continuance of a tradition

With being a naturally occurring material that is strong enough to build a wall while still having favourable properties in terms of thermal conductivity, the potential of turf is considered self-evident. Decay of substance is stronger than with most conventional building materials but appears possible to limit to an extend that is acceptable. By introducing various measures to reinforce weak spots in the turf construction living conditions inside, as well as necessity of refurbishment, should be brought to a level adequate for today’s demands in architecture.

By limiting water influx into the wall, damages and deformation through frost and thaw should be limited. Further, this makes the interior climate more controllable, reducing the risk of mould and damp air. Through adding a conventional membrane roofs should become completely waterproof and allow a larger variation of inclinations. Sealing the walls and adding floor constructions should improve interior conditions to a cleaner and more hygienic standard, as it is common in architecture today.

Working with integration into the landscape, using it as part of the structure, and carving architectural spaces out of the massiveness of turf walls seems to bare the potential of generating buildings in a close dialogue with its surrounding.

Implementing these and further measures, as well as working with the architectonic tools that are native to turf building is imagined leading towards a highly insulated, regionally inspired architecture that is extensively relying on natural and bio degradable building materials. While the applied construction methods sure have their limitations and are certainly not adequate to replace conventional building methods on a big scale, the application for a specific spectrum of realities in an Icelandic context appears feasible.

Not only would cultivating this tradition be a starting point for an architectural style native to Iceland but could lead to a continuance of a long practiced way of building. As decay is wearing down historic turf structures, perpetuating the habit of periodic reconstruction is the only way of truly preserving the Icelandic turf building tradition.

next steps

As ideas proposed in this work are developed on a theoretical basis, measures solving one problem might bring up another. Therefore, it is imperative to improve theories and constructional details further with the input of experts of various professions, both from a theoretical as well as practical field of expertise. Subsequently mock up constructions should be considered to challenge ideas under realistic conditions in a smaller scale.

As turf is a natural material it needs to be further examined how changes of composition influence behaviour as part of a construction. With a certain amount of research done on turf in the role of being soil, a primal goal could be to understand how to link insights from pedological examination to the use of turf as a building material – as was done in this work to a certain extent.

To be able to work towards an actual construction of a modern turf building its place within building regulations needs to be determined, especially in the prospect of fire safety, tolerances of size accuracy and warranty.

Discussions about the place of the Icelandic turf building tradition within the World Heritage Convention and conservational approaches should be done with inclusion of a broader spectrum of people involved. It needs to be determined how to handle a historic building whose degradation is inevitable and part of a long practiced custom of accepted decay and periodic rebuilding – as it can be found in other cultural areas.

“tradition is not the worship of ashes, but the continuance of fire”

Gustav Mahler 1860 - 1911

glossary

Aeolian input – mineral material deposited into the soil by wind

Al-Þing – (=Althing) assembly active since the time of the settlement governing the nation

Andosol – soils from glass-rich volcanic ejecta

Árefti – layer above the rafters of a roof protecting them from the moisture of turf

Baðstofa – main sleeping room, usually in the very back of the most recent turf farms; used not only for sleeping but for chores as well

Búr – cold pantry for storing various foods

Burstabær – type of turf farm with all the rooms facing the yard equipped with its own wooden gable

Byggðasafn Skagfirðinga – the Skagafjordur Heritage Museum in North-western Iceland

Einskeri – turf scythe with two handles, pieces of Torfa are cut in one work-step

Einása-, Tvíása- og Þríasaþak – roof construction with one, two or three purlins

Eldhús – kitchen within a turf farm

Fornverkaskólinn – (=school of old crafts), institution by Byggdasafn Skafirðinga, University of Holar and North-Western university promoting traditional crafting skills

Gangbær - hallway-farm-type

Glaumbæjarhnaus – turf blocks found extensively at Glaumbær turf farm; pattern on the wall face like Klambra, but the whole thickness of the wall is made from turf

Glaumbær – a well-preserved turf farm in North-western Iceland in the Skagafjordur area

Histosol – soils with the highest organic content in Iceland, mostly from incompletely decomposed plant residue

Íslenski Bærinn – turf house museum in the south of Iceland close to Selfoss

Kálfasperruþak – special variation of a rafter-roof construction

Klömbruhnaus / Klambra – blocks of turf, cut in an angle to lean onto each other and close gaps when weight is applied

Laufás – well preserved turf farm in the north of Iceland; studied extensively by Hörður ÁGÚSTSSON

Náttúrfræðistofnun Íslands - Icelandic Institute of Natural History

Páll – traditional turf spade, contrary to modern spades with a flat blade

Skáli – main hall of a long house or turf house cluster; losing most of its functions to the Baðstofa in the historic development of the turf farm

Skemma – storage rooms of various kind

Snidda – diamond shaped blocks of turf, used to construct walls with a live grass cover, often used in regions with extensive precipitation

Stafgólf – iterant distance of structural frames of wood

Strengur – strips of turf, identical to a piece of Torfa cut in half; also used for wall construction in absence of turf blocks

Torfa – strips of turf cut from the ground with a turf-scythe; used for horizontal reinforcement of walls

Torfbær – conglomerate of buildings forming a farm / residence

Torfjlár – the turf-scythe, a scythe like tool to cut turf for construction and finishing touches to the wall

Tvískeri – turf scythe with one handle, Torfa can be cut in two work-steps; also used for finishing touches in turf building

Tyrfingstaðir – turf farm where the turf building course took place

Undirristuspaði – the undercutting spade; used to cut pieces of turf from the soil horizontally or to remove hummocks from agricultural land;

Útihús – outer houses of a turf farm; various purposes as stables or sheds

Vitrisol – soil of the Icelandic desert areas

WRB – World Reference Base; a pedological system for naming soils

figures

references

ADAM, Jean-Pierre (1994): Materials and techniques. Roman Building. London: B.T. Batsford Ltd

ÁGÚSTSSON, Hörður (1998a): Íslensk byggingararfleifð I. Reykjavík: Húsafriðunarnefnd ríkisins

ÁGÚSTSSON, Hörður (1998b): Íslensk byggingararfleifð II. Reykjavík: Húsafriðunarnefnd ríkisins

ALBERTI, Leon Battista (1986): The ten books of architecture : the 1755 Leoni edition. New York, NY: Dover Publ.

ARADÓTTIR, Ása L., ARNALDS, Ólafur (2001): Ecosystem degradation and restoration of birch woodlands in Iceland. Nordic Mountain Birch Ecosystems. UNESCO, (January), pp. 293–306

ARADÓTTIR, Ása L., EYSTEINSSON, Thröstur (2004): Restoration of birch woodlands in Iceland., (October 2015), pp. 195–209

ARCHDAILY.COM (2009): Hof Residence / Studio Granda. online available at https://www.archdaily.com/13324/hof-residence-studio-granda

ÁRNADÓTTIR, Lilja, GESTSSON, Gísli, SVEINBJÖRNSDÓTTIR, Guðrún (1986): Kúabót í Álftaveri / Lilja Árnadóttir, Gísli Gestsson, Guðrún Sveinbjörnsdóttir. Árbók Hins íslenzka fornleifafélags

ARNALDS, Ólafur (2000): The Icelandic 'Rofabard' soil erosion features. Earth Surface Processes and Landforms, 25 (1), pp. 17–28

ARNALDS, Ólafur (2008): Soils of Iceland. JÖKULL No. 58 Agricultural University of Iceland, Keldnaholt, 112 Reykjavík, (58), pp. 409–421

ARNALDS, Ólafur (2015): The soils of Iceland. Dordrecht ; Heidelberg [u.a.]: Springer

ARNALDS, Ólafur, ÓSKARSSON, Hlynur (2009): A soil map of Iceland. Náttúrufræðingurinn, 78, pp. 107–121

BJÖRNSSON, Guðmundur (1910): Baðstofa og eldiviður. III. Hvort er betra, torfbær eða timburhús. Skólablaðið, pp. 69–73

BOAS, Franz (1888): The central Eskimo. Washington, D.C.: Washington Government Printing Office

BRAUNGART, Michael, MCDONOUGH, William (2015): Cradle to cradle. München Berlin Zürich: Piper

BRINK, Stefan (2012): The Viking world. (1st ed.). London [u.a.]: Routledge

BROWN, R.J.E (1966): Influence of vegetation on permafrost. In: Permafrost International conference proceedings November 11th-15th, 1963 Lafayette, Indiana (pp. 20–25). Washington, D.C.: National Academy of Sciences - National Research Council

BRUCE, John Collingwood, BREEZE, David J. (2006): Handbook to the Roman wall. (14th ed.). Newcastle upon Tyne: Society of Antiquaries of Newcastle upon Tyne

BUBER, Martin (1923): Ich und du. Leipzig: Insel-Verl.

CHRISTENSEN, Karen Marie Bojsen, VILHJÁLMSSON, Vilhjálmur Örn (1989): Nordatlantisk arkæologi : vikingetid og middelalder : bebyggelse og økonomi. Nordatlantisk arkæologi : vikingetid og middelalder : bebyggelse og økonomi. Højbjerg: Hikuin

CNN.COM (2017): Turf homes: Inside the grass-topped farmhouses that defined Iceland by Kate SPRINGER. CNN style. CNN online available at https://edition.cnn.com/style/article/turf-homes-iceland-osm/index.html

COLE, Theodor C H (2015): Wörterbuch der Biologie Dictionary of Biology : Deutsch/Englisch English/German. Berlin, Heidelberg: Springer Berlin Heidelberg

COOK, Jeffrey (1996): Architecture indigenous to extreme climates. Energy and Buildings, 23 (3), pp. 277–291

DAVIÐSSON, Erlingur, PÁLSSON, Ingólfur (1979): Torfrista í Staðarbyggðarmýrum / Erlingur Davíðsson, Ingólfur Pálsson. Súlur, 9 ((1)), pp. 75–82

DEZEEN.COM (2015): Rural Icelandic cottages by PK Arkitektar have turf roofs and burnt timber cladding. online available at https://www.dezeen.com/2015/12/17/pk-arkitektar-holiday-cottages-rural-ice-

land-turf-roofs-burnt-timber-association-of-academics/
DICT.CC (n.d.): dict.cc. online available at https://enis.dict.cc/ [23/10/2017]
DISSANAYAKA, Shiromi Himalika, HAMAMOTO, Shoichiro, KAWAMOTO, Ken, KOMATSU, Toshiko, MOLDRUP, Per (2012): Thermal Properties of Peaty Soils: Effects of Liquid-Phase Impedance Factor and Shrinkage. Vadose Zone Journal, 11 (1)
DISSANAYAKA, Shiromi Himalika, HAMAMOTO, Shoichiro, KOMATSU, Toshiko, KAWAMOTO, Ken (2013): Thermal Properties for Peaty Soil Under Variable Saturation and Their Correlation to mass transport parameters in gaseous and aqueous phases., 39, pp. 21–32
DUDEN HERKUNFTSWÖRTERBUCH (2014): Duden - Herkunftswörterbuch; Der Duden in 12 Bänden; Etymologie der deutschen Sprache. (Anette [Red.] AUBERLE, Ed.) (5.). Berlin; Mannheim; Zürich: Wermke Matthias
EINARSSON, Bjarni F. (1995): The settlement of Iceland : a critical approach ; granastaðir and the ecological heritage. Reykjavík: Hið íslenska bókmenntafélag
EINARSSON, EyÞór (2005): Flóra og gróður Íslands in: Íslandsatlas. Reykjavik: Edda
EINARSSON, Markús Á. (1984): Climate of Iceland. In: H. VAN LOON (ed.): Quarterly Journal of the Royal Meteorological Society (pp. 673–697). Amsterdam: Elsevier
EINARSSON, Þorleifur (1968): Jarðfræði : saga bergs og lands. Reykjavík: Mál og menning
EN.VEDUR.IS (n.d.): Icelandic Met Office - climatology data. online available at http://en.vedur.is/climatology/data/
EUROPEAN COMMITTEE FOR STANDARDIZATION (2017): Building components and building elements - Thermal resistance and thermal transmittance - Calculation methods (ISO 6946:2017). Brussels: CEN
EUROSTAT (n.d.): Your key to European statistics. European Commission online available at http://ec.europa.eu/eurostat/web/main/home
FEILDEN, Bernard M., JOKILEHTO, Jukka (1993): Management guidelines for world cultural heritage sites. Rome: ICCROM
FISCHER WELTALMANACH (2017): Ländervergleich Island-Österreich. Frankfurt am Main: S. Fischer Verlag GmbH online available at https://www.weltalmanach.de/laendervergleich/
FORNVERK.IS (n.d.): No Title. online available at http://www.fornverk.is/node/33
FRAMPTON, Kenneth (1987): Towards a Critical Regionalism: Six Points for an Architecture of Resistance. In: Hal FOSTER (ed.): The anti-aesthetic: essays on postmodern culture (5th ed., pp. 16–30). Port Townsend, Washington: Bay Press
GESTSSON, Gísli (1959): Gröf í Öræfum., pp. 5–87
GÍSLADÓTTIR, Fanney Osk, BRINK, Sigmundur Helgi, ARNALDS, Ólafur (2014): Nytjaland (The Icelandic Farmland Database). Agricultural University of Iceland Report, 49 (49)
GRÖNVOLD, Karl, ÓSKARSSON, Níels, JOHNSEN, Sigfús J., CLAUSEN, Henrik B., HAMMER, Claus U., BOND, Gerard, BARD, Edouard (1995): Ash layers from Iceland in the Greenland GRIP ice core correlated with oceanic and land sediments. Earth and Planetary Science Letters, 135 (1–4), pp. 149–155
GUÐMUNDSSON, Ágúst (2012): The geology of Iceland in relation to global tectonics. Berlin ; London: Springer
GUDMUNDSSON, Thorsteinn (1978): Pedological studies of Icelandic peat soils. Aberdeen: University of Aberdeen
GUÐMUNDSSON, Valtýr (1889): Privatboligen på Island i sagatiden samt delvis i det øvrige Norden. Privatboligen på Island i sagatiden samt delvis i det øvrige Norden. København: Høst & Søn
GUNNARSON, Gisli (1987): Upp er boðið I saland : einokunarverslun og islenskt samfelag 1602-1787. Reykjavik: Örn og Örlygur

HAFSTEINSSON, Sigurjón Baldur (2010): Museum politics and turf-house heritage. Þjóðarspegilinn. Reykjavik: Félagsvísindastofnun Háskóla Íslands

HALLGRÍMSDÓTTIR, Margrét (1993): Húsakostur Viðeyjarklausturs : um byggð í Viðey fram á 18. öld. Húsakostur Viðeyjarklausturs : um byggð í Viðey fram á 18. öld. Reykjavík: Árbæjarsafn

HANNESSON, Guðmundur (1942): Húsagerð á Íslandi / Guðmundur Hannesson samdi. Húsagerð á Íslandi. Reykjavík: Prentsmiðjan Edda

HEIDEGGER, Martin (1971): Building Dwelling Thinking. In: Poetry, Language, Thought. New York, NY: Harper & Row

HJÁLMARSSON, Jón R. (1993): History of Iceland : from the settlement to the present day. Reykjavík: Iceland Review

HOMEDSGN.COM (2017): Studio Granda Creates a Contemporary Turf House in Reykjavik, Iceland. online available at https://www.homedsgn.com/gardur-landhouse/

HORREBOW, Niels (1753): Zuverläsige Nachrichten von Island. Copenhagen Leipzig: bey Friedrich Christian Pelt

ICOMOS (1964): The Venice Charter 1964. IInd International Congress of Architects and Technicians of Historic Monuments, pp. 1–4

ICOMOS (1994): The Nara Document on Authenticity

ICOMOS (2000): World report 2000 on monuments and sites in danger. München: KG Saur

ISLENSKIBAERINN.IS (n.d.): online available at http://islenskibaerinn.is/english/

JÓHANESSON, Björn (1960): The soils of Iceland; with a generalized soil map. Reykjavík

KAISER, Gabriele, ARCHITEKTURZENTRUM WIEN (2006): Architektur in Österreich im 20. und 21. Jahrhundert. Basel [u.a.]: Birkhäuser

KARLSSON, Gunnar (2000): Iceland's 1100 years : the history of a marginal society. (1st Editio.). London: Hurst

KAWAZOE, Noboru (1965): The Ise Shrine and its cultural context. In: Tange KENZO (ed.): Ise - prototype of Japanese architecture (pp. 165–207). Cambridge: MIT Press

KRISTINSSON, Guðjón (2017): personal communication June 10th, 2017.

KRISTINSSON, Hörður (1987): A Guide to the Flowering Plants and Ferns of Iceland. Reykjavik: Örn og Örlygur

KROONEN, Guus (2013): Etymological Dictionary of Proto-Germanic. Leiden; Boston: LUBOTSKY, Alexander

KUJALA, Kauko, SEPPÄLÄ, Matti, HOLAPPA, Teuvo (2008): Physical properties of peat and palsa formation. Cold Regions Science and Technology, 52 (3), pp. 408–414

LAMPRECHT, Heinz-Otto (1987): Opus Cementitium - Bautechnik der Römer. Düsseldorf: Beton Verlag

LANDMÆLINGAR ÍSLANDS (2016): DEM (Digital Elevation Model). Akranes online available at https://www.lmi.is/en/stafraen-gogn/

LÁRUSSON, Hannes (n.d.): personal communication June 11th, 2017.

LÁRUSSON, Hannes (2014): The icelandic farmstead.

LEHNER, Erich (2016): Elementare Architektur: Traditionen des Bauens in außereuropäischen Kulturen. (2nd ed.). Wien: Institut für Vergleichende Architekturforschung

LEHTOLA, Veli-Pekka (2002): The Sámi people - traditions in transition. Aanaar: Kustannus-Puntsi

LEY, Karsten (2017): Wider das Universelle - Kritik des Re(gion)alismus. Der Architekt, (3), pp. 34–37

LOHMEYER, Gottfried, POST, Matthias (2013): Praktische Bauphysik : eine Einführung mit Berechnungsbeispielen. Praktische Bauphysik : eine Einführung mit Berechnungsbeispielen (8., vollst.). Wiesbaden: Springer Vieweg LUCAS, Gavin, BATEY, Colleen (2009): Hofstaðir: excavations of a Viking age feasting hall in North-Eastern Iceland. Reykjavík: Inst. of Archaeology

MÄCKLER, Christoph (2016): Über das Element der Öffnung: Innenraum - Zwischenraum - Außenraum. Der Architekt, (4), pp. 41–45

MAGER, Tino (2016): Schillernde Unschärfe : der Begriff der Authentizität im architektonischen Erbe. Schillernde Unschärfe : der Begriff der Authentizität im architektonischen Erbe. Berlin: De Gruyter

MAGNÚSSON, Ásgeir Blöndal (1989): Islensk orðsifjabók. (2. prentum.). Reykjavik: Ordabók Háskólans

MASEA-ESAN.DE (n.d.): MASEA-DATABASE. Valley: Fraunhofer Institut für Bauphysik online available at http://www.masea-ensan.de/

MERRIAM-WEBSTER.COM (n.d.): Merriam-Webster online dictionary. online available at https://www.merriam-webster.com/

MINKE, Gernot (2004): Das neue Lehmbau-Handbuch : Baustoffkunde - Konstruktionen - Lehmarchitektur. Das neue Lehmbau-Handbuch : Baustoffkunde - Konstruktionen - Lehmarchitektur (6., .). Staufen bei Freiburg [Breisgau]: Ökobuch

MINKE, Gernot, KRICK, Benjamin (2014): Handbuch Strohballenbau; Grundlagen, Konstruktionen, Beispiele. (3.). Staufen bei Freiburg: Ökobuch-Verlag.

NORDAHL, Else (1988): Reykjavík from the archaeological point of view. Uppsala: Societas Archaeologica Upsaliensis

ÓLAFSSON, Guðmundur (2004): Frá skála til gangabæjar : húsagerð á miðöldum. Hlutavelta tímans

ÓLAFSSON, Rögnvaldur (1911): Leiðrétting. Ingólfur, 47

ÓLAFSSON, Sigfús A (1974): Fysiske og fysisk-kemiske studier af Islandske jordtyper. Fysiske og fysisk-kemiske studier af Islandske jordtyper. København: Kongelige Veterinær- og Landbohøjskole, Hydroteknisk Laboratorium

OLIVER, Paul [Hrsg.] (1998): Encyclopedia of vernacular architecture of the world. (Repr.). Cambridge [u.a.]: Cambridge Univ. Press

OTTÓSON, Jón Gunnar, SVEINSDÓTTIR, Anna, HARÐARDÓTTIR, María (Eds.) (2016): Vistgerðir á íslandi. Fjölrit Náttúrufræðistofnunar nr.54.

PASSIVHAUS INSTITUT (2015): Kriterien für den Passivhaus, EnerPHit und PHI-Energiesparhaus-Standard. Darmstadt: Passivhaus Institut

PKDM.IS (n.d.): bhm vacation homes. online available at https://pkdm.is/projects/bhm

POKORNY, Julius (1958): Indogermanisches etymologisches Wörterbuch. 3 Bände. (2. Aufl.). Bern [u.a.]: Francke

ROBERTS, H. M., FORSTER, Amanda, GUÐMUNDSSON, Garðar, HOLT, Anton, MCGOVERN, Thomas H., MEHLER, Natascha, et al. (2001): Fornleifarannsókn á lóðunum Aðalstræti 14-18 = Archaeological excavations at Aðalstræti 14-18, 2001 : a preliminary report = framvinduskýrslur. Reykjavík: Fornleifastofnun Íslands

ROBERTS, H. M., SNÆSDÓTTIR, Mjöll, MEHLER, Natascha, ALDRED, Oscar, GUÐMUNDSSON, Garðar, SVEINBJÖRNSDÓTTIR, Árný E., et al. (2004): Excavations at Aðalstræti, 2003. Excavations at Aðalstræti, 2003. Reykjavík: Fornleifastofnun Íslands

ROTH, Alfred (1955): Die Wallfahrtskapelle in Ronchamp: 1952/54, Le Corbusier, Paris. Das Werk: Architektur und Kunst, 42 (12), pp. 375–385

RUDOFSKY, Bernard (1964): Architecture Without Architects. New York, NY: Museum of Modern Art

SACHER, Edwin (1938): Die aus Grassoden und Holz gebauten Höfe und Kirchen in Island. Würzburg: Triltsch

SCHÖNBURG, Kurt (2017): Lehmbauarbeiten : Aktualität der herkömmlichen Lehmbauarbeiten, wirtschaftliche und technische Vorteile, Lehm und Lehmbaustoffe, Neubau und Sanierung von Lehmbauten, Lehm-Gestaltungsarbeiten, Schäden an Lehmbauten. Lehmbauarbeiten : Aktualität der herkömmlichen Lehmbauarbeiten, wirtschaftliche und technische Vorteile, Lehm und Lehmbaustoffe, Neubau und Sanierung von Lehmbauten, Lehm-Gestaltungsarbeiten, Schäden an Lehmbauten (2., überar.). Berlin Wien Zürich: Beuth Verlag GmbH

SCHRÖDER, Uwe, SCHNEIDER, Hartwig (2018): Identität der Architektur. 1.Ort. Positionen zum Ortsbezug in der Architektur. Köln: Verlag der Buchhandlung Walther König

SCHROEDER, Horst (2010): Lehmbau - Mit Lehm ökologisch planen und bauen. (1st ed.). Wiesbaden: Vieweg + Teubner
SCOTTISH LIME CENTRE (2002): Conservation of Plasterwork. Edinburgh: Historic Scotland
SIGURÐARDÓTTIR, Arnheiður (1966): Híbýlahættir á miðöldum. Híbýlahættir á miðöldum. Reykjavík: Menningarsjóður og Þjóðvinafélagið
SIGURÐARDÓTTIR, Sigríður (2007): Torf til bygginga. Torf til bygginga. Varmahlíð: Byggðasafn Skagfirðinga
SIGURÐARDÓTTIR, Sigríður (2008): Building with turf - English version by Nancy Marie Brown. Building with turf. Varmahlíð: Byggðasafn Skagfirðinga
SIGURÐARDÓTTIR, Sigríður (2011a): Gamlir byggingahættir. Gamlir byggingahættir. Varmahlíð: Byggðasafn Skagfirðinga
SIGURÐARDÓTTIR, Sigríður (2011b): Sögur úr Glaumbæ. Sögur úr Glaumbæ. Varmahlíð: Byggðasafn Skagfirðinga
SIGURÐARSON, Guðmundur St., ZOËGA, Guðný, SIGURÐARDÓTTIR, Sigriður (2014): Lesið í landið. Varmahlíð: Byggðasafn Skagfirðinga
SIGURÐARSON, Guðmundur St., ZOËGA, Guðný, SIGURÐARDÓTTIR, Sigriður (2017): Reading the landscape - English translation by Nancy Marie Brown. Varmahlíð: Byggðasafn Skagfirðinga
SIGURÐSSON, Helgi (n.d.): personal communication May 26th - 28th, 2017.
SOIL SURVEY STAFF (1999): Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. (2nd Editio.). Natural Resources Conservation Service. U.S. Department of Agriculture
STATISTICS ICELAND (2017): Iceland in Figures 2017. online available at https://hagstofa.is/lisalib/getfile.aspx?ItemID=13913
STATISTIK AUSTRIA (2017): Österreich - Zahlen, Daten, Fakten. Wien
STEFÁNSSON, Hjörleifur (2013): Af jörðu : íslensk torfhús. Af jörðu : íslensk torfhús. Reykjavík: Crymogea
STENBERGER, Mårten, ROUSSELL, Aage, STEFFENSEN, Jón (1943): Forntida gårdar i Island : meddelanden från den nordiska arkeologiska undersökningen i Island sommaren 1939. København: Munksgaard
STUDIOGRANDA.IS (n.d.): Gardur residence.
online available at https://www.studiogranda.is/Gen/Gardur/GardurText.html
STUDIOGRANDA.IS (2007): Hof residence. online available at https://www.studiogranda.is/Gen/Hof/HofText.html
SWANTON, Michael J (1997): The Anglo-Saxon chronicle. (1. publ.). London: Dent
THETURF.NET (n.d.): No Title. online available at http://www.theturf.net/gudjon/
THORDARSON, Thor, LARSEN, G. (2007): Volcanism in Iceland in historical time: Volcano types, eruption styles and eruptive history. Journal of Geodynamics, 43 (1), pp. 118–152
TRANSLATE.GOOGLE.COM (n.d.): Google Translate. online available at https://translate.google.com/#is/en/
TZONIS, Alexander, LEFAIVRE, Liane (1981): The grid and the pathway. Architecture in Greece, 15, pp. 164–178

UNESCO (1972): Convention Concerning the Protection of the World Cultural and Natural Heritage. General conference seventeenth session. Paris
UNESCO (1977): Operational Guidelines for the Implementation of the World Heritage Convention. Paris
UNESCO (2005): Operational Guidelines for the Implementation of the World Heritage Convention.
UNESCO (2013): Periodic Report - Second Cycle - State Party Iceland.
online available at http://whc.unesco.org/en/statesparties/is/documents/
UNKNOWN (2017): personal communication June 9th, 2017.
UWDC ICELANDIC ONLINE DICTIONARY (n.d.): Íslensk-ensk orðabok.

online available at http://digicoll.library.wisc.edu/IcelOnline/Search.TEId.html [23/10/2017]
VALENA, Tomáš (2007): Ortsbezug als inspirierende Kraft. Der Architekt, (3), pp. 28–33
VAN BRONSVIJK, JEMH (1995): Neue Herausforderungen für den Allergologen. In: W. JORDE (ed.): Allergologie für die Praxis 2. Asthma bronchiale Neudeitio Provokationsteste-Milben (pp. 1–7). München-Deisenhofen: Dustri-Verlag
VAN HOOF, Joost, VAN DIJKEN, Froukje (2008): The historical turf farms of Iceland: Architecture, building technology and the indoor environment. Building and Environment, 43 (6), pp. 1023–1030
VISIR (1936, September): Listirnar og Ísland nú á dögum. Visir. Reykjavik
VITRUVIUS POLLIO, Marcus, FENSTERBUSCH, Curt (1987): Über Architektur ; Zehn Bücher über Architektur. (4. Aufl.). Darmstadt: Wissenschaftliche Buchgesellschaft
VOLHARD, Franz, RÖHLEN, Ulrich (2009): Lehmbau Regeln : Begriffe - Baustoffe - Bauteile. (3., überar.). Wiesbaden: Vieweg + Teubner
WALKER, Bruce (2006): Scottish turf construction. Historic Scotland Technical Advice. Edinburgh: Historic Scotland
WALKER, Bruce, MCGREGOR, Christopher (1996): The Hebridean blackhouse. Historic Scotland Technical Advice. Edinburgh: Historic Scotland
WALKER, Bruce, MCGREGOR, Christopher, LITTLE, Rebecca (1996): Earth Structures and Construction in Scotland. Historic Scotland Technical Advice. Edinburgh: Historic Scotland
WATANABE, Yasutada (1974): Shinto art: Ise and Izumo shrines. (1. English.). New York, NY: Weatherhill
WEDGWOOD, Hensleigh (1862): A dictionary of English etymology Vol II. London: Trübner
WHC.UNESCO.ORG state parties (n.d.): UNESCO World heritage convention - state parties. online available at https://whc.unesco.org/pg.cfm?cid=246
WHC.UNESCO.ORG tentative lists (n.d.): UNESCO World heritage convention - tentative lists. online available at http://whc.unesco.org/en/tentativelists/
WHITE, C. R., SEYMOUR, R. S. (2003): Mammalian basal metabolic rate is proportional to body mass2/3. Proceedings of the National Academy of Sciences, 100 (7), pp. 4046–4049
WRB IUSS WORKING GROUP (2014): World reference base for soil resources 2014 - International soil classification system for naming soils and creating legends for soil maps. World Soil Resources Reports No. 106. Food and Agriculture Organization of the United Nations
YOUTUBE.COM (2014): Arc Architects Turf Building In Iceland. online available at https://www.youtube.com/watch?v=zaaqMj5HwuU&t=9s
YOUTUBE.COM (2015): Turf house adventure. online available at https://www.youtube.com/watch?v=DXOKzIrInt-M&t=341s
YOUTUBE.COM (2016): Iceland - Helgi Sigurðsson - cutting turf for house building. online available at https://www.youtube.com/watch?v=hV4Bk8FtkfI
ÞJÓÐMINJASAFNS ÍSLANDS (2011): UNESCO World Heritage Submission - The Turf House Tradition. Reykjavik: þjóðminjasafns Íslands
ÞJÓÐMINJASAFNS ÍSLANDS (2012): Laufás. Reykjavik: þjóðminjasafns Íslands
ÞJÓÐMINJASAFNS ÍSLANDS (2015): Keldur. Reykjavik: þjóðminjasafns Íslands
ÞORGILSSON, Ari (1966): The book of the Icelanders. (Halldór HERMANNSSON, Ed.) (Reprint.). New York, NY [u.a.]

figure 68 - the home of a curious student

acknowledgement

The sincerest "thank you" to everyone who helped making this endeavor possible. To my family, enabling and encouraging my curiosity that ultimately led to this work. To my friends and companions, supporting and pushing me towards my goals while keeping me good company along the way. To everyone at university giving me this platform to evolve.

Danksagung

Ein herzlichstes "Dankeschön" and all jene, die in der Entstehung dieser Arbeit zu meiner Seite gestanden sind. Meiner Familie, welche mich seit jeher in meiner Neugierde und Lernfreude fördert und unterstützt. Meinen Freunden, die mir Ansporn, Hilfe und Weggefährten zum Erreichen meiner Ziele sind. Allen Beteiligten an der Technischen Universität Wien, welche mir dieses Studium und daraus resultierende Entwicklung ermöglich haben.