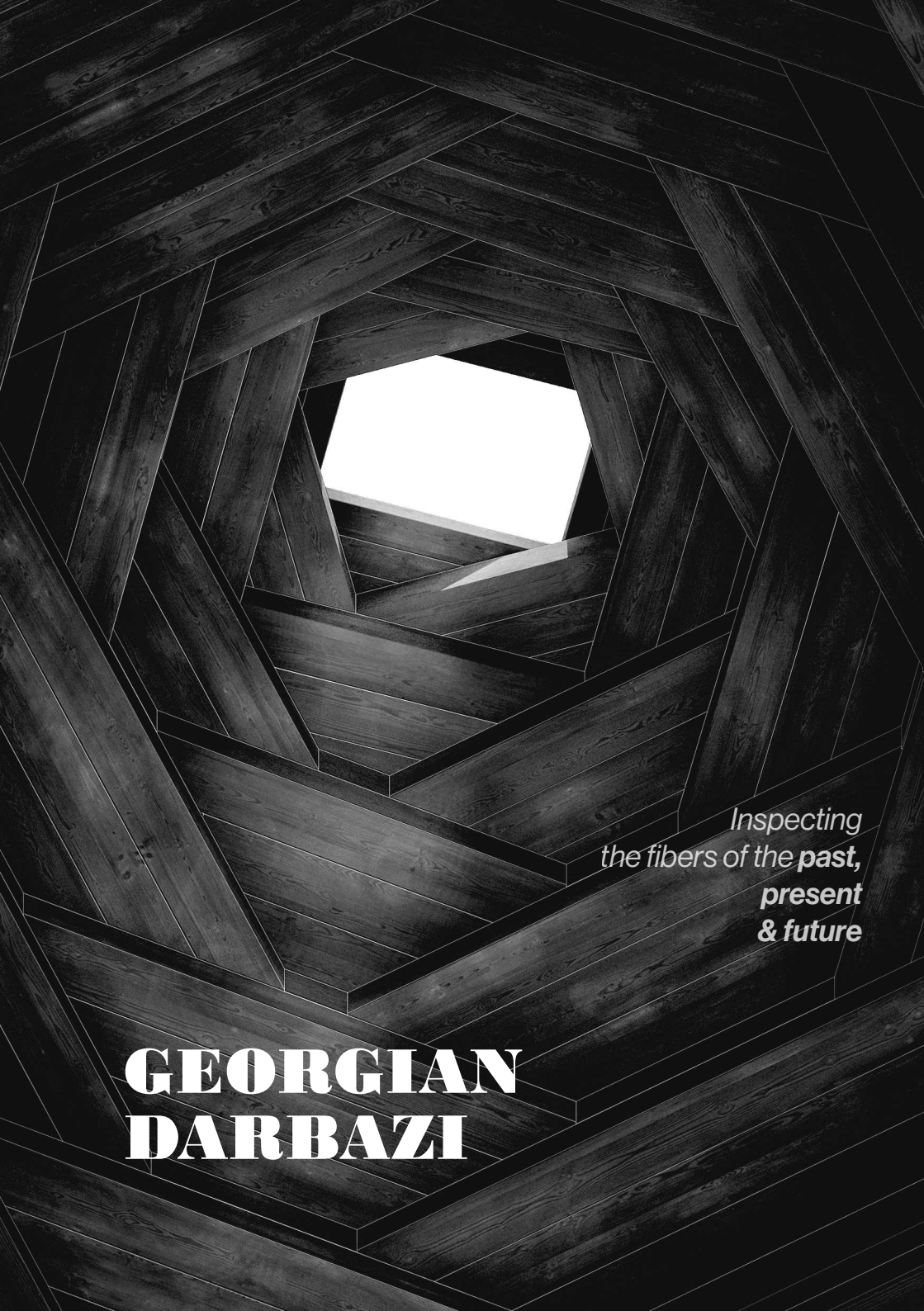

Inspecting
the fibers of the ***past,***
present
& future

GEORGIAN DARBAZI

Politecnico
di Torino

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Master Thesis in Architecture Construction City
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Georgian Darbazi: Inspecting the fibers of the past, present & future

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Abstract

One of the main foci of this thesis is to investigate the development of the accumulated knowledge about timber use in Georgian secular architecture, more specifically in the Meskheti historical region, where the cases of interest are located - "*Darbazi*" dwellings hut-alike structures with corbelled roofing and halfway underground. We shall browse through these specific dwellings, briefly introducing their historical and technical background, and more importantly stress their state of art accompanied by the visual data collected from the preliminary in-situ inspections in several villages of Southwestern Georgia.

First and foremost, we shall summarise an essential bibliography about the vernacular folk architecture of Georgia, discussing more deeply the architectural endeavours from the Southwestern part, whilst observing the cultural, political and environmental form-giving processes behind the technological veils.

The first chapter explores the ***past*** knowledge about "*Darbazi*" dwellings through the main scopes of technology, building materials, geometry and history, starting from the first evolutionary processes in the Antic period till the latest formations of the XX century, with complementary parallels to some similar structures in various regions of the globe. The acquired materials allow us to have a visual and analytical tour of these primitively sophisticated structures.

In the second chapter, we shall overview the international and national methodologies of evaluation of the existing timber structures, alongside the brief discourse of information and knowledge state in collective national data. The primary aim is to shed light on the ***present*** conditions and poor conservation state of some aforementioned structures, collected from the preliminary visual survey, carried out mostly in the remote villages of Georgia. This one-scope inspection is an attempt to underline the importance of technological analysis of wooden heritage in the country.

The third chapter introduces several available tools and standards for ***future*** preservation/restoration of historic timber buildings in international practice and consequently shows the application of these methodologies to the selected case studies. Hereby we also attempt to explore the existing resources of wood material and its treatment methods, but more importantly - the potential involvement of local public and/or private actors in fostering these valuable structures.

რეზიუმე

ამ ნაშრომის ერთ-ერთი მთავარი მიზანი დაგროვილი ცოდნის კვლევა და ანალიზია, რომელიც საქართველოს საერო არქიტექტურაში ხის გამოყენებას ეხება, განსაკუთრებით კი მესხეთის ისტორიულ რეგიონში, სადაც წარმოდგენილია „დარბაზის“ ტიპის საცხოვრებელი ნაგებობები - ქოხისმაგვარი სტრუქტურები, რომლებსაც კონსოლური გვირგვინოვანი გადახურვა აქვთ და სანახევროდ მიწაში არიან ჩაფლულნი. ნაშრომში შევეხებით ამ ნაგებობების ისტორიულ და ტექნიკურ ფონს, განსაკუთრებულ ყურადღებას კი გავამახვილებთ მათი არსებული ფიზიკური მდგომარეობის შესახებ, ინფორმაცია რომელზეც შეგროვებულია სამხრეთ-დასავლეთ საქართველოს რამდენიმე სოფელში წინასწარი დათვალიერების საფუძველზე.

პირველ რიგში, შევაჯამებთ უმნიშვნელოვანეს ბიბლიოგრაფიას საქართველოს ვერნაკულარული არქიტექტურის შესახებ, სადაც ამომწურავად ვისაუბრებთ ქვეყნის სამხრეთ-დასავლეთ რეგიონის არქიტექტურულ მიღწევებზე და განვიხილავთ კულტურული, პოლიტიკური და ბუნებრივი ფაქტორების გავლენას საცხოვრისის ტექნოლოგიურ მხარეზე.

პირველი თავი მოიცავს წარსულ ტექნოლოგიურ, გეომეტრიულ და ისტორიულ ცოდნას „დარბაზული“ ნაგებობების შესახებ, ანტიკური პერიოდის ევოლუციური პროცესებიდან XX საუკუნის საბოლოო ფორმირებამდე, პარალელების გავლებით ზოგიერთ მსგავს ნაგებობასთან მსოფლიოს სხვადასხვა რეგიონებში. მოპოვებული მასალები საშუალებას გვაძლევს, ვიზუალურად და ანალიტიკურად გავიაზროთ ეს პრიმიტიულად დახვეწილი სტრუქტურები.

მეორე თავი მოიცავს ხის ნაგებობების აღსარიცხად შემუშავებულ საერთაშორისო და ადგილობრივ მეთოდოლოგიას, ასევე მოკლე მიმოხილვას ეროვნული მონაცემების წიაღში არსებული ცოდნის მდგომარეობის შესახებ. მთავარი მიზანია ნათელი მოვფინოთ არსებულ პირობებს და მოცემულ სტრუქტურათა არასახარბიელო მდგომარეობას, რომელიც შეგროვებულია წინასწარი ვიზუალური კვლევის საფუძველზე, ძირითადად საქართველოს შორეულ სოფლებშია განხორციელებული. ეს ერთჯერადი ინსპექცია არის მცდელობა, რომ ხაზი გავუსვათ ხითხურობით შესრულებული მემკვიდრეობის ტექნოლოგიური ანალიზის მნიშვნელობას ქვეყანაში.

მესამე თავი გვთავაზობს საერთაშორისო პრაქტიკაში არსებულ რამდენიმე მეთოდს და სტანდარტს, რომელიც ისტორიული ხითხურობის სამომავლო შენარჩუნება/აღდგენისათვის გამოიყენება, და შესაბამისად, ამ მეთოდოლოგიების მორგებას შერჩეულ ნაგებობებზე. ასევე, ვეცდებით შევისწავლოთ არსებული ხის რესურსები და მათი დამუშავების მეთოდები, მაგრამ, რაც უფრო მნიშვნელოვანია - ადგილობრივი საჯარო და/ან კერძო სუბიექტების ჩართულობის პოტენციალს ამ ღირებული სტრუქტურების შესანარჩუნებლად.

Methodology

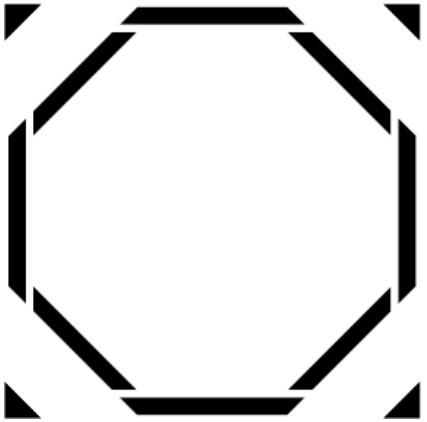
This thesis has mainly been conducted in a consequential manner by using historical research, on-site exploratory evaluations and proposing restoration scenarios.

The first mode serves as an intermediate tool for collecting, translating and summarising archival knowledge about vernacular Georgian architecture. Most of the used sources, that are written in Georgian and Russian languages, have been summarised and partially adapted to English. Moreover, some of the materials were taken from the available state (government) data online.

After preliminary research on Politecnico di Torino grounds, which included distillation of the vast topic of Georgian wooden architecture into the scope of a singular type of vernacular structures , collection of essential part of bibliography, overviewing the destinations for case study dwellings, which were selected afterwards from the South-West areas of the country, more specifically in villages of Balanta, Khizabavra, Saro, Vale, Chobareti and Ude, located in the mountainious region of Samtskhe-Javakheti.

The second stage of the research consisted of on-site visits to the selected case-studies (*Darbazi* dwellings) mentioned above with the integration of an in-situ evaluation strategy. Unfortunately, half of the houses on the planned agenda were inaccessible or collapsed at the time, but it was still possible to access and analyse 16 of dwellings. Alongside general measurements (made with portable laser and measuring tape), photo-survey and brief interviews with locals (inhabitants, owners), specific technological aspects have been chosen to evaluate these findings on-site, primarily focusing on biodegradation and decays of timber roofs and frameworks, because of their cultural significance .

Final part of the research, focused on the resolving methods for degradation issues in these wooden structures, incorporates materials on various technological interventions from local traditional knowledge, as well as modern findings from international expertise.



Introduction

Primitive does matter

> "For as long as there has been architecture, it has been justified, and sustained by reference to primitive building" - Joseph Rykwert, *On Adam's House in Paradise* (1972)

Fig. 1/ *Charles-Dominique-Joseph Eisen (1720–1778), Frontispiece from Essai sur l'architecture, second edition, 1755. Engraving. DOME MIT Library collections*

Since the dawn of mankind, following the exodus from cave dwellings, horizontal and vertical elements rendered in a large spectrum of materiality have been utilized for constructing a shelter. Humans started building habitats with the most primitive configuration, such as the Dolmens - bearing the ultimate material weight and human effort, moving onto a rather friendly and submissive natural element – wood, within its utmost authentic dendrological form. An XVIII century image from Marc-Antoine Laugier's *Essai sur l'architecture*[1], depicts how the "man in his primitive state", a "savage" in need of habitat, has laid over some branches in a triangular manner, resting on tree trunks as its natural supports.

Adrian Forty[2] suggests that we often underestimate the meaning and value of primordial endeavours and mistreat the word "primitive" itself, using it to signify the exotic, uncivilized, anonymous, indigenous, etc, - mysterious huts, that sleep tightly far away over the mountains, waiting to be discovered by the anthropologists. However, we live among the examples and influences of primitive architecture, with or without our comprehension. Human beings have an almost innate geometrical sensibility, that has displayed itself through various forms in various civilizations within various chunks of historical timeline and continues to do so by referring to the same "primitive" origins.

> "The primitive, therefore, is purely an ideal, necessary to conceive of in order to think about society, but not to be confused with any actual state, whether historical or present." – says Forty (Odgers 2006, 8)

These architectural manifestations of a human being as a dweller, however crude and primordial, have led to an avalanche of diverse structural ramifications across the globe. A substantial part of these structures has been built in long-lasting materials – stone and brick masonry, followed by steel and concrete, leaving behind *wood* as the initial biological element, the backbone of the masonry construction with numerous amicable properties, destined to be consumed by time and environmental conditions, but reinterpreted and portrayed within the archives.

Regardless of these implications, some cultures did not abandon their "primal" efforts but continued to refine and perfect their modes of architectural expression instead and adapt to the everchanging climatic, political and social circumstances. For instance, Swedish (Fig. 3) and Japanese (Fig. 2) examples of modern wooden construction display the historically transmitted value and respectful attitude towards their heritage, whilst exploring new ways of their building origins.

Fig. 3/ *Reconstruction of Summer house by General Architecture. Sweden. Photo by MIKAEL OLSSON. Source: https://divisare.com/*

Fig. 2/ *Shiiba house by Mandai Architects. Kyoto, Japan. Photos by YASUHIRO TAKAGI. Source: https://divisare.com/*

1. *Marc-Antoine Laugier. Essai sur l'architecture, second edition, 1755. From the article OTHER LIVES: CHARLES EISEN AND LAUGIER'S ESSAI SUR L'ARCHITECTURE – Rebecca Williamson, 2019*

2. *Odgers, Jo, Flora Samuel, and Adam Sharr, eds. Primitive: Original Matters in Architecture. New York: Routledge, 2006. ISBN 9780415385398.*

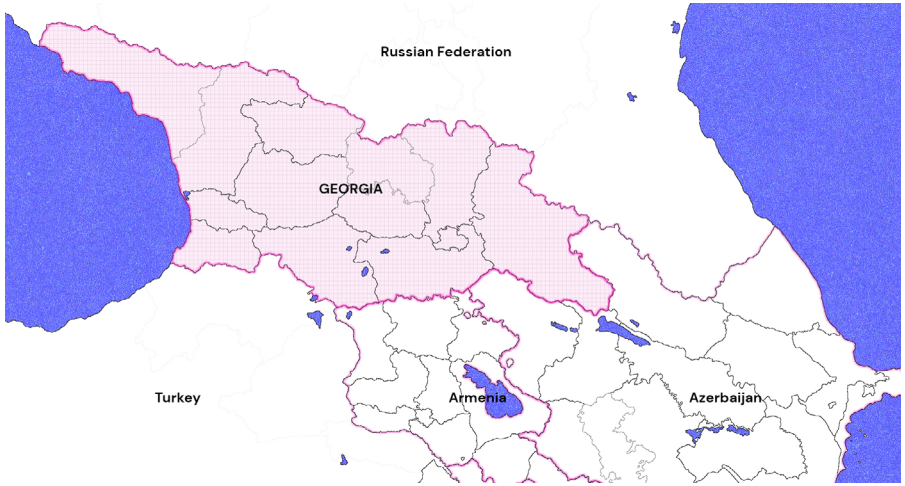


Fig. 4/ *Map of Georgia and neighbouring countries.*

The place of our interest, a small country on the edge of Eastern Europe and Western Asia, named **Georgia**, is in the Caucasus mountains laid in between of Black Sea and the Caspian Sea. Its neighbouring countries are Turkey, Armenia and Azerbaijan from the South, and Russia – from the North. Like some other geopolitically complex areas, this country has a bricolage of architectural heritage, varying from "primitive" to highly sophisticated forms of expression, primarily embodied in stone and wood materials.

Archaeological evidence of wood craftsmanship on Georgian territory dates to the Eneolithic and Bronze[1] ages, including footprints of wooden pillars & roofing systems from *Colchida*[2]. Ancient visits of Xenophon, Vitruvius[3] and other historians and/or explorers of this era, have left behind some data about the folk woodworking culture of Georgian ancestors.

Some literature mentions that inhabitants were skillful in the use of timber material for defensive and dwelling structures. For instance, in one of his books, Vitruvius briefly described the habitats built by native tribes on the coastline and into the sea, disguised as fortifications using timber and brushwood materials. We also read that these dwellings were built by layering the timber logs on top of each other, progressively shrinking towards the top, forming corbelled/ "crowned" ceilings. These structures represent the rudiments of subsequently developed dwelling types of *Darbazi*[4], *Djargvali*[5] and *Patskha*. Hippocrates, Apollonius of Rhodes and Dionysius of Halicarnassus also confirm this information about Colchis and their building culture. Additionally, some authors mention the export of wood material and naval transport constructed by highly skilled local woodworkers. We find crucial discussions in "Colchian and Phrygian" houses[6] (*Fig. 5*) enriching the pre-existing explorations with visual reconstructions of historical structures and parallels with consequent developments of Georgian architecture.

Architectural morphologies in wood

The use of wood in vernacular architecture extends to every distant corner of Georgian borders and beyond. We can observe a variety of these examples in a modern environment, but due to the degradable character of the material itself, history provides richer and more illustrative sources. Some of the most reliable sources – N. Jabua's "The Secular Architecture of Old Georgia" (2018), V. Beridze's "XVI-XVIII Century Georgian Architecture" (1983) and M. Garakanidze's "Georgian Architecture in Wood" (1959) deploy a multidisciplinary

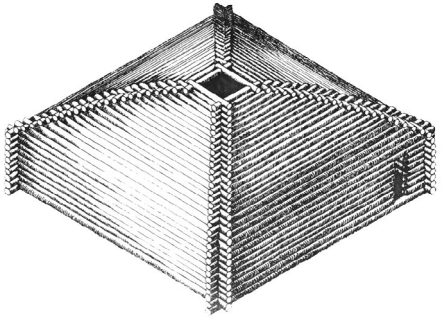


Fig. 5/ *Reconstruction-of-Colchian-hut-according-to-Vitruvius-by-G.-Kipiani.jpg*

1. *There is physical historical evidence from the Bronze Age (3000-2000 B.C.) indicating the use of woodworking tools during that time. i.e., wooden beams with dimensions of 21*28cm with cut joints.*
2. *Colchida - ancient Georgian civilisation, documented building culture in western Georgia from II B.C - IV A.C*
3. *Vitruvius. The Ten Books on Architecture. Translated by Morris Hicky Morgan. Cambridge: Harvard University Press, 1914. Book II, Chapter 1, Section 4.*
4. *Darbazi – a type of Georgian dwelling with wooden corbelled roof. See Glossary*
5. *Djargvali and Patskha - primitive types of dwelling in Western Georgia*
6. *Kipiani, Gia, and Nodar Amashukeli. Kolkhuri da Frigiuli Sakhlebi [Colchian and Phrygian Dwellings]. Tbilisi, 1995.*

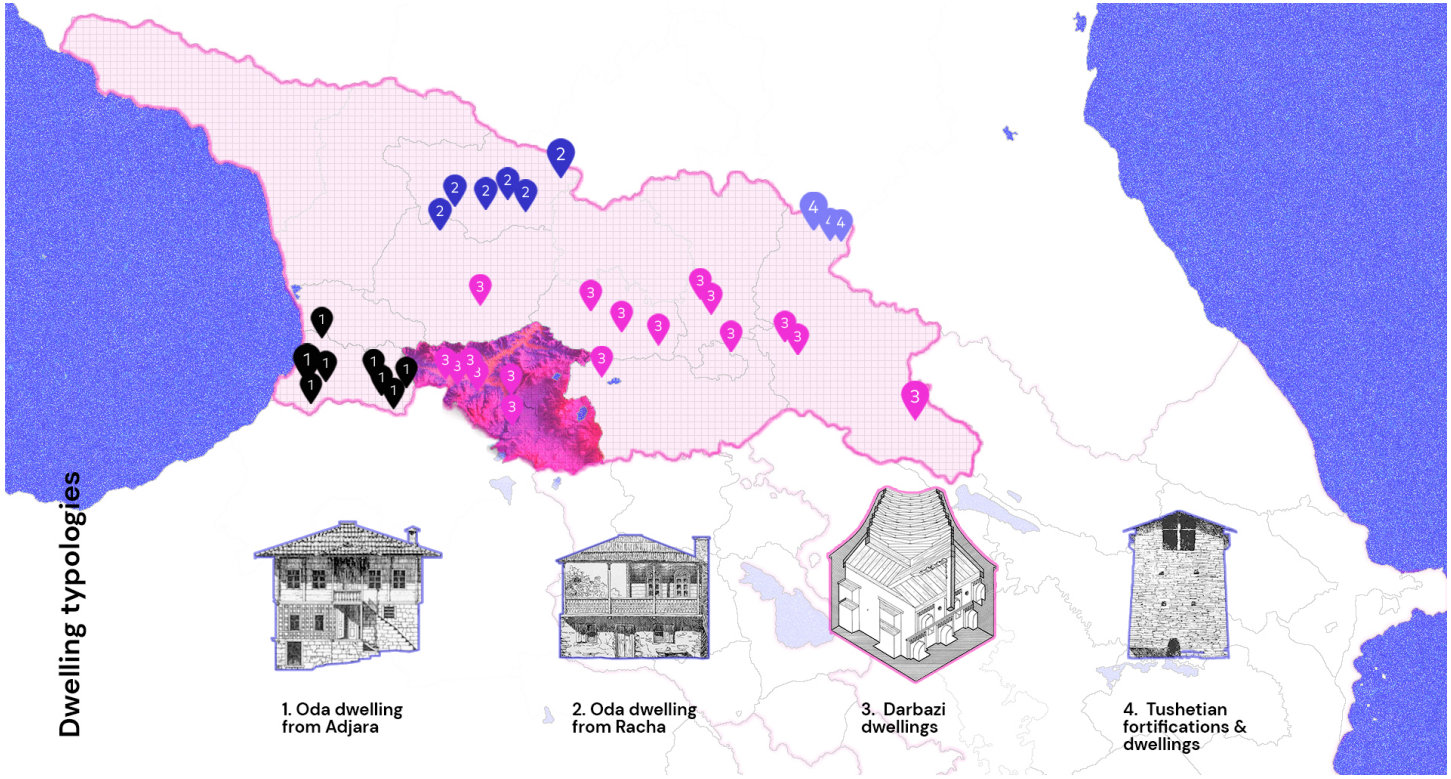


Fig. 6/ *Mapping of general types of folk wooden architecture in Georgia, highlighting the Samtskhe-Javakheti region, the destination of this research.*

approach to the exploration of traditional wooden interfaces in various regions of the country.

As we mentioned before, the wood culture across the Georgian territories initiated millennia ago. The geographical and climatic conditions nourished the ecosystem throughout this time and gave people logical solutions to their habitat needs. The majority of the structures explored within this book[7] are distributed within the mountainous areas, rich with forestry and natural stone resources, thus the architectural imagery across the country is somewhat consonant, but still unique within the planning system, construction details and decorative features.

We can borrow the classification of some wooden structures from the aforementioned books and display them on the map (Fig. 6):

1,2. Oda dwellings, which itself has subcategories from different regions: Imereti region; Adjara region; Abkhazeti region and Racha region; (Map is showing only two regions with distinct types of Oda dwellings)

Oda represents one of the most common types of dwellings in Georgian culture, especially spread throughout the Western part of the country, the roots of which emerged from Colchian civilization. These houses have two main representations: one-storey structures that stand on stone pillars for ventilation and others with masonry stone bases on the ground floor and wooden frameworks on the top. They are generally adjusted to the local terrain and commonly have a square-shaped framework with four-sloped roofing. Odas are built with refined lumber elements, and specific wooden species, which ensure structural strength and make dismantling and assembling processes more agile. The most expressive part of *Oda* dwelling is its thoroughly decorated balcony, which serves as a welcoming gesture and social hotspot.

3. *Darbazi* dwellings, which can be differentiated on a regional level: from Kartli-Kakheti and Samtskhe-Javakheti zones;

Darbazi refers to a dwelling with a specific type of crowned ceiling structure called *Gvirgvini*[8]. They differ throughout three regions of Georgia due to the geomorphological conditions and historical events. Some houses, from Kartli- Kakheti region for instance, differ from the other type of *Darbazi* with planning system and placement within the environment: while the dwellings in Samtskhe-Javakheti areas identify as pit-houses among the mountains, others in the East are free-standing structures, often within the urbanized areas. Some of the most significant characteristics of *Darbazi* houses include the incorporation of a central hearth, and primary pillars functioning as bearing and decorative elements at once.

4. Fortifications and dwellings from **mountainous** regions, such

7. *Garakanidze, Mikheil. "საქართველოს ხით ხუროთმოძღვრება" (Georgian wooden architecture). Tbilisi: Khelovneba; Sabchota Sakartvelo. 1959*

8. *Gvirgvini - a type of corbelled ceiling in Georgia. See glossary*

as Pshavi, Tusheti, Svaneti, etc.

In the Northern Caucasus mountain range, multiple variations of *fortified dwellings* can be found. These multistorey buildings integrate several functional spaces within a single corpus – chambers for military purposes, domestic activities, and even livestock. Aside from that, the neighbourhood planning system in almost every region follows the terrace principle. Due to harsh climatic conditions, slate stone masonry is utilised as their primary construction material, however, a significant part of dwelling complexes is built with timber and some architectural elements, such as wooden balconies and openings, lighten the overall composition.

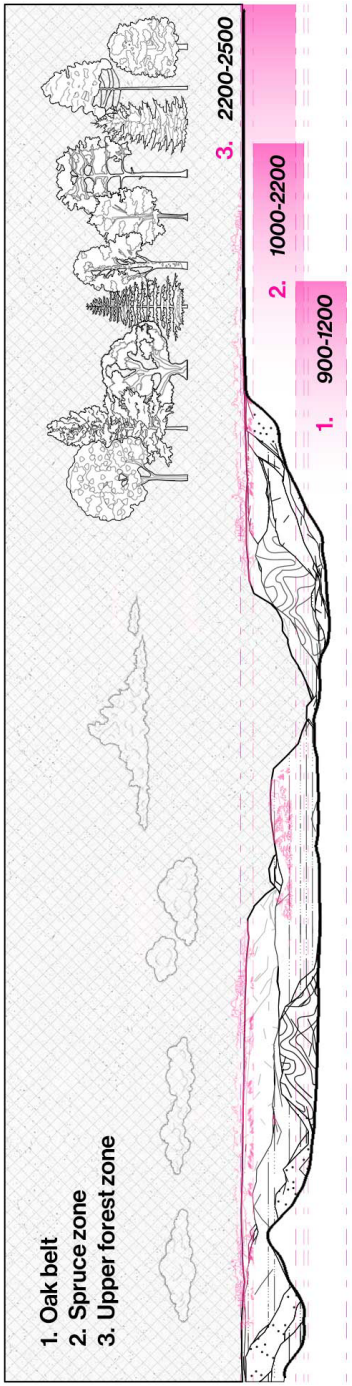
Some of the previous types of wooden structures have been preserved along the years in ethnographic open-air museums displaying vernacular architecture collected from different regions and folk traditions. with the aim of preserving and enhancing their material and cultural value. These cultural repositories are spread all around the country. Some of the most interesting and informative museums are located in big cities, incorporating major types of Georgian vernacular architecture. They represent significant platforms for conservation of cultural heritage. One of its fine examples[9] is located in the capital of the country - Tbilisi, where the open-air museum gatekeeps numerous significant restored samples of Georgian vernacular architecture.

Dendrological outlines of the Samtskhe-Javakheti region

To fully comprehend the importance of wooden material within Georgian traditional architecture, one has to derive from its logistical basis, including historical morphologies respectively with both – horizontal and vertical zones of dendrological distribution, as well as a general overview of geomorphological factors in the Samtskhe-Javakheti area. This district, as mentioned before, is located in the Southwest part of Georgia. In the east, it borders the Arsiani ridge. In the north, it borders the Adjara-Imereti ridge. And in the east borders by the Javakheti ridge in the south—by the border of Turkey. Location and the complexity of the terrain in between the Southern Caucasus Mountain ranges, and the deficiency of forest cover (amounting to 11.5% by the data in 1962) are the reasons behind the dry and continental climate in this area. According to the information Iason Abashidze[10] has acquired, this has assured rich historical forest coverage

9. *The Giorgi Chitaia Open Air Museum of Ethnography located in Tbilisi, Georgia*

10 *Abashidze, Iason. „დენდროლოგია მცენარეთა გეოგრაფიის საფუძვლებით. ნაწილი II." (Dendrology with the geographical foundations of plants (Part II)). Tbilisi: Shromis Tsiteli Droshis Ordenis Sakartvelos Sasoplo-Sameurneo Institutis Gamomtsemloba. 1962*



of the whole territory, except high mountain alpine slopes, even in some places with mesophilic forests. Nowadays in Javakheti, there remain only impoverished remnants of these forests scattered in the whole territory: Tetrobi, Chobareti, Samsari, Merenia, Balkho, etc.

In Javakheti, beech-spruce forests have also survived on the border of the Borjomi-Bakuriani woodlands, above Aspindza municipality. However, approaching the Tetrobi-Chobareti area, these forests thin out. Only in the vicinity of the Borjomi-Atskuri zone and in the valleys south of the Adjara-Imereti ridge are there considerable spruce-Abies and beech groves. The rest of Meskheti-Javakheti is, however, forestless; it has xerophytic grass cover or bare slopes, and even the remaining forests are poorly diversified.

Forest belting in this district can be made out to be possible only in the northern and northwestern parts; elsewhere, the vertical belts cannot be distinguished due to the absence of forests.

1. Oak Belt: This follows the valley of the river Mtkvari in a narrow strip to the south, over about 900 to 1200 m above sea level, in this altitude you can find from here onwards: Georgian oak [*Quercus iberica*], Eastern oak [*Quercus velutina*] (in the upper part), Caucasian hornbeam [*Carpinus betulus*], Hop-hornbeam [*Ostrya virginiana*],

field maple [*Acer campestre*], common Ash [*Fraxinus exselsior*], brushwood [*Carpinus orientalis*]; common nut [*Corylus avellana*], Privet [*Ligustrum*], *Uzani* [*Viburnum lantana*], common hazel [*Euonymus vulgaris*], warted spindle [*Euonymus verrucosus*].

2. Spruce Zone: It extends from 1000 to 2000-2200 meters above sea level, and it's represented mostly by spruce-conifer-pine and oak (*Q. macruanthera F. et M*) stands. Of the deciduous species typical Ash [*Fraxinus exselsior*], silver birch [*Betula pendula*], trembling poplar [*Populus tremula*], wild pear [*Pyrus caucasica*], crabapple [*Malus orientalis*].

3. Upper Forest Zone: From 2200-2300 meters to 2400-2500 meters, and it is represented by subalpine forests, which include: high mountain maple [*Acer pseudoplatanus*], Cupressus [*Sorbus aucuparia*], standing poplar [*Salix caprea*], Sosnovsky pine [*Pinus sylvestris*], eastern oak [*Quercus velutina*], hornbeam [*Prunus padus*], Common nut [*Corylus avellana*], common reed [*Rhododendron lute*].

Most of this district is occupied by the Javakheti mountain steppes, especially in the Akhalkalaki area. They are secondary steppes caused by deforestation. Historical records testify that these currently stepped areas were rich in forestry up to the 16th century. Remains of these historic forests can still be found, existing as some separate trees and small dendrological patches on the Javakheti fields. Out of these forestries some specific species of trees were used in the construction of historical dwellings, such as *Darbazi*. Most common species in Samtskhe-Javakheti region were Spruce and Oak, combined with some smaller species such as brushwood.

Historical records

Meskheti refers to the historical region of Southwest Georgia, including the part of river Mtkvari[1] valley, neighbouring historical part of Georgia - Tao-Klarjeti[2] and Armenia, on the edge of ancient Greece. As for the term Meskhi – it signifies an ethnic representative of this area. Here the native tribes started forming unions and joint civilization from X - IX century BC, consequently going under the governance of the Iberian Kingdom [3] (Ancient Georgian Kingdom). Nowadays, the overall ethnographic background of the Meskheti region is mixed because of numerous historical events and the forced transmigration of mostly Georgian, Armenian, Turkish, Jewish and Russian people. (Makalatia, 68)

This place bears vital significance for Georgian cultural and political background, which might be justified by being the southern buffer zone with a rich exposure to various internal and external political forces, such as the Urartu kingdom, Achaemenid Empire, Ancient Greece, Arabic/Islamic kingdoms, Byzantine, Turkish, Mongolian and Russian

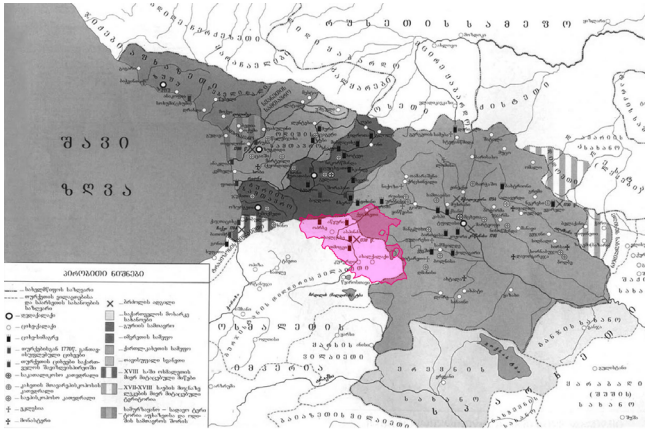


Fig. 7/ *Georgia in – 1750-1800. Highlighting the territory of historical region of Meskheti, modern Samtskhe-Javakheti region. Source: https://burusi.wordpress.com/*

1 Mtkvari (Kura) – prime waterway in Caucasian geomorphology deriving from Turkey republic, interflowing into Georgian domain and drains within Caspian Sea.

2 Tao-Klarjeti – historical region of Georgia, currently within the borders of republic of Turkey

3 Historical outlines from the books "Meskheti da Meskhebi" by Shota Lomsadze and "Meskhet-Djavakheti" by Sergi Makalatia

Empires while maintaining fidelity to the Western values. These historical events resulted in numerous casualties over the millennia, as well as socio-cultural and economic setbacks, regardless of the inevitable amount of positive cultural exchange and various influences.

In terms of value and significance, the region contains numerous examples of both - tangible and intangible heritage, including architectural and cultural assets, large part of which is nowadays located within the Turkish border. Furthermore, according to Lomsadze's findings, as mentioned before, it has been a place of ideological and cultural synthesis of Western and Eastern worlds resulting in the early humanism era rendered through social intelligence, art, literature and science in XII-XIII century Georgia.

Skipping through some historical and knowledge gaps, we can learn from Sergi Makalatia's ethnographical research in the Meskheti region (1938) about multiple typical vernacular villages and settlements with historical fortifications built in local stone with lime mortar, some others carved out within cliffs. He mentioned the dominant part of inhabitants still living in the pit houses (referred to as *Darbazi* or Modarbazuli in this thesis) during that period. This distribution has changed over time, more intensively during the Sovietisation era in the early XX century, when the new dwelling types spread over the plane villages. Thus, people fled the curvy mountains to inhabit the open plains and abandoned traditional underground dwellings for an urbanized living system.

Inception

The deep roots of *Darbazi* dwelling reach the primal Colchi huts and go even beyond, where they find and settle on the simple system of corbelled timber logs, covered in mixture of clay/mud and mulch/ hay. But if we skip through some time ahead in the I-III c. CE, the similarity between the planning of *Darbazi* and caved houses, for instance, in *Uplistsikhe* (*Fig. 8*) becomes rather evident, where the simplest form of these dwellings is represented by a *Derepani*[4] leading to the central living

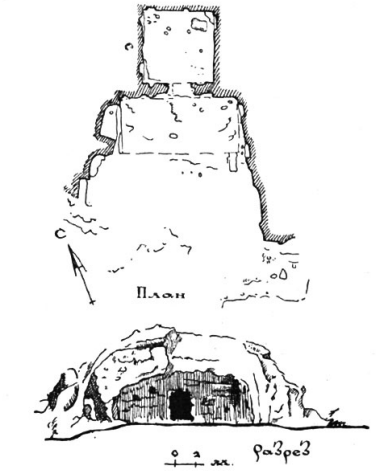


Fig. 8/ *Garakanidze, Mikheil, Views of cave dwelling in carved complex Uplistsikhe, Georgian wooden architecture. 1959*

4. Derepani – portico; hallway (see glossary)

space and culminating in a dark enclosed granary[5].

Moktseuli is an archaic prototype of the simplest quadrangular centric-crowned roofing system with a skylight opening in the middle, pillars supporting a three-levelled horizontally laid ceiling structure. Sumbadze observed Moktseuli with two, three and four-sided corbelled slopes, the latter of which appears a vital precondition for *Darbazi* dwelling classification.

A rather interesting fact is using the word *Moktseuli* for these corbelled pit houses before the adaptation of the term *Darbazi* in the XVIII century when the class difference and architectural complexity brought a necessity of demarking these notions relatively – while the first is a simple lowered roof adapted for domestic activities, the second renders an evolved stage of wooden architectural mastery and composition.

Structure

Darbazi ceiling has a signifying term – *Gvirgvini*, commonly referred to as the "Swallow Nest" by the locals due to its corbelled nature. This structure can be categorized into two types: with one displacement (singular-element) and with multiple displacements (multi-element). There are some defined rules used for obtaining structural equilibrium, such as the selection of linear and analogous geometrical elements arranged in strictly symmetrical manner. They are used in the square-shaped ceiling construction, covering the central fire of the household, which shifted into the masonry wall in later times, approximately in XIX century. The ceiling framework, depending on geographical area and environmental preconditions, rests on the set of wooden columns, prime pillar(s) and masonry walls. In some older cases, actual living trees have been used as primary load-bearing structures with the frameworks built around their trunks.[6] (Makalatia 1938, 31)

"The whole ceiling system rests on continuous transversal beams, creating a total impression of the inviolability of the load-bearing structure" – says Garakanidze (Garakanidze 1959, 68). These choices also speak for the local knowledge implying rational economic and technological solutions in the habitats. In numerous cases, the carpenter used thoroughly decorated wooden pillar as a centre of structural and visual composition, also called *Deda-bodzi*[7] (Fig. 9). This pillar inherited

5. Житница [Zhitnitsa] – granary; a storehouse for threshed grain. Garakanidze, p.68

6. Makalatia, Sergi. "მესხეთ-ჯავახეთი (ისტორიულ-ეთნოგრაფიული ნარკვევი)" ("Meskhet-Djavakheti (Historic-ethnographic essay"). Tbilisi. 1938

7. Deda-bodzi – prime pillar supporting longest load-bearing beam under the Gvirgvini dome and commonly placed near the centre of Darbazi hall. see the Glossary.

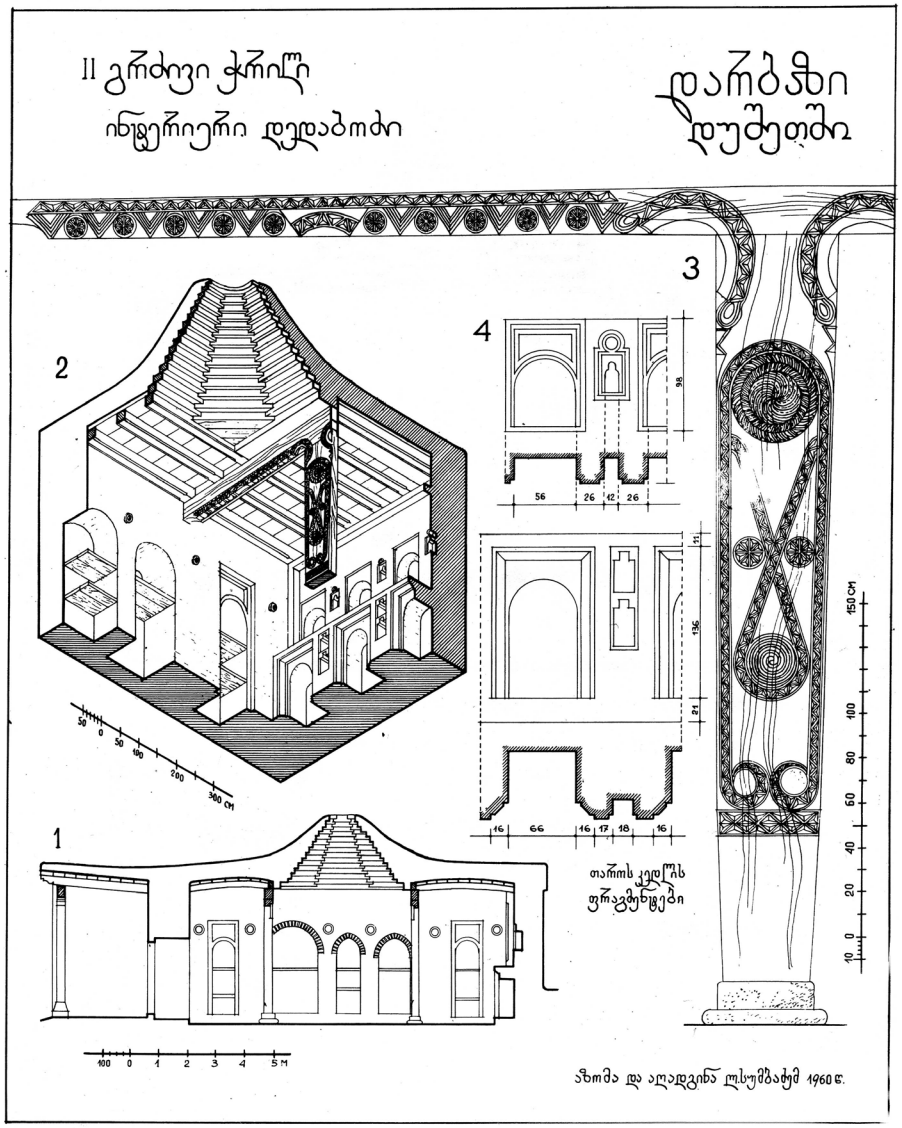


Fig. 9/ *Longinoz Sumbadze, Darbazi according to the measurements and reconstruction by L. Sumbadze, longitudinal section (1) , interior (2), Deda-bodzi with the Tavkhe beam (3), fragments of the niches (4), "The Architecture of the Georgian Folk Dwelling Darbazi", 1984.*

the symbolism of a mother figure in Georgian culture, as the bearer of immense loads and essential support of a household. With the intricate attention to symmetrical architectural rhythm, decorative elements and overall visual/spatial comprehension of the dwelling, we can declare that local masters were highly skilled in expressing the artistic character of their creations.

Technology & Planning system

Darbazi substantially is a habitat of patriarchal basis containing up to 30-40 people spread into three – to four generations. Therefore, one of main prerequisites it should meet is spatial capacity and feasibility for organic spatial growth. Enlargement of space was mostly achieved either by lengthening an entire dwelling with additional supports or by appending pillarless cells. The latter was determined by the dimensions of a primary beam (7-9 m). As a rule, there are one or two rooms destined for living spaces in *Darbazi*, mostly it is a room called *Takarebiani Oda.* It is common around subalpine and alpine meadows, where livestock farming is the primary domestic activity and a rather only mean of survival. Other essential room types mostly include the ones of the generic *Darbazi* planning system.[8]

Within the technological aspect, we observe a range of solutions based on previously mentioned reasons. For instance, local stone (mostly andesite-basalt) from boulder-rich areas and wood from conifer forests were actively employed for building *Darbazi* houses in the Samtskhe-Javakheti region. Capacity and height of quadrangular spaces in *Darbazi* was determined by the forestry specifications and resources. Therefore, shortening the height of Gvirgvini while maintaining the total height of the room was achieved by intermediate columns and consoled beams.

The technology of the roof includes covering the main structure of long-span timber logs with mulch, chaff, and hay. As for finishing elements, generally, the builders used compressed soil greased with a clay mixture on top. Voids between the beams were filled with juniper branches. The building materials vary mostly in the use of wooden species, type of stone, presence/absence of soil cover and joinery in each region of the country. In many settlements, these roofs are unified making them feasible for accessible passage. On the other hand, the roofing system in Eastern regions of Georgia has a variety of solutions, with one or two *Dedabodzi*[9] (prime pillar) paired with other horizontal and vertical supports. There are several schemes given to illustrate the **construction** of the *Gvirgvini*

8. See Technology & Planning system.

9. Dedabodzi – see the glossary.

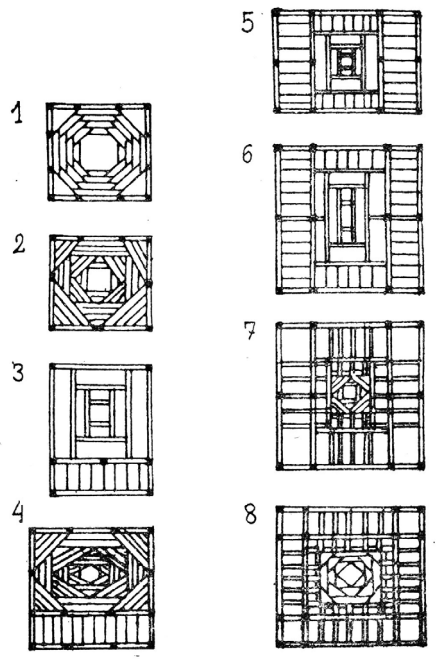


Fig. 10/ *Longinoz Sumbadze, Construction structure of Meskhetian Darbazi, "The Architecture of the Georgian Folk Dwelling Darbazi", 1984.*

system in Western Georgia.

Scheme 1 – *Darbazi* with wall-bound columns and octangular parallel or angular laid Gvirgvini.
Scheme 2 – Wall-bound columns with pentagonal-based ceiling.
Scheme 3 – Simple *Darbazi* structure elongated in one direction with a single load-bearing pair of a beam and a column;
Scheme 4 – Same structure with hexagonal-based *Gvirgvini* and two supporting columns.
Scheme 5 – *Darbazi* space consists of a simple elongated *Moktseuli* core with two pairs of beam-column supports on each side.
Scheme 6 – Same structure with consoled cross beams tapering the core unit.
Scheme 7 – *Darbazi* with two intermediate mid-column purlins and overhang beams above
Scheme 8 – Double-run *Darbazi* with overhang beams on all four wings.

Eventually, along with the evolution of lifestyle, evolved the architecture *Darbazi* dwellings – firstly, by increasing the complexity of the roofing system and shifting from quadrilateral to octagonal and at times hexadecagonal[10] arrangement of the beams, thus resulting in broader ceiling area; secondly, by expanding overall space by organically adjoining more spaces around primary hall and finally, by introducing the embedded furniture. Moreover, we can meet additional rooms in *Darbazi* complex, such as *Satone* chamber for baking bread, *Sabdzeli* - storage space for livestock feed, *Boseli* (also named *Akhori*[11]), which was destined for cattle and a living/nesting space near it - *Boslis-oda* (also named *Takarebiani-oda*[12]), mostly having corbelling ceiling structure only from two parallel sides, covered by slated plane, leaving one narrow skylight.

An entrance point called *Karapani*[13] took rather important role in the whole *Darbazi* ensemble, as a welcoming gesture and prototype for all other formations of porticos and balconies in vernacular Georgian architecture embodied in various shapes and materials (Garakanidze 1959, 73).

10 Octagonal and hexadecagonal – respectively eight and sixteen sided polygons

Climate and environment

The architectural system of *Darbazi* in every region of Georgia has accumulated deep knowledge and apprehension of environmental and climatic conditions, building material specificities and social needs.

Speaking of natural conditions, Sumbadze has discussed some form-giving factors of these housings. For example, how arid continental climate with moderately cold winter and moderately hot summer paired with terrain peculiarities and foothill slopes shaped the *Darbazi* habitat with fire in the centre, covered with rather plane rooftops and blending in with the environment.

A common characteristic of *Darbazi* is its deep penetration of the ground, consequently maintaining stable temperatures in summer and winter without energy losses. However, due to the rough climate and at times insufficient thermal resources, inhabitants of the Meskheti–Javakheti region utilized livestock body temperature by keeping their stall enclosed within the housing assembly.

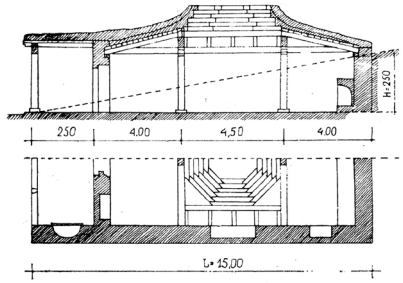


Fig. 11/ *Longinoz Sumbadze, Darbazi with four-slated roof. Maximum slope of the terrain, "The Architecture of the Georgian Folk Dwelling Darbazi", 1984.*

Ventilation here is achieved with a skylight opening and main door. The opening itself has relative dimensions to the total area of space

11. Akhori – same as Boseli – stall for cattle. see Glossary

12. Takarebiani-oda – A type of corbelled roofed space. see glossary.

13. Karapani – portico; a shed at the entrance of the house. see glossary.

with a 1:100 ratio, providing sufficient airflow and lighting for the whole dwelling. Additionally, in certain *Darbazi* housings cellars with drinking water were used – the shafts accumulated the overall temperature and vented internal space.

The settlements were commonly used only on the mountain slopes directed towards the sun, mostly with a 45-degree slope or more, as a precondition for shelter from enemies. In the Meskheti region, more extreme measures had to be adopted in form of pitting habitats primarily underground.

The slope of the soil itself, which covered the dwelling, had certain proportions, according to environmental conditions, varying from the ratio of **H/L= 1/6** (maximum height of 2.5 m.) to **H/L= 1/4** (max. height of 3.75 m), as usual. With this arrangement, the rooftop of the lower dwelling served as a terrace for the upper one, merging them into one composition.

Hearth (*Kera*[14]), as a source of warmth and light, is a prime formgiver of *Darbazi* dwelling. Sumbadze mentions the myth of Prometheus (Amirani in Georgian mythology) to emphasize the footprint of the primitive survival mode of an early human being on its own living space.

While having all the panoramic ambience of a hearth, the issue of its smoke residue has been neutralized in *Darbazi* housing, with a special structural arrangement of the ceiling oriented on the smoke exhaust. The core includes a pair of wooden wall plates laid on frontal and rear walls, with another pair laid transversally above, represented as a base, two

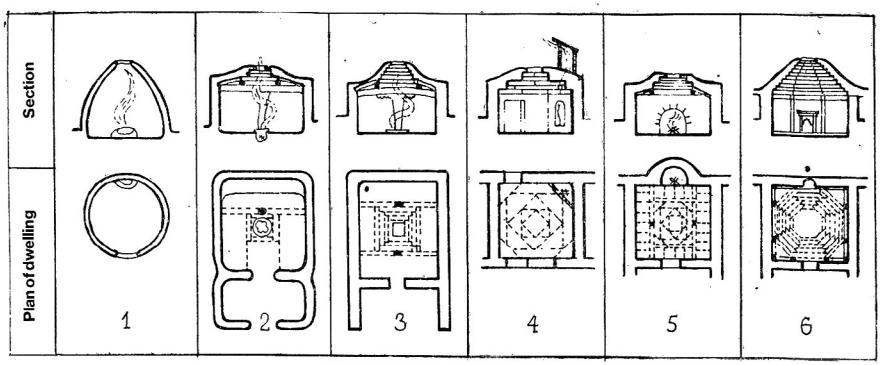


Fig. 12/ *Longinoz Sumbadze, Evolution of Hearth within Darbazi dwelling, "The Architecture of the Georgian Folk Dwelling Darbazi", 1984.*

14. Kera – term signifying Hearth in Georgian. See glossary.

transversal load-bearing beams named *Tavkhe*[15]*, covered with a set of rafters,* and, finally, a pair of longitudinal beams with another set of rafters laid above. The progressive layering of rafters, placed perpendicularly to the walls, results in a slight slope enduring rainwater leak, while ensuring the smoke flows from the periphery to the central skylight. To increase the slope, at times hogged loadbearing beam was inserted into the structure. These practical solutions – roof slope, transfer of precipitation and smoke - became interwoven into the structural DNA of *Darbazi*.

The evolution of a hearth in *Darbazi* was depicted as a scheme by Sumbadze and it shows the dominance of centroidal planning in every development stage, regardless of fireplace shift. (Fig. 12)

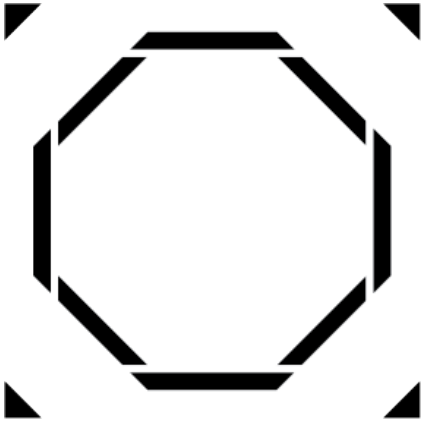
Another solution for keeping constant thermal comfort within a habitat, rendered to be putting it halfway through the ground, where average soil temperature (measured 2 m below ground level) in summer could lower down to 17-18 degrees, while during winter it warmed up to approximately 11-12 degrees. Generally, temperature difference below the 2-meter threshold gets rather insignificant, therefore, keeping the dwelling spaces in the 2-2.5-meter height range appeared rational for local builders.

This solution also rendered *Darbazi* as a **shelter**, a refuge mostly from Southern enemies. Historically, the region of Meskheti–Javakheti has been subjected to numerous attacks and raids, locals left dispossessed of their families and belongings. Thus, people adjusted their habitat to external threats by minimizing the number of openings, keeping the façade as subtle as possible and, most importantly, by keeping an underground secret hideout also called *Darani*[16].

In this way, common enemy united people not only inside the dwelling but from the outside too – plain facades laid in a terraced manner and submerged organically into the hills served as a dire strategy for disguising the village appearance and shield it from outsiders.

15. Tavkhe – Load bearing central beam under Gvirgvini structure. See glossary

16 . Darani - a type of defensive underground settlement. See glossary



Bibliographical odyssey
(State of Art)

Georgian wooden architecture

Mikheil Garakanidze

The development of documented knowledge about Georgian building culture started in the ancient era, with Vitruvius, Xenophon, Hippocrates, Apollonius of Rhodes, Arrian of Nicomedia[1] portraying the civilization dwelling by the Black Sea.

Vitruvius has briefly described the habitats integrated with fortifications built by native tribes in one of his books[2], built in a fashion of layering the timber logs on top of each other, progressively shrinking towards the top. These structures represent the rudiments of subsequently developed dwelling types of *Darbazi*[3], *Djargvali*[4] and *Patskha*. Moreover, in the 1st century AD, a Greek geographer Strabo[5] left behind some writings about the rich forestry of *Colchida* and the city housings with wooden roofs and tiled coverings developed in a proper architectural manner.

One of the vital books about timber construction "Georgian wooden architecture"[6], where the author provides us with the most relevant cases containing a wide spectrum of historical data and folk literature, fortified with richness of graphical materials. In this work, he mainly stresses on various dwelling types and their arrangements within the villages, as well as introducing several examples of cult architecture. Equally valuable part is the overview of Georgian craftsmanship along with its technological guidelines, native tools and masters of wood construction.

The author initiates the narrative with archaeological evidence of neolithic and bronze age habitats, burials and construction tools, gradually moving to the antic period, where the architectural findings of Bagineti[7] resemble the widely spread national dwelling type - *Oda*[8].

Georgian historical literature started generating from the 5th-century rendering via various genres, such as hagiography, folk poetry, historic texts, etc. Meanwhile, there have been manifold gaps in architectural developments in the country, as well as complications in fostering built heritage and documented knowledge, due to various political reasons. Regardless, the author discusses numerous wonderful examples of artefacts, the majority of which are embodied in surviving monumental architecture and have been constructed with masonry materials, nonetheless, there were other non-surviving pieces erected in timber, such as castles, dwellings, complex supporting timber constructions, etc., evidence of which we mostly owe to the archaeological excavations. It is worth mentioning that the craftsmanship level of most of these pieces, belonging not only to the ancient era but also the Middle Ages, is quite competitive to their contemporary peers and has placed Georgia on a global architectural map centuries ago.

Moreover, in the book, we find the documentation by Vakhushti Bagrationi[9] of Lazi craftsmen - the masters of timber construction in Western regions of the country. Further contributions to historic data were made by other Georgian public figures like David Guramishvili, Sulkhan-Saba Orbeliani, etc. Caucasus was also an exotic destination for some foreign geographers and historians like Teramo Cristoforo Castelli

1. Arrian of Nicomedia - a Greek historian

2. Vitruvius. The Ten Books on Architecture. Translated by Morris Hicky Morgan. Cambridge: Harvard University Press, 1914. Book II, Chapter 1, Section 4.

3. Darbazi - type of Georgian dwelling with wooden corbelled roof. See Glossary

4. Djargvali and Patskha - primitive types of dwelling in Western Georgia. See Glossary

5. Strabo. The Geography of Strabo. Translated by Horace Leonard Jones. 8 vols. Loeb Classical Library. Cambridge, MA: Harvard University Press; London: William Heinemann Ltd., 1917-1932.

6 . Garakanidze, Mikheil. "საქართველოს ხით ხუროთმოძღვრება" (Georgian wooden architecture). Tbilisi: Khelovneba; Sabchota Sakartvelo. 1959

7. Bagineti - same as Armaztsikhe. the first capital of Kartli region.

8 Oda - ancient type of Georgian dwelling constructed in wood material, widely spread in Western Georgia

9 Vakhushti was a Georgian royal prince, geographer, historian and cartographer of XVII c.

(1626), Arcangelo Lamberti[10] (1633), Jean Chardin[11] (1672), Frédéric DuBois de Montperreux (1798) et others.

According to Garakanidze, from the 18th century, the close relations with the Russian empire resulted in positive influences on wooden mastery of Georgian architecture, which resulted in adaptive transformations of this knowledge in every region of the country. He brings up the example of Ivan Pantukhev[12] documenting the traditional wooden dwellings, emphasising their coherence with climatic and sustainability requirements in western regions of Georgia.

Following the timeline of knowledge progression, we come across essential monographs by Ivane Javakhishvili[13] describing the history and present of building culture in Georgia. His writings and findings contributed massively to the upcoming explorations of national history.

The 20th century had a rather positive aftermath in documenting Georgian vernacular architecture and ethnographic diversity, mostly with the help of native and Russian scholars, who were assigned to travel around the country to study, record and portray various local dwelling systems and lifestyles. The author has discussed the critical research made by Giorgi Chubinashvili[14] and Nikolay Severove[15] on the topic of *Darbazi*-type houses, influencing fellow researchers Longinoz Sumbadze[16] and Ruben Aghabayan[17], who left significant writings and illustrated surveys carried out in the mid-Soviet times. "A thousand-year tradition existing behind these simple dwellings, presented in this publication, provides a broad foundation for the development of some initial forms, the basic elements of monumental architecture". (Chubinashvili 1927, 3)

10. Arcangelo Lamberti. Relatione della Colchide hoggi detta Mengrellia, nella quale si tratta dell'Origine, Costumi e Cose naturali di quei Paesi. Also - "Colchide sacra"

11. Jean Chardin. Journal du voyage du Chevalier Chardin en Perse.

12. Pantukhev, Ivan. "О пещерных и позднейших жилищах на Кавказе" (About cave and later dwellings in the Caucasus). 1896

13. Ivane Javakhishvili. მასალები ქართველი ერის მატერიალური კულტურის ისტორიისათვის: მშენებლობის ხელოვნება ძველ საქართველოში (Materials for the history of the material culture of the Georgian nation: Art of construction in ancient Georgia). 1946

14. Chubinashvili, Giorgi - was a Georgian art historian, pioneers in the institutionalized and documented studies of Darbazi dwellings in Caucasus region.

15. Severove, Nikolay - Georgian Soviet architect, documented numerous examples of Darbazi structures across Georgia.

16. Sumbadze, Longinoz - Georgian architect and researcher of Darbazi folk dwellings.

17. Aghababyan, Ruben - Armenian architect and researcher of Darbazi structures in Georgia and Armenia.

Architecture of Georgian Folk Dwelling Darbazi

Longinoz Sumbadze

The primary source for this research is a rich monograph[18] containing thorough research of *Darbazi*-type housings all around Georgia and beyond. The author Sumbadze, who has dedicated numerous years of studies to grasping and sharply illustrating national heritage, introduces the book with seven chapters, initiating the discourse from the general structural arrangement of dwelling and roofing particularly, to the point of implying similar examples from Caucasus, Eastern Europe, India, etc. He also discusses the birth and sustaining conditions of these corbelled structures, as well as their role in contemporary Georgian architecture.

There were some vital references for concluding his research, some of which are aforementioned works of Giorgi Chubinashvili and Ruben Aghababyan, also Friedrich Baumhauer[19], Mikhail Andreyev[20], Giorgi Lezhava, M. Jandieri, T. Tchikovani, et others. The planimetric survey starting in 1938 just for one dwelling in Samtskhe-Javakheti, transformed into a systematic series of inspections of *Darbazi*-like structures and had various outputs in publications, for instance, the cornerstone of Sumbadze's works - "Colchis dwelling on Vitruvius"[21].

His research about vernacular wooden architecture transcending the borders of this region incorporates parallels from works from fellow scholars from Tajikistan, Romania and Ukraine. The author also mentions the influence of studying the systemic analysis methodology for Russian crowned wooden pieces on establishing the framework to unfold Georgian corbelled structures.

All in all, the author has contributed massively to the knowledge development himself, via collecting handful of on-site surveys and detailed measurements of *Darbazi*-type housings in South Caucasus, with pioneering analysis through various structural, technological and geometrical scopes. This decomposition of vernacular scholarship appeared to be quite influential and unique in further studies and creation of Georgian architecture.

18. Sumbadze, Longinoz. Архитектура Грузинского народного жилища Дарбази [The Architecture of the Georgian Folk Dwelling Darbazi]. Tbilisi: Metsniereba, 1984.

19. Baumhauer, Friedrich. Forschungen über die Hausformen in Georgien. 1928

20. Mikhail Stepanovich Andreyev was a Russian-Uzbek and Soviet orientalist, cultural researcher of Central Asia, ethnographer, linguist, and archaeologist.

21. "Colchis dwelling on Vitruvius". Akademii Nauk GSSR. 1960.

Architecture of Georgian Folk Dwelling

Ruben Aghababyan

Another monograph[22] we need to explore within the *Darbazi* context is the assembly of previous studies of Ruben Aghababyan. Here he focuses primarily on the influence of centric-dome early residential and more specifically *Darbazi*-type structures on monumental architecture of Georgia and Caucasus civilizations, initiated from the neolithic period approximately 16 000 BCE. We can share his theory, that monumental structures don't seem to have direct prototypes/archetypes and they must have been built in wooden materials in early historic periods.

The author applies the same well-known examples of Georgian early history and mythology as L. Sumbadze and others in their works, informing us about the development of intelligence on the Black Sea coastline and beyond. According to his Assyrian sources, once during XI-VIII BC, there was a prosperous kingdom in the Meskhetian area. As we follow the observations of the author on this discourse about *Darbazi* origins, we see the transformation of a primitive hut with an entire framework into a more sophisticated separate roofing structure.

In the book, Aghababyan stresses various notable factors of Georgian building manners, such as consideration of sanitation norms, ventilation, thermal comfort, etc; Not to mention the fidelity to general rules of structural arrangement and economically effective local materials, incorporation of anti-seismic, insolation-wise and other technological measures in residential architecture, more profoundly in *Darbazi* housings. We observe similar default discussions about spatial extents, ratios and other characteristics, as seen in the works of his fellow researchers. But here, additionally, we are provided with separate discourse about the portico (balcony space), as an influential architectural element upon other types of Georgian national architecture, especially the aesthetics of traditional housings in the capital - Tbilisi.

The author hereby provides insights about *Darbazi* dwelling with the help of Alexander Negri's scriptures describing one example from a mere structural and technological point of view. Later, he briefly discusses S. Lisitsian's work[23] about Armenian vernacular corbelled dwellings, which provides an insightful parallel to Georgian examples. Moreover, he discovers some structural similarities to Indigenous American dwellings[24] and some local architecture in Hindukush[25]. As for the references in the planning system, he mentions the Greek Megaron[26] with the rectangular adjoining / interflowing spaces, starting from column-stacked porticos and arrangement choices of primary supports around the core opening in the central space. As Aghababyan stresses, some of these motives are adapted later by numerous assets of monumental architecture in Georgia and Armenia.

Meskheti-Javakheti

Sergi Makalatia

Some other authors provide supplementary materials and notes to the general research of *Darbazi* dwelling. For instance, in Sergi Makalatia's on-site ethnographical research[27], later published in 1938, covers vast range of observations, including historical author described multiple typical vernacular villages and settlements with historical fortifications, some of those carved out within steep cliffs. He mentions *Darbazi*-type pit-houses as primary habitat of that time. In the book we mostly encounter ethnic and ethic aspect of this region, descriptions of movable and intangible heritage, representing local rituals, as well as day-to-day life.

Meskheti da Meskhebi

Shota Lomsadze

Shota Lomsadze in his work[28] provides a myriad of historical events in the Meskheti region, entangled with multiple internal and external political forces. While the work covers essentially the factual chain of Georgian history, he still manages to discuss and assess the socio-cultural aspects. For instance, he stresses that the Meskheti region has been a place of ideological and cultural synthesis of Western and Eastern worlds, and a birthplace for early humanism gaining expression through various aspects like social intelligence, art, literature and science in XII-XIII century AC.

22. *Agababyan, Ruben. Архитектура грузинского народного жилища [Architecture of Georgian Folk Dwelling]. Tbilisi: S.M. Kirov Georgian Industrial Institute Scientific Technical Publishing, 1945.*

23. *Listsian, Stepan. "К изучению армянских крестьянских жилищ (Карабахский карадам)" [Towards the studies of Armenian vernacular dwelling], Moscow : Kavkazskii etnograficheskii sbornik. , 1955*

24. *Houses and House-life of the American Aborigines by Lewis Henry Morgan*

25. *Chitral – a town in Hindu kush mountains, Pakistan*

26. *Megaron - in ancient Greece and the Middle East, architectural form consisting of an open porch, a vestibule, and a large hall with a central hearth and a throne*

27. *Makalatia, Sergi. მესხეთ-ჯავახეთი (ისტორიულ-ეთნოგრაფიული ნარკვევი) [Meskhet-Djavakheti (Historic-Ethnographic Essay)]. Tbilisi, 1938.*

28. *Lomsadze, Shota. მესხები და მესხეთი [Meskhians and Meskheti]. Tbilisi: Ghia Sazogadoeba - Sakartvelo, 2000.*

Even though most of Makalatia's monograph does not directly depict Meskhetian building culture, it's of high importance for comprehending local civilised society and its values. As much as Lomsadze's work is beneficial for understanding and appreciating the long-term journey of the country, trying to regain and/or maintain its cultural heritage.

XVI-XVIII Century Georgian architecture

Vakhtang Beridze

The book[29] discusses the ongoing architectural and construction processes during the XVI-XVIII century period of Georgian kingdoms, despite harsh political and social background, including civil and religious architecture. The author provides us with a table of built structures with construction dates and general information. The main characteristics of this period included a more stable political environment, which gave way to rehabilitation/reconstruction processes and construction of new structures of high priority, such as fortifications, division of nobility houses and adaptation of urban distribution to them. However, the aesthetic aspect of architecture in this era wasn't subject to a change, Beridze mentions (Beridze, 15), as it mostly remained in a feudal framework.

Beridze also talks about the organization of construction processes, its funding methods, and more specifically, how only the critical projects had the privilege of having drawings and preparatory materials, and that regular civic architecture was commonly built informally, with "experience" and verbal scholarship.

Farmer's dwelling

Beridze classifies Georgian dwelling types into three main categories: ones from East and South Georgian plains; ones from Western Georgia (except Svaneti and Racha); ones from the Caucasus Mountain range; (Beridze, 262)

The author stresses that, according to the archaeological discoveries, the roots of southern *Darbazi* dwellings might have dated back to V-IV millennia. As the primary advantage of these housings, as Beridze tells us, we might consider their arrangement and planning structure, which can be flexible and shapeshifting.

The differences between Kartlian and Meskhian *Darbazi* were initially noted by Giorgi Chitaia[30] in 1926. Kartlian *Darbazi* dwelling has the following characteristics: a) Gvirgvini ceiling covers only the central part of the house, not the entire space; b) the hearth in the centre underneath Gvirgvini; c) The mother-pillars *Dedabodzi*, which have tapered shape towards capital part, play a crucial part in construction and aesthetic aspects of dwellings. The combination of supporting pillars, which represent the integrity of the patriarchal family structure and can define the dwelling's aesthetic value, also varies within Kartlian *Darbazi*, but generally they don't exceed four pieces.

The author has taken some dwelling examples to compare their artistic and architectonic aspects, concluding that *Darbazi*-type housings can have multiple interesting variations.

Meskhetian *Darbazi* shares some critical similarities with its peers in Kartli but differs in spatial organization with larger cattle stalls, the absence of *Dedabodzi* and a simpler structure of the Gvirgvini ceiling.

From Hearths to Volcanoes: The Armenian Glkhatun

Guillaume Othenin-Girard

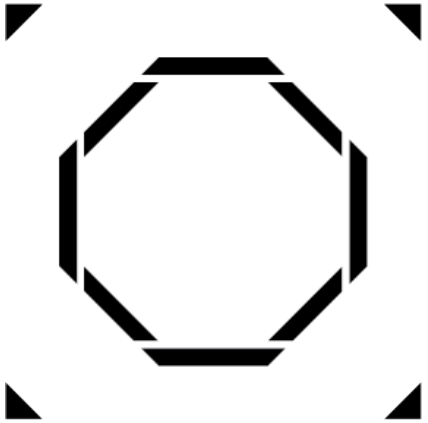
In this article[31], describing pithouse dwellings with corbelled roofing systems of Armenia called Glkhatun, author focuses on mythological roots and ties in his research, relying primarily on Armenian terminology and preconception that most settlements with these housings were inhabited by Armenian communities. While admitting the vagueness of categorisation within the vernacular architecture, he still aims to bridge some informational gaps with the provision of a survey in central Armenia among families inhabiting glkhatner.

The paper profoundly describes multiple physical and social facets of the dwelling, the historical/mythological motives and environmental conditions behind its building manner, as well as illustrating them through verbal and graphical modes. Despite its shortness in word count, the paper can give a comprehensive insight into a Glkhatun (*Darbazi*) construction style.

29. Beridze, Vakhtang. XVI-XVIII საუკუნეების ქართული ხუროთმოძღვრება [XVI-XVIII Century Georgian Architecture]. Tbilisi: Khelovneba, 1983.

30. Chitaia, Giorgi – Georgian professor and distinguished researcher of Georgian vernacular architecture.

31. Guillaume Othenin-Girard. "From Hearths to Volcanoes: the Armenian glkhatun." Drawing Matter Journal 1: The Geological Imagination. 2023



Chapter I
Exploring the essence of Darbazi.

The development timeline of Darbazi dwellings

We can identify several steps of development of *Darbazi* housings along with the evolution of Gvirgvini ceiling structures.

Some authors suggest that the ancestors of modern *Darbazi* might be ancient dwelling types of *Shulaveri* civilisation with dome roofs and circular planning (Sumbadze 1984, 175-189), and predecessors of ***Kvatskhela***[1] houses, incorporating the main typical assets of *Darbazi* - a central hearth with concordant centric planning, primary pillar and roofing structure ***Moktseuli***. (Jabua 2018, 40) *Moktseuli and* ***Darbazuli*** (*fig. 2.1.1*) are relict prototypes of corbelled roofing that integrate four main pillars supporting three rows of horizontally and transversally overlaid timber beams.

"The existence of a simpler form of *Moktseuli* in the *Kvatxelebi* dwelling cover seems inarguable to us. It is from here—with the primitive *Moktseuli* ('a roof that narrows')—that the development of the crowned *Darbazi* wooden dome begins, evolving over millennia to the unique dodecagonal Gvirgvini in the Karagadji village, assembled from 452 beams." (Sumbadze [1984], [189], translated by Gvantsa Tskipurishvili)

The initial simple choice for roofing is executed in two slopes, evolving into three and four-sloped structures, the principles of which are derived from ancient **Colchi** huts in Western Georgia. They date back to III millennia BC, living within this "primitive" framework until the early Iron Age. In the meantime, another branch of wooden dwellings developed in the Eastern part of the country (Fig. 14). The evolution of lifestyle and household growth demanded the planar expansion of housings, resulting in additional chambers and increasing the span of the wooden framework. These preconditions stimulated aesthetic explorations within corbelling structures. (Jabua 2018, 42)

The first illustrated and published examples of dwelling with *Moktseuli* roofing were in Shuapkho[2] village by Sergi Makalatia[3]. In this depiction of *Darbazi*, we observe two tapered pillars under the main skylight supporting most of the upper structure. The Planning composition resembles the Greek Megaron[4] with a frontal portico and enclosed primary space.

According to Sumbadze, this kind of corbelled ceiling with a skylight is enough precondition to classify a dwelling as *Darbazi*. As historical evidence indicates, this habitat was widely spread throughout the whole country by the end of the XVII century, varying through the complexity of planning and the roofing system. A less developed version of *Darbazi*, which was mostly built with quadrangular and octangular bases in the Meskheti region, was called *Modarbazuli*, while its richer analogue in the Kartli and Kakheti districts had complex woodworking structures with variable octangular and at times dodecagonal shapes.

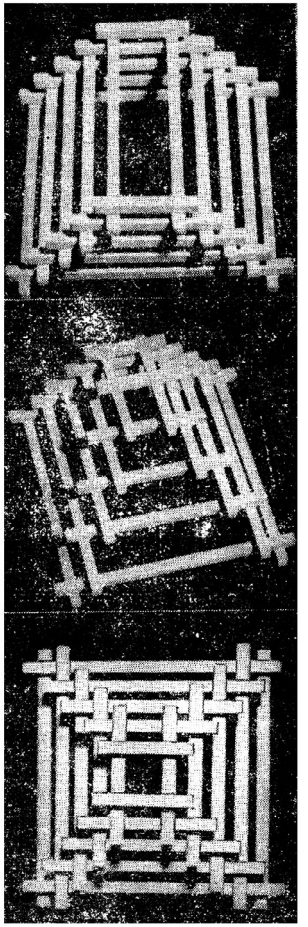


Fig. 13/ *Longinoz Sumbadze, Moktseuli structure types. Reconstruction, "The Architecture of the Georgian Folk Dwelling Darbazi", 1984*

1. archaeological site of Kvatskhela in the Shida Kartli region, considered an exemplary monument of the Kura-Araxes culture. The site features two burial grounds: one located directly on the former settlement's territory, known as the Kvatskhela cemetery, and another nearby, referred to as the Tvlepia Spring cemetery. These findings highlight the significance of the area in understanding the early cultural and social practices of the region. Source: https://memkvidreoba.gov.ge/objects/immovable/immovableObject?id=20232

2. Shuapkho – a village in the Mtskheta-Mtianeti region, Georgia

3. Makalatia, Sergi. "ფშავი" (Pshavi), Tbilisi: Nakaduli. 1985. 109

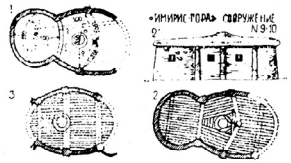
4. Megaron, in ancient Greece and the Middle East, architectural form consisting of an open porch, a vestibule, and a large hall with a central hearth and a throne. Source: https://www.britannica.com/

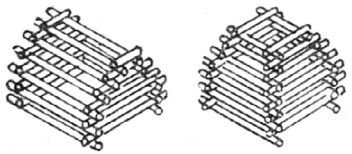
Fig. 14/ *Historical timeline of Darbazi evolution*

W - SW

V- IV Millennia BC

Shulaveri civilisation. centric domic structures with vertical axis of symmetry and central skylight



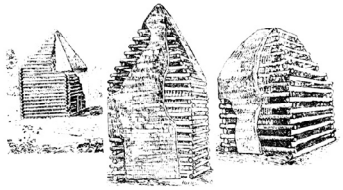


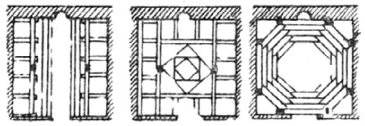
III Millennia BC

Colchida civilisation. Djargvali huts with simple superimposition

II-I Millennia BC

Colchida civilisation. Corbelled roofing structures with central skylight





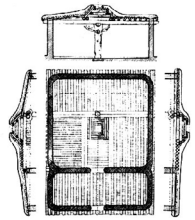
Middle ages to XX c.

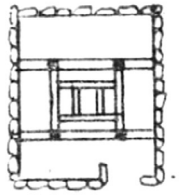
Takarebiani Oda, Modarbazuli and Darbazi dwellings in Southern Georgia Samtskhe-Javakheti

E - SE

Beginning of the III Millennia BC

Mtkvari-Araxes civilisation. quadrangular structures with timber framework, enlarged interior space



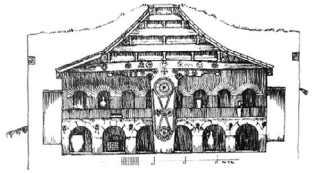


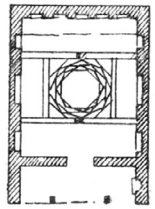
Early middle ages from VI c.

Medieval dwelling type from Bolnisi in South-East Georgia.

Late middle ages to XX c.

A simple type of "Moktseuli" crowned ceiling in Eastern Georgia - Kartli and Kakheti regions





XVII-XX c.

Darbazi with evolved type of Gvirgvini crowned system in Eastern Georgia - Kartli and Kakheti regions

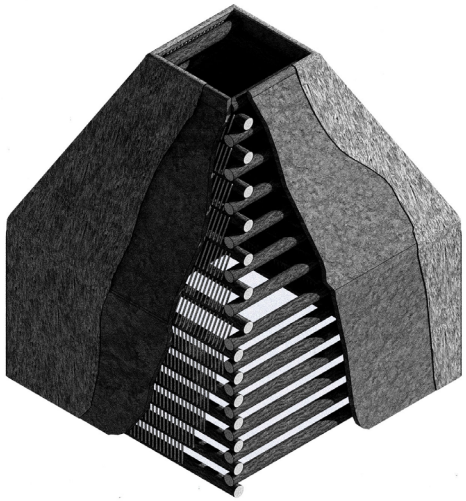


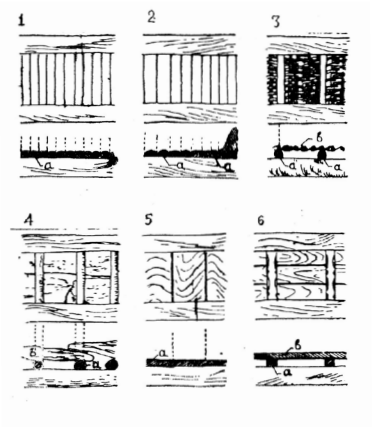
Fig. 15/ *Isometric reconstruction of Colchi hut showing the assemblage*

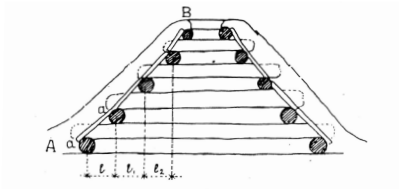
From the technological point of view, *Darbazi* with all its attributes can be interpreted as rather simple assemblage, but variations of *Gvirgvini* dome or *Moktseuli* ceiling arrangement, with the combination of framework choices, could render some structural intersections or elements quite complex. Vitruvius has described the early principle of Gvirgvini dome build-up in his book millennia ago. (Fig. 15)

> "Among the Colchians in Pontus, where there are forests in plenty, they lay down entire trees flat on the ground to the right and the left, leaving between them a space to suit the length of the trees, and then place above these another pair of trees, resting on the ends of the former and at right angles with them. These four trees enclose the space for the dwelling. Then upon these they place sticks of timber, one after the other on the four sides, crossing each other at the angles, and so, proceeding with their walls of trees laid perpendicularly above the lowest, they build up high towers. The interstices, which are left on account of the thickness of the building material, are stopped up with chips and mud. As for the roofs, by cutting away the ends of the crossbeams and making them converge gradually as they lay them across, they bring them up to the top from the four sides in the shape of a pyramid. They cover it with leaves and mud, and thus construct the roofs of their towers in a rude form of the "tortoise" style."[5]

Majority of these corbelled structures, that survived to this day, employ wooden logs as primary load-bearing elements. The reasons for these have already been discussed above – common people were in need for fast and cost-effective solutions within the times of annexation and poverty. However, these obstacles did not stop technological development of *Darbazi* dwellings.

For instance, the task of covering larger spaces, elevates the ratio between span and beam diameter, therefore some of these structures





▲ **Fig. 16/** *Longinoz Sumbadze, Way of constructing quadrangular Gvirgvini of parallel setting, "The Architecture of the Georgian Folk Dwelling Darbazi", 1984.*

◀ **Fig. 17/** *Longinoz Sumbadze, Gap infill variations within quadrangular Gvirgvini of parallel setting, "The Architecture of the Georgian Folk Dwelling Darbazi", 1984*

can cover spans of 8x8 meters. The principle of span-beam ratio includes the upper beams of *Gvirgvini*, meaning that, their diameter shrinks gradually until reaching the skylight. This principle of gradual adjustment of beam geometry facilitates structural equilibrium of the whole crown, meaning that lighter elements are positioned on top, transferring the loads to heavier elements below. This arrangement of cross-laid beams has its principle (Fig. 16) of even distribution guaranteeing a vertical-horizontal chain of stress-flow within pre-loaded wooden structure[6].

5 Vitruvius: The Ten Books on Architecture. Vitruvius. Morris Hicky Morgan. Cambridge: Harvard University Press. London: Humphrey Milford. Oxford University Press. 1914.

6 The crown structure is generally covered with the massive layer of soil from top.

Once laid, the roofing system of *Gvirgvini* is tightened with wooden pins or juniper branches, greased with hay-mixed clay and covered with mass of compacted soil, thickness of which arrives at 50-70 centimetres.

Types of construction

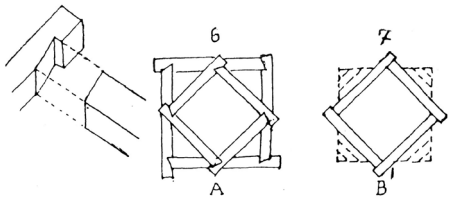


Fig. 18/ *Longinoz Sumbadze, Joinery methods within quadrangular crown, "The Architecture of the Georgian Folk Dwelling Darbazi", 1984*

The construction sequence within *Gvirgvini* structure varies and generally depends on the number of facets. The simplest build-up example of **quadrangular crown of parallel setting** includes jointless layover of the wooden logs or lumber beams on top of each other. Within this arrangement two parallel sets of beams, which are laid strictly on the quadrangular framework basis, form the gaps between the rows, consequently creating the need for infill, types of which has been depicted by Sumbadze (Fig. 17). In Meskheti region, this gap is called *Sarke* signifying mirror. Commonly, people were using one or two layers of materials for covering the structural gap – combination of simple wooden bars, branches, slate stones and/or interwined wicker technique technique.

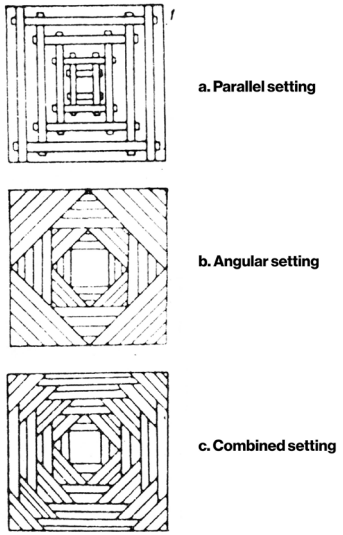


Fig. 19/ *Some main typologies of Gvirgvini forms according to Longinoz Sumbadze, "The Architecture of the Georgian Folk Dwelling Darbazi", 1984*

Another simple, yet more holistic layout of roofing is **quadrangular** *Gvirgvini* **of angular setting**, where every second horizontal element is placed in angular fashion with respect to lower beam. This arrangement does not leave any gaps and tolerates deviations from the quadrangular framework base, but instead has limitations of construction height. Within this layout we meet a few types of joinery (Fig. 18), depending on the vertical position of beams, if they share the same horizontal plane, a simple interconnection

is formed. However, limited wooden resources sometimes led to modifications, and Sumbadze stresses that not every peasant could deploy mathematical equations for structural optimisation – common people built predominantly on empirical basis.

A blend of previous roof making techniques results in **combined setting** *Gvirgvini*. (Fig. 19, C) This arrangement can be agile, especially within lower rows the octangular ring beams, probably due to the primary objective of utilising short structural elements and optimising the cover sequence. As we can see, the distance between adjacent beams is gradually shrinking towards the top, generating a spectre of roofing solutions. Playing with these intermediate facets and axes can result in two different *Gvirgvini* structures, examples of which can be mostly found in Meskheti region. Nevertheless, the average dimensions of covered space and beam elements remain within same range across the built structures.

Upper level of technological sophistication in *Darbazi* is embodied within **octangular crown of parallel setting**, (Fig. 20) according to Sumbadze's classification. However, the geometry shows equal similarities of this arrangement to both - angular and parallel setting. Two main ways of Gvirgvini construction have been explored within the book: Kartlian and Meskhetian methods (named accordingly to the distribution zones). "The beams always have quadrangular cross-section and are thoroughly hewn within both roofing types." (Sumbadze [1984], [46], translated by Gvantsa Tskipurishvili)

Kartlian method of erecting crown structure implies beam attachment with *Naotkhali* meaning quarter notch, which is similar to tabled scarf joint. (Fig. 20) Here, horizontally adjacent wooden members are intertwined on half level of the another, serving the equal structural purpose and forming an continuous vertical chain. Visual lightness exuding from this structure fascinates the observant, methodology of which derived from the need for aesthetic and cultural shift/evolution, the author says.

Instead, **Meskhetian** technique utilizes beam layover without vertical notches. (Fig. 20) The horizontal ring is formed with the help of simple joinery along the total length of a beam and fixed by wooden pins in the ends. Remaining voids are filled with the baulk boards, which might be tilted, thus giving various lighting effects after final construction.

The principal difference between these two methods is the incentive of slope – whereas in Kartlian *Darbazi* this reference line depends on beam section ratio itself, in Meskhetian structures this slope is measured with double height of a beam respectively to its singular width. Regardless of these differences, the scholar noticed some inconsistencies within the theoretical construction principles and depicted through the scheme. (Fig. 22) We can see the shift of the lowest angular beams towards the center.

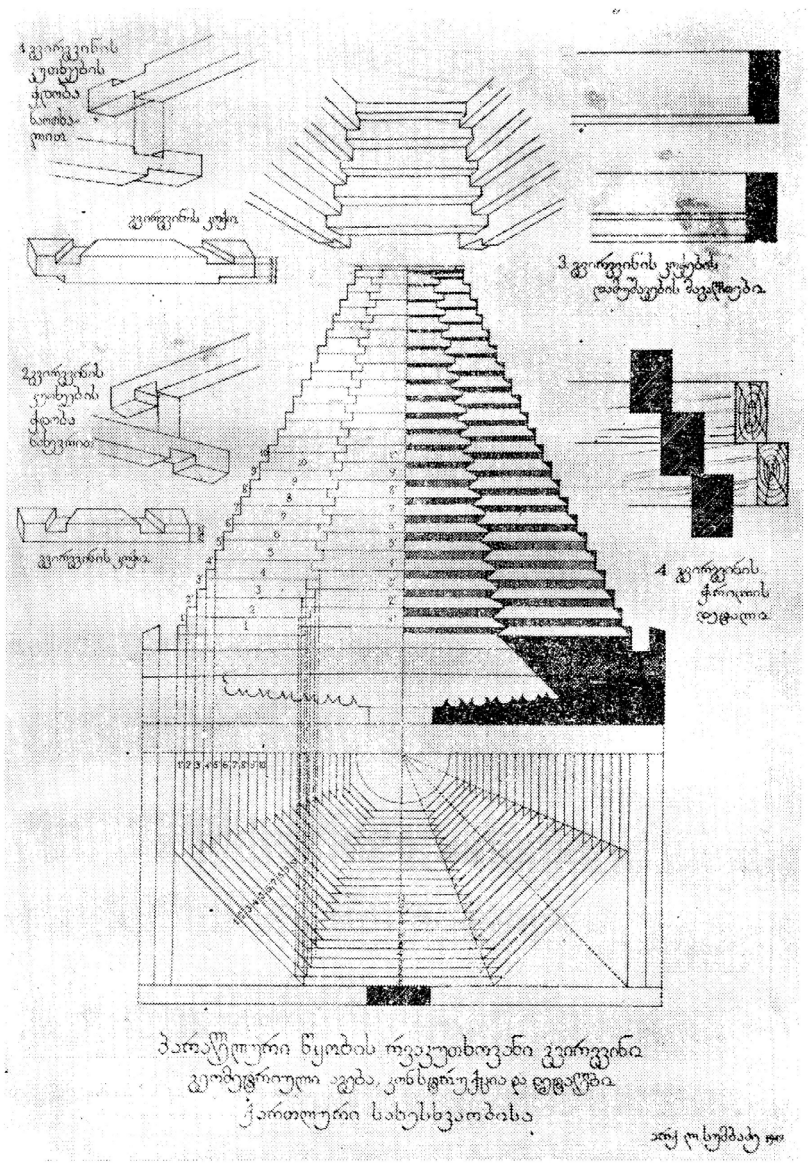


Fig. 20/ *Longinoz Sumbadze, Octangular Gvirgvini of Parallel setting. Geometrical buildup of the construction and details of Kartlian ramification of Darbazi dwelling, "The Architecture of the Georgian Folk Dwelling Darbazi", 1984.*

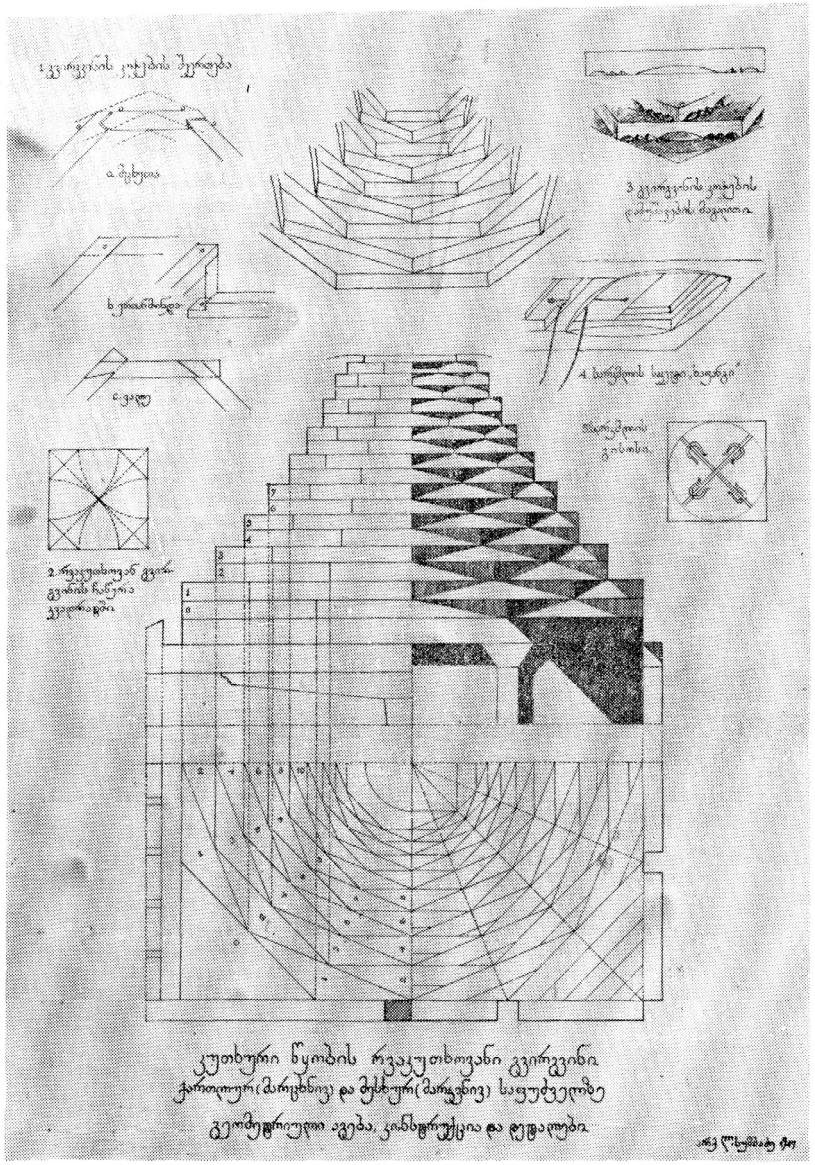


Fig. 21/ *Longinoz Sumbadze, Octangular Gvirgvini of angular setting. Geometric structure, construction and details based on Kartlian (left) and Meskhian (right) methods, "The Architecture of the Georgian Folk Dwelling Darbazi", 1984*

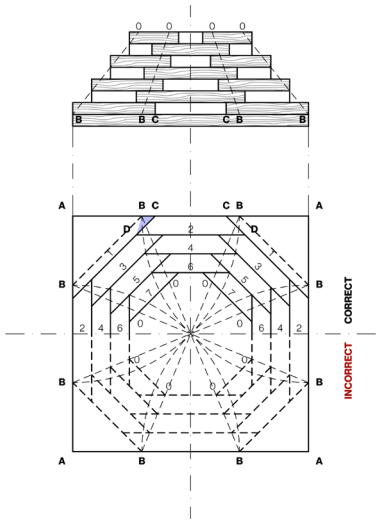


Fig. 22/ *Construction of octangular Gvirgvini of parallel settin according to L. Sumbadze.*

"Field observations convinced us that the edges of *Gvirgvini* appear correct when the imaginary borderlines of BO, connecting the polyhedron B corners with the center of *Gvirgvini*, pass through the intersection midpoints of DC lateral beam edges" (Sumbadze [1984], [59], translated by Gvantsa Tskipurishvili)

The ultimate step of corbelled system is represented by **octangular crown of angular setting.** (Fig. 21) Its layout and geometrical peculiarities are discussed below; therefore, we shall overview those technological details, that elevate rather simple quadrangular ceiling to the heights of octangular woodworking masterpiece, deserving to be called "swallow nest". Fascinated Sumbadze often describes this structure as crystalised natural formation and provides construction scheme illustrating its simplicity, yet subtleness – neatly hewn beams are stacked perfectly among each other, connected at the ends with simple joinery.[7] (Sumbadze, 55)

Depending on the dimensions of a beam within each row, at times craftsmen modified the layouts and adapted their resources accordingly. However, they still strived to obtain the aesthetic standards and stayed truthful to the perfect square base of the crown. In general, author observed that "the form of base (initial) octagon should be regular (with equal edges and angles) solely in *Gvirgvini* structures of angular setting." (Sumbadze [1984], [59], translated by Gvantsa Tskipurishvili)

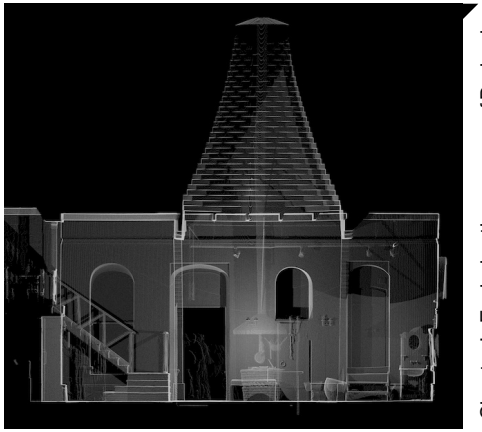
Exceptional example of *Gvirgvini* wood-weaving technique is **dodecagonal** shape **of angular setting**. There are only two built structures of this type observed exclusively in Georgia, both built in the beginning of 20Th century. (Fig. 23) The most fascinating aspect of this scheme lies within its geometrical choices, which are illustrated in the next section. As for the technological aspect this structure is not far from

7 We can identify this type of joint as half lap scarf joint. Source: Branco, J. & Descamps, Thierry. (2015). Analysis and strengthening of carpentry joints. Construction and Building Materials. 97. 10.1016/j.conbuildmat.2015.05.089.

octangular *Gvirgvini*, however, it extends more vertically and slowly transforms into the fake dome.

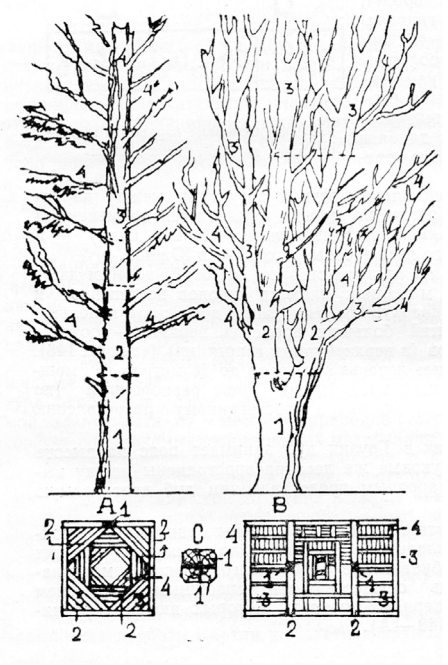
As Sumbadze mentions, this is the geometrical limit for crowned roofing system of *Darbazi* set by craftsmen themselves, due to their architectural sensibility, meaning that "greater multiplication of facets might eliminate the tectonic clarity, increase the height excessively, lose the scale, abnormally increase the ratio of the Gvirgvini height to the main space of the room". (Sumbadze [1984], [64], translated by Gvantsa Tskipurishvili)

The territorial differences within the construction of different types of crowned structures can also be explained by the distribution of dendrological resources. In eastern Georgia we meet deciduous forestry such as **Oak** and **Beech** species up to 50 meters in height, which have miscellaneous body parts useful for various structural elements; Meanwhile, in the West and south of the country people were using **Fir** and **Spruce** trees with regular trunks and gradually shrinking crowns – suited for every element within the construction of *Gvirgvini* roof. As we can see, craftsmen tried to be economically and environmentally sustainable by utilising every part of a tree. (Fig. 24) (Sumbadze, 239)



▲ **Fig. 23/** *Porakishvili Darbazi, 2023. Source: https://easteast.world/*

▼ **Fig. 24/** *Longinoz Sumbadze, The use of wood for Darbazi covering in Eastern and Southern Georgia, "The Architecture of the Georgian Folk Dwelling Darbazi", 1984*



One of the most substantial and appealing aspects of *Darbazi* dwelling is its bricolage of geometrical solutions. Several types of layering arrangements are illustrated below, split into three main groups:

a. centric-corbelled four-sloped domes.
b. three-sloped corbelled *Moktseuli* system.
c. two-sloped longitudinal system with employment or absence of the ridge beam. (Fig. 25)

We shall adopt the observations from Longinoz Sumbadze's monograph and discuss some of these geometrical classifications in a relative manner – picking the most comprehensive and characteristic schemes out of all the ramifications. This chapter focuses exclusively on the examination of centric-corbelled roofing systems. (Sumbadze, 40-63) Here are some major characteristics and important notes about the topic of discussion - Centric-corbelled domes:

The difference between structural forms is acquired by deploying:

- combination of basic types;
- shapeshifting of a polygon in the vertical axis in various combinations;
- employment of new type polyhedrons;
- deviation from general geometrical rules;
- differences between construction methods.

Common characteristics of all dome systems are:

1. quadrangular layout;
2. centric layout;
3. corbelled execution methodology with multiple rows/tiers transferring structural loads in a hierarchical manner.

The major part of these dome systems goes under centric classification and might have variable arrangements:

1. Parallel setting
2. Combined setting
3. Angular setting.

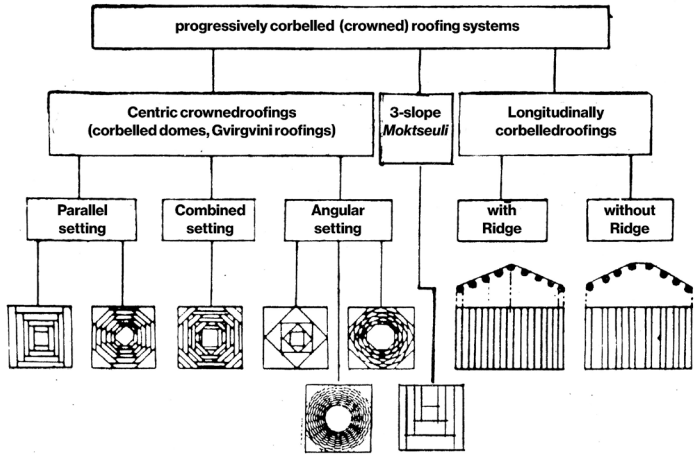


Fig. 25/ *Longinoz Sumbadze, General classification of corbelled ceiling systems, "The Architecture of the Georgian Folk Dwelling Darbazi", 1984*

Parallel and Angular superimpositions

Most widespread types of crowned roofing structures are classified as parallel or angular arrangement of beams. Therefore, we shall review these methods briefly. Firstly, within *Gvirgvini* of parallel setting roofing beams are gradually combining towards the centre. Secondly, it covers only the framework, not the total area of the structure, leaving some gaps between ridges. For simplicity, we abbreviated these terms accordingly: **PS** for parallel setting, **AS** for angular setting.

From the comparison of several fundamental construction schemes of *Gvirgvini* setting, we can conclude that:

- In *Gvirgvini* with **parallel** setting is, in essence, a continuation of corbelling walls, (observed within the ancient Colchi huts[8]) but with the principle of gradual shrinking towards the centre of the ceiling. Whereas, in **angular** setting, this principle is neglected with rotation of the beams.
- Parallel setting results only in partial cover of the roof – as a framework, leaving hollow interspaces in-between. Whilst the angular system is able to create continuous cover. In angular setting the height of each row is generated by the beams along the whole perimeter, when in parallel setting, they elevate only along

8. *See the Historical record chapter.*

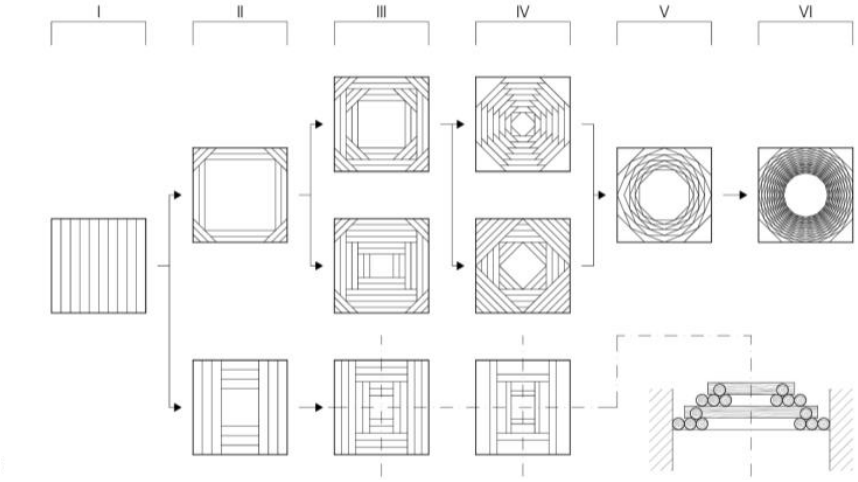


Fig. 26/ *Evolution of crowned dome (Gvirgvini) in Darbazi dwellings, according to L. Sumbadze*

mid-perimeter, another half left for additional infill. For example, in quadrangular PS[9] Gvirgvini there are two beams in each row, in AS – four beams, etc. With one exception of specific type octangular AS Kartlian *Darbazi*, where each row of the beams is joined with half of its height.

- In structural terms, AS *Gvirgvini* represents more stable arrangement, than PS.
- PS *Gvirgvini* can be more defined and clear arrangement, as the shape of quadrangular basis stays the same towards the centre, while in AS number of facets may vary.

A predefined geometrical system of AS *Gvirgvini* results in specific parameters of the roofing structure, with only choice of construction scheme basis and material parameters. Otherwise, span reduction rate, ergo - the speed of covering space, is already predefined.

In PS *Gvirgvini* system of arrangement is more flexible and speed of construction directly depends on shift extent of beam rows towards the centre. The character of PS roofing system lies within its pyramid nature, enhanced by the skylight illumination – the higher *Gvirgvini* extends, the richer is comprehension of geometrical essence.

9. PS – shortened for Parallel setting; AS – shortened for Angular setting; CS – shortened for Combined setting.

According to the observations of Sumbadze, evolution of centric-dome structures in Georgia had a core objective of covering the quadrangular spaces, which has been achieved in various manner due to construction material accessibility.

We have already comprehensively examined basic types of *Gvirgvini* settings in previous section within their technological aspect. Now, following the existing scholarship[10], we can slowly dive into the geometrical logic behind these schemes.

Sumbadze stresses, that the octangular layout must be derived from quadrangular setting of *Gvirgvini*, shapeshifting in terms of facet multiplication and continuing this behaviour until reaching its vertical limits in subsequent types (Fig. 26). We can observe the gradual rise of ceiling slope concordant with the expanding need for a richer architectural expression. The polygon may keep evolving, but in *Gvirgvini* it never transforms into the circle, as there's no need to mimic the dome with infinitely shortening timber joists.

Starting from **Quadrangular** *Gvirgvini* **of PS**, which is the direct reminiscent of Colchian huts, we can obtain a few general principles. For instance, this scheme was used for covering large-span spaces such as 8x8 meters and utilized exclusively square shape basis, continuing this regularity up to the crown tip.

Quadrangular *Gvirgvini* **of AS** provides more flexibility to a craftsman on this matter, as the base of the crown can transform almost infinitely. Author's observations from multiple villages confirm this theory, as the common dwellings with rather primitive roofing structures have irregular plans, especially within the construction of Akhori (cattle stall), where a few rotated rows of superimposed beams easily fill in a cover gap. The scheme generated by Sumbadze shows geometrical relativity between the edges of the crown base. (Fig. 27) He

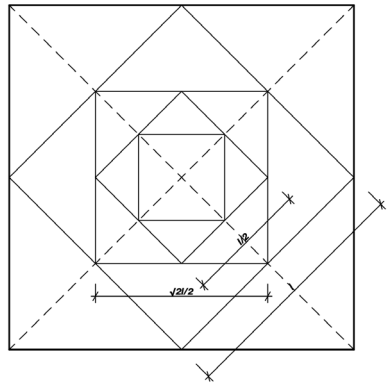


Fig. 27/ *Quadrangular Gvirgvini of angular setting. Calculation of basic parameters*

10 Sumbadze, Longinoz. "Архитектура Грузинского народного жилища Дарбази "(The architecture of the Georgian folk dwelling Darbazi). Tbilisi: Metsniereba. 1984

gives a clear example:

"To cover a 5x5 meter square in this manner, a beam with the largest length of only 3.55 meters will be needed and for the reduction of cover up the 50x50 cm skylight only six rows of shrinking squares will be necessary. Elevation of *Gvirgvini* with arbitrary beam height of 20 cm will be only 1.20 meters." (Sumbadze [1984], [42-43], translated by Gvantsa Tskipurishvili)

Combining two previous methods of roof construction creates the unique design of *Gvirgvini*. Within this arrangement, the spacing between beams decreases as we move upwards, creating a variety of roofing options. Sumbadze demonstrates how manipulating these intermediary aspects and dimensions can lead to the formation of two distinct *Gvirgvini* formations (Fig. 28 , A and C) not only horizontally, but also vertically. For these reasons of geometrical and structural equilibrium, author singles out the scheme with regular octagon, which is spread around the whole country and across its borders, within wooden and masonry architecture.

Another form of polygonal bricolage is **Octangular** *Gvirgvini* **of PS**, where the planar and lateral design display the accumulated architectural and artistic intelligence once again. As mentioned above, the results of this arrangement depend on cross-sectional proportions of a beam.

Octangular *Gvirgvini* **with AS** is a comprehensive example of geometrical shapeshifting. Sumbadze stresses, that here most important objective is deconstructing the

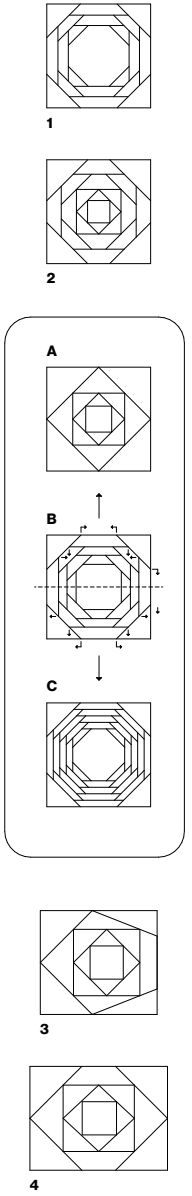


Fig. 28/ *Gvirgvini with combined setting. Formation process accodring to L.Sumbadze*

octagon basis. As we can see (Fig. 29), by gradual rotation of diagonals, intersection nodes E, F, G, etc. form facets, their midpoints when connected form another row of beams, and the layout continues in the same manner shrinking towards the middle point. Author provides us with fascinating numerical translation of this structural arrangement.

$$AE = FB = BL = l - OB = l - \sqrt{\frac{1}{4}l^2 + \frac{1}{4}l^2} = l - \frac{1.414}{2}l = l - 0.707l = 0.293l$$

$$AE = 0.293l$$

The facets of the first octagon

$$a_1 = IE = EF = AF - AE$$

$$AF = AO = \sqrt{\frac{1}{4}l^2 + \frac{1}{4}l^2} = \frac{\sqrt{2}l}{2} = 0.707l$$

$$AE = 0.293l; IE = a_1 = 0.707l - 0.293l = 0.414l;$$

$$\boldsymbol{IE = a_1 = 0.414l}$$

The facets of consequential octagons

$$a_2 = a_1 \cos 22.5° = 0.924a_1$$

$$a_3 = a_2 \cos 22.5° = a_1 \cos 22.5° * \cos 22.5° = a_1 \cos^2 22.5° = 0.924^2 a_1$$

$$a_n = a_1 * \cos^{n-1} 22.5°$$

$$\boldsymbol{a_n = a_1 * 0.924^{n-1}}$$

For example, to cover quadrangular plan with dimensions 5x5 meters, within the first row must be deployed at least 2.10-meter-long beams, for the second row 2.10x0.924=1.94 meters, etc. The primary concept of angular corbelled layout lies within the combination of these gradually shortening beams in both horizontal and vertical axes. According to the geometrical analysis conducted by Sumbadze (as seen above), the shrinking ratio is 1:0.9238. Therefore, length of adjacent sides vertically of octagon are

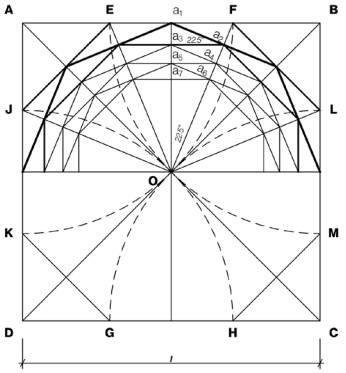


Fig. 29/ *Construction of octangular Gvirgvini with angular setting.*

closely related to each other as a larger part of golden ratio function. But we can clearly understand from all historical accounts, that local people didn't possess any organized mathematical knowledge, it always has been a matter of aesthetic and artistic order, defying the obstacles during execution. (Sumbadze, 61-62)

There are only two examples of *Darbazi* dwellings with dodecagonal Gvirgvini, which can be found exclusively within Georgian borders. As Sumbadze stresses, fitting a 12-sided polygon into the square was achieved with addition of angular beams to the octangular base. The image shows clearly (Fig. 30) the geometrical tricks used to erect this complex crown.

1. The edge RS of the first dodecagon, given that square edge equals ***l*** :

$$RE = DE \times tan(15°) = \frac{1}{2} l \times tan(15°) = 0.134l$$
$$RE = 0.134l$$
$$RS = 2 \times RE = 0.268l$$

2. The edge od second dodecagon, $\mathbf{a_2}$:

$$a_2 = TE = 2 \times \big(RE \times cos(15°)\big) = a_1 \times cos(15°)$$
$$a_2 = 0.966 a_1$$
$$a_n = a_1 \times cos^{(n-1)}(15°) = a_1 \times 0.966^{(n-1)}$$

3. Locating the points JKLM for the transitional angular beams:

$$AI = \sqrt{2} \times AP^2 = AP \times \sqrt{2}$$
$$AP = AO - OP$$
$$AO = \sqrt{\frac{1}{4} l^2} = 0.707l$$
$$OP = OR = EO/cos(15°) = \frac{l}{2cos15°} = \frac{l}{2 \times 0{,}966} = \frac{l}{1{,}932} = 0{,}517\, l$$
$$AP = 0.707l - 0.517l = 0.190l$$
$$AJ = 0.19l \times \sqrt{2} = 0.268l$$

4. Identification of the span for KJ transitional angular beam

$$KJ = 2 \times PJ$$
$$2 \times PJ^2 = AJ^2;\ PJ^2 = \frac{AJ^2}{2}\quad PJ = \frac{AJ}{\sqrt{2}} = \frac{0{,}268l}{0{,}414} = 0.188l$$
$$KJ = 2 \times 0.188l = 0.376l$$

In this manner, if we signify the half of central angle within regular polygon as a (for ***n***-sided polygon would equal to 360/2n), the resulted beam span for every ***n+1*** th row, will be equal to previous span ***n*** multiplied by ***cosα.***

$$a_2 = a_1 \times cos(\alpha)$$
$$a_3 = a_2 \times cos(\alpha) = a_1 \times cos^2(\alpha)$$
$$a_4 = a_3 \times cos(\alpha) = a_1 \times cos^3(\alpha)$$
$$a_n = a_1 \times cos^{(n-1)}(\alpha)$$

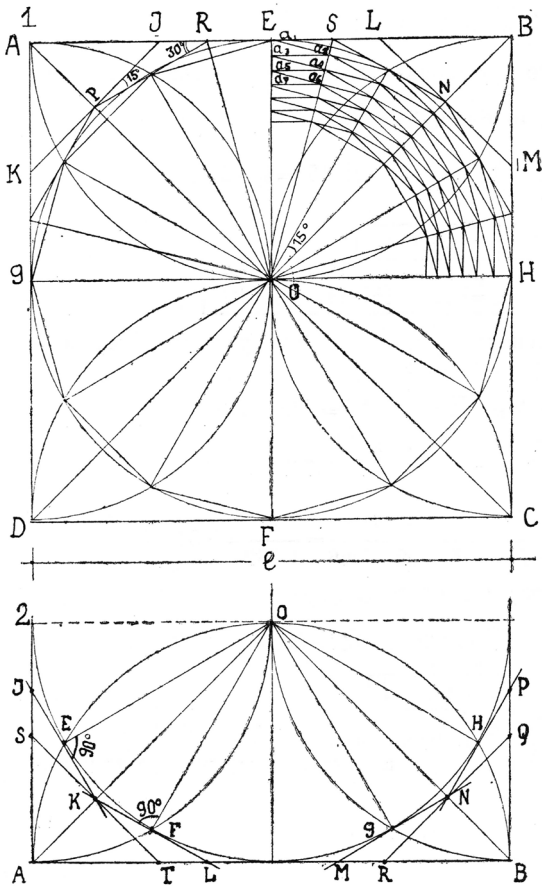


Fig. 30/ *Longinoz Sumbadze, Construction of dodecagonal Gvirgvini on a square base, "The Architecture of the Georgian Folk Dwelling Darbazi", 1984*

Cross-border ramifications

Longinoz Sumbadze has dedicated whole chapter to major and subtle influences that corbelling roofing techniques has had over masonry civil architecture. Geometric principles, that have been instinctively generated by ancient people still live within stone domes of numerous Christian masterpieces in Georgia and beyond, but the wooden frameworks and timber huts, they have been based on, either struggle to survive or have been lost forever.

However, this type of transfiguration for covering *habitable spaces* has not been widely used around the world. We meet these houses in a few regions of Georgia – Samtskhe, Javakheti and Kartli, as well as their analogues in Armenia (Azarashen, Glkhatun) and Azerbaijan (Karadam) within South Caucasus.

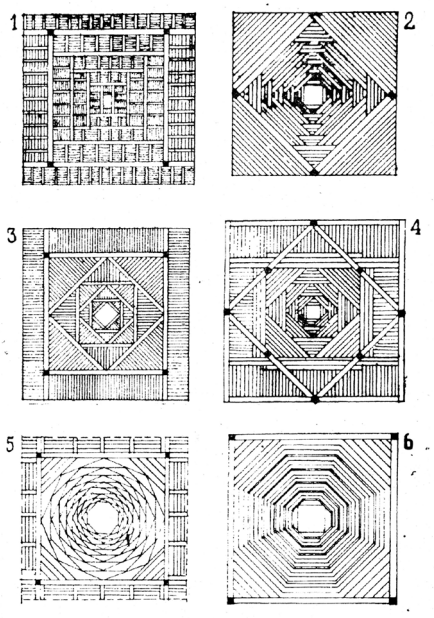
Parallels within Caucasus, Anatolian plain and Pamir mountains

Fig. 31/ *Azarashen, courtesy of Samvel Karapetyan. Source: Armenian Geographic. "Азарашен в Армянском Нагорье." Armenian Geographic. Accessed August 14, 2024.*

The distribution of wooden corbelled structures around Caucasus region has a deep historical and practical reasoning. Georgia, Armenia, modern-day Azerbaijan and Turkey had a continuous fluctuation of borderlines and massive waves of transmigration throughout centuries. Consequently, *Darbazi*-like dwellings can still be found in Armenian and Azerbaijani rural areas nowadays.

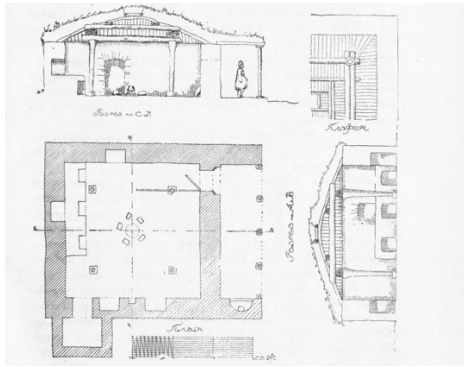
In **Armenia**, these dwellings are called ***Glkhatun*** (Arm. Գլխաթուն) meaning "head house" and *Azarashen* (Arm. հազարաշեն) meaning "a thousand-built". The planning system, as well as their architectonic characteristics are considerably similar to the Georgian peers. (Fig. 31) However, there are some dissimilarities as well, for instance the lateral structure here might have additional inclined reinforcement bars. Sumbadze has reconstructed several types of Armenian roofing types (Fig. 32), where we can see the peculiarities within construction details, such as thickness of secondary elements and their various alignment. "In Armenia both types of quadrangular and octangular parallel roofings were used, but within large buildings mostly dome with combined setting is deployed."[11] (Sumbadze, [1984], [88], translated by Gvantsa Tskipurishvili) Particular attention needs to be paid to 6th scheme, where each row frame has been constructed independently from each other. Other than that, Glkhatun differs from *Darbazi* with absence of central hearth as a composition axis and instead incorporates *Tonir* (Armenian tandoor) under the main floor.

In the mountainous villages of **Azerbaijan**, we can often find the "swallow dome" structures, which the locals call ***Karadam*** (Az. *Qaradam*) signifying "black house" and "are recognized as one of the ancient forms of Transcaucasian civil architecture"[12]. (Sumbadze, [1984], [90], translated by Gvantsa Tskipurishvili) We can see some examples of



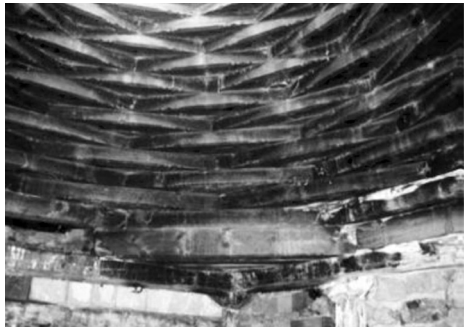
▲ **Fig. 32/** *Longinoz Sumbadze, Basic forms of corbelled In Armenia according to Vardanyan, "The Architecture of the Georgian Folk Dwelling Darbazi", 1984*

▼ **Fig. 33/** *Longinoz Sumbadze, Karabakh karadam. Plan. Sections. Plafond (ceiling) by Stepan Lisitsian, "The Architecture of the Georgian Folk Dwelling Darbazi", 1984*



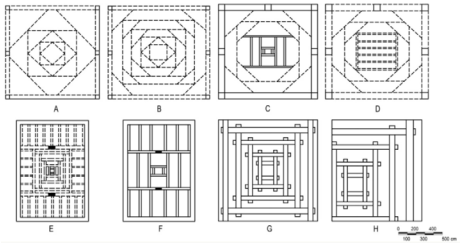
11. S. Lisician, discussing four-sided parallel structures and the term "Azarašen" in a 1927 publication of Известия КИАИ (Tiflis).

12. Ilina, Marianna Ivanovna. Древнейшие типы жилищ Закавказья [The Oldest Types of Dwellings in Transcaucasia]. Moscow: Izdatel'stvo Akademii arkhitektury SSSR, 1946



▲ **Fig. 34/** *Swallow Cover from Kars Harakani Hz. Complex. Source: Şen, K., & Erdoğan, S. (2019). Geleneksel Tunceli evlerinde kırlangıç (tüteklikli) örtülü bir konut örneği. Fırat Üniversitesi Harput Araştırmaları Dergisi, 6(12), 35-52.*

▼ **Fig. 35/** *Examples of the octagonal type kirman covering. Source: Erarslan, A. 2021. A Traditional Wooden Corbelled Dome Construction Technique from Anatolia. The Eastern Anatolian Tandoor House with its Wooden "Swallow-Dome" Type of Roof. Journal of Asian Architecture and Building Engineering 21, no. 4: 1275–1303.*



these dwellings from Lisitsian's survey[13] (Fig. 33), which mostly have parallel setting ceiling structure with unhewn logs supported by four freestanding wooden columns, rendering as primitive archetypes. Like Georgian houses, Karadam can be found with different ground placements, including the pit houses – analogues of Meskhetian dwellings, however, the level of wooden craftsmanship has not evolved here as much as in Northern territories. (Sumbadze, 92)

In order to find other corbelled structures near Caucasus region, we need to expand the borders up to Eastern Anatolian plain, **Turkey**, locally called ***tüteklikli*** [14] houses (Fig. 34). Superimposed arrangement of these roofs is named "lantern roofed" or *kirman* in Turkish. A scholarly article "A Traditional Wooden Corbelled Dome Construction"[15] gives an in-depth explanation of the corbelled dome technique and underlines the use of locally sourced wood and traditional craftsmanship as integral to the method of construction. Alike natural and agricultural conditions have led to the development of such of "hidden houses" within Turkish lands,

13. Lisitsyan S., К изучению армянских крестьянских жилищ (Карабахский карадам) [On the study of Armenian peasant dwellings (Karabakh karadam)], "News of the Caucasian Historical and Archaeological Institute", vol. III, Tiflis, 1925

14. tüteklikli is called a central opening of corbelled roof

15. Erarslan, A. (2021). A traditional wooden corbelled dome construction technique from Anatolia. The Eastern Anatolian Tandoor house with its wooden "swallow-dome" type of roof. Journal of Asian Architecture and Building Engineering, 21(4), 1275–1303. https://doi.org/10.1080/13467581.2021.1929243

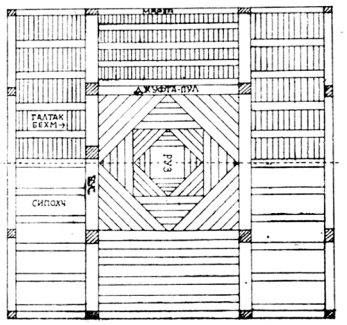
Fig. 36/ *"Chid" the Pamiri Traditional house. Source: Pamir Institute. https://pamirinstitute.org/2022/02/03/chid-the-pamiri-traditional-house-aryan-cultural-heritage/*

similarities of which to Georgian *Darbazi* dwellings are obvious, including planar design, structural arrangement and construction details, alongside with terraced distribution of neighbourhoods. Use of talismanic primary pillars (*direk* in Turkey), household auxiliary chambers and soil covering are also some common characteristics of swallow dome structures. However, we can observe some major differences, like distribution of living spaces on two floors, use of mixed structures for primary crown and incorporation of tandoor.

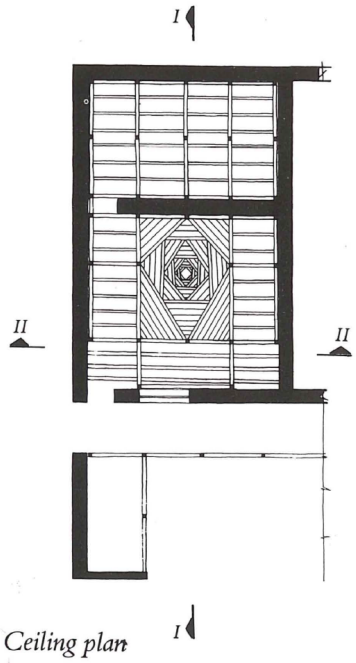
As the author mentions, there are two main cover types – quadrangular and octangular, techniques of which are same of *Gvirgvini* construction (Fig. 35).

"The number of corbelling layers in both types varies according to region but is usually 5, 7, 9 or 10. The construction of the original form of the tüteklikli roof does not make use of nails." (Erarslan 2021, 8)

Fig. 37/ *Longinoz Sumbadze, Scheme of ceiling construction in Tajik village, "The Architecture of the Georgian Folk Dwelling Darbazi", 1984*

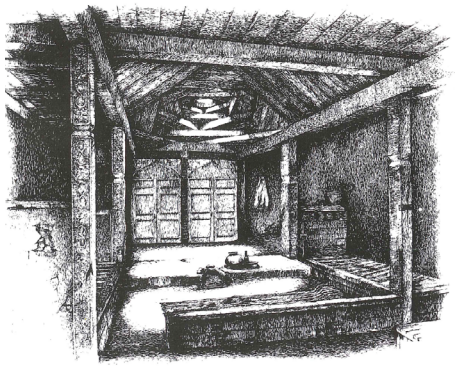


Pamir, North-Western part of **Tajikistan** hides dwellings with corbelled ceilings and central skylight, called "***Chid***". Sumbadze tells us about harsh environmental conditions, such as the altitude range of 1000 – 2500 meters asl, dry climate and highest seismic activity, that these dwellings had to adapt to. However, the similarities of



▲ **Fig. 38/** *Bipush house of Mr Taj. Zargaran Deh Chitral. The traditional Chitral house plan (Source: The Indigenous architecture of Chitral'; Study by National College of Arts, Lahore, 1980).*

▼ **Fig. 39/** *Bipush house of Mr Abdul Wahid. Goldoor Chitral. Interior view (Source: The Indigenous architecture of Chitral'; Study by National College of Arts, Lahore, 1980).*



Chid to Caucasian examples are obvious, especially using primary pillar and various decorations, as well as with open planning and positioning under the ground. For instance, in mountainous Tajik villages, roofing might be aligned with ground level or get even lower.

One of the most interesting aspects of Chid dwellings are folk traditions, reflected on its planning system. For example, the built-in seatings along the perimeter and indoor well, placed underground, transforming into a performance stage during family gatherings. Another hidden gem within construction is method of season-tracking among the beams.

Regardless, Tajik examples of corbelled roofs (Fig. 37) have some fixed architectural capabilities like the ceiling elevation range, geometrical proportionality of flat cover with the central dome and only one type of superimposition applied throughout the country – quadrangular crown of angular setting (Fig. 36). In this sense, Georgian *Darbazi* creates a feeling of more architectural unity due to its structural choices.

"Both objects have accumulated profound architectural and construction folk traditions, developed in the depths of centuries (if not millennia), in accordance with local natural and climatic social and domestic preconditions." (Sumbadze, [1984], [99], translated by Gvantsa Tskipurishvili)

Wooden corbelled structures from Pakistan and North America

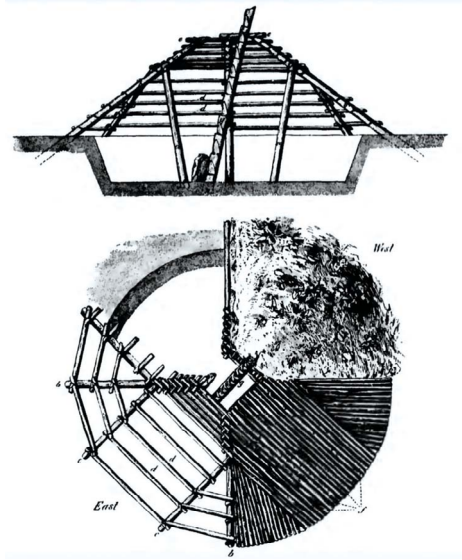


Fig. 40/ *Drawings of a historic pit house, from James Teit and Franz Boas, The Thompson Indians of British Columbia (1900).*

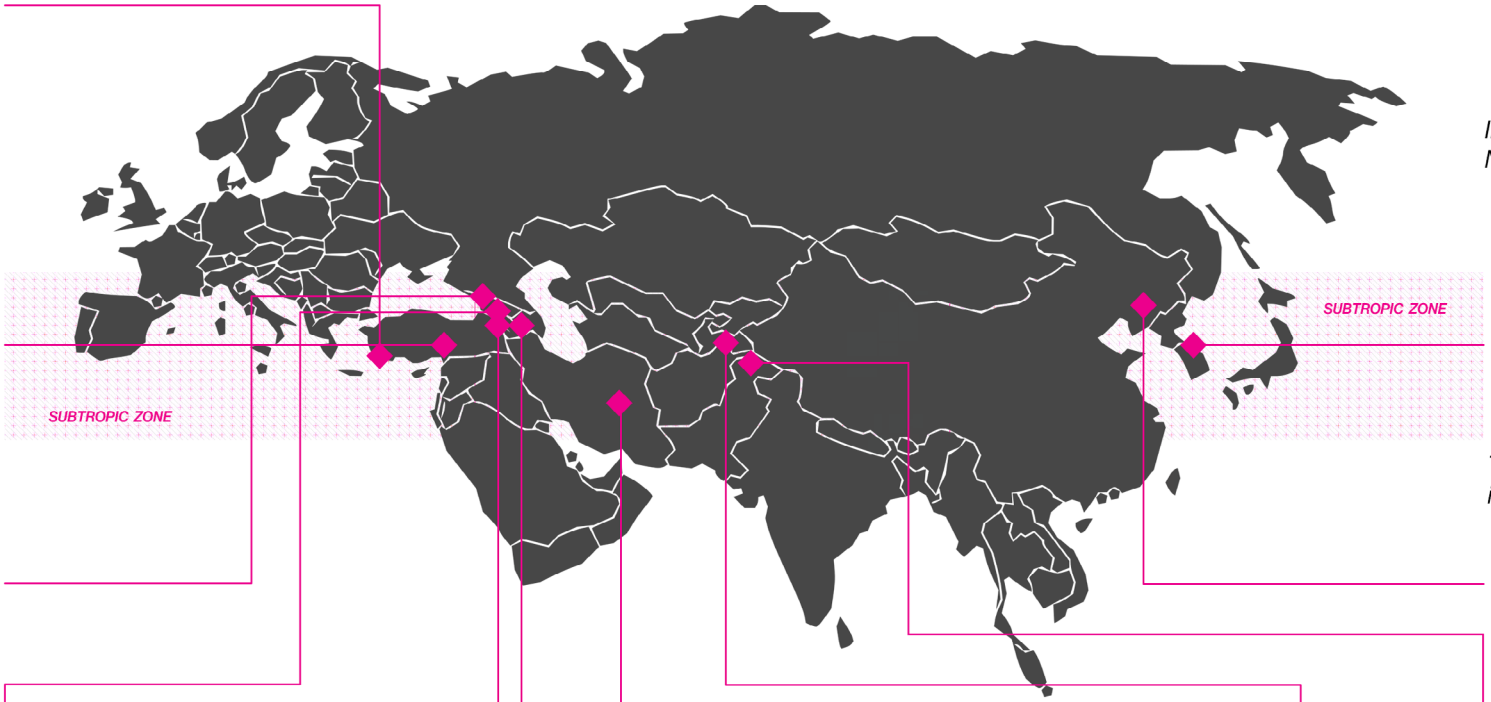
Some of the distant relatives of *Darbazi* dwellings are found in Chitral, **Pakistan**, located on a similar elevation range of 1500-2000 meters asl. Hassan[16] has described some of these vernacular dwellings in a short but elaborate manner. They are hidden within the Hindu Kush mountain range and are called ***Bipush*** (Fig. 38, Fig. 39) and *Kho*. They incorporate similar spaces to *Darbazi*, for family gatherings, storage, etc. However, the most significant similarity is found within the corbelled ceiling of primary halls. The dwellings are distributed on sloped areas in a terraced manner. This arrangement can be paralleled with the mountainous settlements of the Samtskhe-Javakheti region in Georgia. (figure)

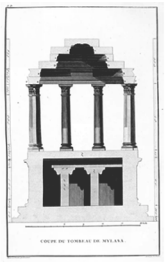
In North America, specifically in **Alaska**, there are typical subterranean houses, inhabited by Eskimo people. These dwellings have corbelled ceilings built with wooden logs, a central spot for fire and a designated skylight above, also used as a gateway. Some of these structures are found in Canada (Fig. 40).

Overall, all these dwellings assembled with wooden materials in superimposed manner, have some other characteristics in common, such as the incorporation of central fire and chambers for family gatherings. Some of them share almost identical ceiling structures, not to mention the terraced arrangement of the neighbourhoods. In this fashion, they can be regarded as distant or close relatives of Georgian *Darbazi*.

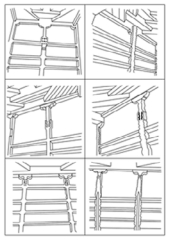
16. *Hassan, Iqbal. The Indigenous Architecture of Chitral. In Mimar 17: Architecture in Development, edited by Hasan-Uddin Khan. Singapore: Concept Media Ltd., 1985.*

Distribution of wooden corbelled structures around the world

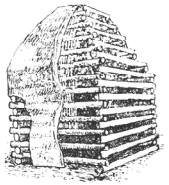




Milas mausoleum stone tombs



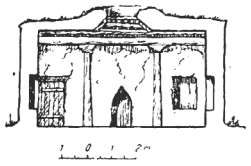
Pontus dwellings in central Anatolia, Turkey



Colchi huts & western Georgian dwellings

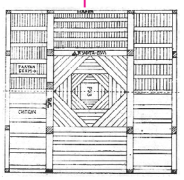
Darbazi type dwellings in South and East Georgia

Glkhatun in Armenia



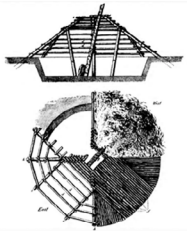
Karadam in Azerbaijan

Georgian settlements in Iran



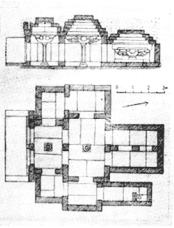
Chid dwellings in Tajikistan

Dwellings of Kalash people, Pakistan



Inuit people pit houses in North America

Tombs of Yeongcheon in South Korea



Tombs Inani in China

Chapter II
In-situ evaluation

This preliminary research is based on substantial part of doctrinal texts provided by ICOMOS Principles for the conservation of wooden built heritage, ISO and EN standards for evaluation and conservation of wooden cultural heritage structures. Although the data collected during the survey including its methodology does not meet all the requirements for an extensive appraisal of real-life structures with the use of diagnostic instruments, the research still attempts to prepare the ground for further studies and detailed inspections of *Darbazi* dwellings throughout the country and hopefully beyond.

To begin with, the main guideline for the assessment of damage within the numerous timber structures in villages of Samtskhe-Javakheti region has been the ISO 13822-2010 normative (Bases for design of structures - Assessment of existing structures). It gives us several directives about the basic terminology, objectives, procedures of assessment and various methodologies for further use of collected data.

The methodology within this report satisfy several criteria from the normative, such as paragraphs 4.5 and 4.7, which have been used during the first phase of the thesis – including the study of the materials, preliminary evaluations with further results and some recommendations within the report; Moreover, we've followed the paragraphs 5.2, 5.3 and 5.5 related to the specifications of material and structures, but unfortunately without the physical testing of wooden samples.

Another important directive incorporated within the report are **EN 335:2013** - Durability of wood and wood-based products[1], which deals with the wood classes and their serviceability conditions. In this case, it was determined that the substantial part of surveyed wooden structures can identify as Use class 2 (UC 2). The paragraph 4.3 of the standard states that "Situations in which the wood or wood-based product is under cover and not exposed to the weather (particularly rain and driven rain) but where occasional, but not persistent, wetting can occur. In this use class, condensation of water on the surface of wood and wood-based products may occur. Attack by disfiguring fungi and wood-destroying fungi is possible. Attack by wood-boring insects, including termites, is possible although the frequency and importance of the insect risk depends on the geographical region1)". (EN 335:2013, p.6)

1. EN 335:2013 - Durability of wood and wood-based products - Use classes: definitions, application to solid wood and wood-based products. This British Standard is the UK implementation of EN 335:2013. ISBN 978 0 580 75630 6

Therefore, *Darbazi* type dwellings, which are embedded halfway in the ground and covered with soil and vegetation layer, subsequently having considerable exposure to the moisture and precipitation, can directly fit the aforementioned criteria and must be treated accordingly.

UNI 11119: 2004 - Italian Standard on "Cultural Heritage - Wooden artefacts . On site inspections for the diagnosis of timber members"[2] has been among the first national standards to establish objectives, procedures and criteria in the evaluation of the state of conservation and assessment of timber members in load-bearing structures through the execution of on site inspection and the use of non destructive techniques and methodologies. In addition to the general standards for assessment methodologies and wood material preservation, it is important to consider the **ICOMOS Principles for the conservation of wooden built heritage**[3] while dealing with historic structures.

These comprehensive guidelines are based on the recognition of versatile wooden heritage all around the globe, its historical, structural and technological complexity alongside with challenges and opportunities within the evolution of wooden craftsmanship. The primary principles within these doctrine are: provision of detailed vocabulary and guidelines for inspections and further evaluations of wooden structures, methodologies for interventions providing the guidance for present-day material use, monitoring and maintenance techniques and documentation.

The ISCARSAH guidelines on the analysis, conservation and structural restoration of architectural heritage[4] continues these recommendations and provides further discussion about the importance of minimal and sustainable interventions while dealing with the cultural assets, exploring the modes of historical research, inspection, structural analysis and consequent treatment across the multidisciplinary workforces.

Multiple principles have been consolidated within this research thesis, such as survey and analysis mechanisms, mostly focusing on visual appraisal of overall structure whilst depicting the traditional techniques and material characteristics used for constructing these dwellings; moreover, general recommendations for subsequent treatment of *Darbazi* structures have been followed to ensure the safeguard its cultural significance.

2. UNI 11119:2004 - Beni culturali - Manufatti lignei - Strutture portanti degli edifici - Ispezione in situ per la diagnosi degli elementi in opera

3 ICOMOS, "Principles for the conservation of wooden built heritage"; GA 2017 6-3-4 – Doctrinal Texts; Ver. 30/07/2017

4 P. Roca, L. Pelà and C. Molins (Eds.) , "The ISCARSAH guidelines on the analysis, conservation and structural restoration of architectural heritage", 12th International Conference on Structural Analysis of Historical Constructions SAHC 2020

Aims of On-site preliminary visual inspections

Our focus for an evaluation of historic dwellings in rural Georgia lies in the appraisal of the oldest subterranean parts erected with timber framework. During the inspections, particular attention was paid to capturing the current state of roofing details, assembled with various types of timber logs, lumber and boards, forming different layouts/ patterns. After assessing the structural layout and the connections of the different elements, a crucial part of these observations was obtaining data on various biological decay of wood material and spotting mechanical deformations, most of which were stored as photographed evidence.

Browsing through multiple case studies, obtained and portrayed below, we can acquire some general information about each dwelling structure, containing substantial data about location coordinates, approximate construction date and ownership history. Unfortunately, due to the properties of local construction materials, geographical distribution, natural environment and anthropogenic and temporal footprint, majority of these dwellings suffer disuse and degeneration, especially the wooden elements, which need constant care and maintenance.

As for the health assessment and damage classification of selected dwellings, specific criteria have been chosen, adapting various analysis methodologies from the examples of structures at international level (i.e. Italy, Portugal, China, etc.).

Integrated tables within each case study contain documented data (photos of dwelling interiors, approximate dimensions of wooden element cross-sections, environmental data, time-slot of each inspection, if applicable, official code attributed by National Agency for the Protection of Cultural Heritage of Georgia, etc.) of several typical wooden structural elements, structured according to the hazard type and intensity, majority in inadequate biological/mechanical condition, thus, accurately illustrating the overall state of conservation and serving as urgent call for interventions.

One on the primary goals of these inspections is to determine and analyse damage class and magnitude to take further actions accordingly. To be more specific, this thesis incorporates intervention scenarios, with more profound analysis and proposal for one case study dwelling, as a collective representation of other structures in similar state of deterioration.

Additionally, this survey has incorporated useful visual documentation – schematic drawings of case studies. The measurements have been taken with simple tools such as measuring tape and digital laser. We believe, that to fully comprehend the inspected dwellings, it's important to explore their geometry and modes of construction and asseblage. Presented axonometric schemes, ceiling plans and sections aim to depict these peculiarities of surveyed structures. All the drawings are put together in the "**Annex**" section, according to the case study sequence.

Decay/defect types in wood built heritage

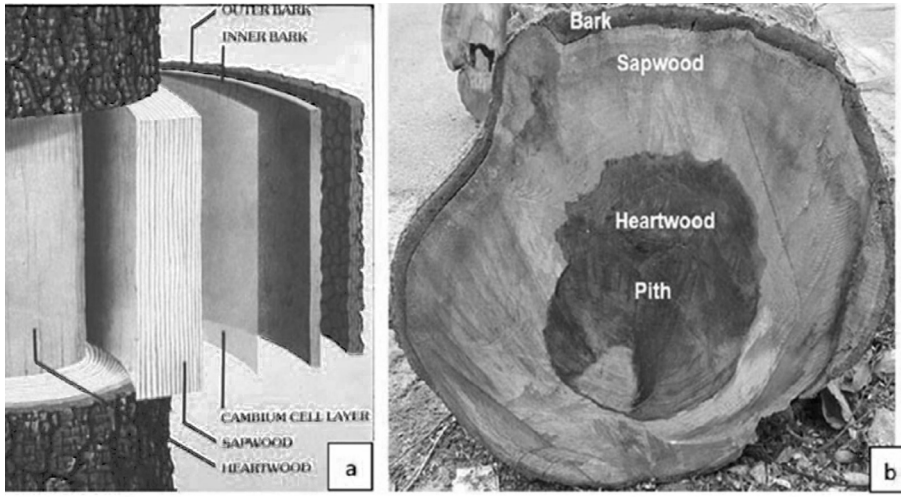


Fig. 41/ *(a) Transverse section of tree trunk (Source: Morris, 1998) and (b) Cross section of tree trunk. Source: Sundararaj, R., Shanbhag, R.R., Padma, S., Shashikala, S., Rao, R.V. (2022). Wood Degradation, Challenges, and Mitigation. In: Sundararaj, R. (eds) Science of Wood Degradation and its Protection. Springer, Singapore. https://doi.org/10.1007/978-981-16-8797-6_1*

Wood has played a significant role in vernacular architecture worldwide throughout the millennia, both as a load-bearing and non-load-bearing material. It has favourable structural and technological properties, as well as the aesthetics to satisfy human needs. Regardless, this building material can suffer from various environmental hazards, like alteration, deterioration, mechanical failure, etc.

The structure of a tree incorporates several concentric layers, including the outer and inner bark, vascular cambium, sapwood, heartwood, and pith (Fig. 41). The outer bark ensures mechanical protection and moisture storage, while the inner bark manages nutrient transportation. The vascular cambium, placed between the bark and wood, produces new growth each year. The sapwood conducts water, and the heartwood placed at the core, darkens (depending on the wooden species) along tree aging. Annual rings, formed during spring and summer, reflect growth, with early wood and late wood distinguished by cell size and wall thickness (Morris, 1998; Wiedenhoeft, 2012).

One of the primary risks when dealing with timber building materials, aside from wood moisture content, comes from live and organic entities, such as various types of fungi, insects, bacteria. These wood-decaying organisms meet some conditions: moisture (generally 25 to 100 percent of dry-wood weight), oxygen, temperature (generally between 10 degrees and 35 degrees Celsius) and food (the wood itself)[5]. The most common and easily spread attackers of structural wood are considered **fungal** microorganisms, proliferating rapidly with the "spores of the fungus landing on timber surfaces"[6].

Fungi

Rot

According to Shupe[7], wood-decaying fungi are grouped into three categories: **brown rot, white rot and soft rot**. (Fig. 42) They attack various chemical components within wood material: cellulose, hemicellulose and lignin, and generate metabolic chain, thus compromising structural integrity of timber. The results of strength deprivation may vary depending on the fungi type, wood species and lumber dimensions.

Brown rot ("Dry" rot) (Fig. 43) is a type of fungi commonly attacking softwoods but potentially is harmful for hardwood as well, while **white-rot** fungi attack is mostly observed on hardwoods. "White-rotted hardwood undergoes little surface alteration, develops a white or bleached appearance, displays near-normal shrinkage and in the early stages of decay is solid to the touch rather than friable." (Shupe, 2008, 6)

Soft-rot fungi deteriorate wood that is exposed to permanent moisture. The wood acquires darker shades mostly appearing dim brown or blue grey with easily removable surface layer. Generally, carbohydrates are the primary food source in wooden material for fungal species, but some they feed extensively on lignin as well. **Lignin** is the natural glue that holds adjacent cells of wooden fibres together.

Stains

However, not all fungi result in degradation, but rather cause discoloration, stains, etc. Hence, many of them are classified as **wood-staining or mildew (Mold) fungi**. They form "fleecy" outgrowths ranging from white and other light shades to black. "The same conditions of moisture, air and temperature that promote wood-destroying and wood-

5. Shupe, T et al. 2008. Causes and control of wood decay, degradation and stain. Louisiana State University Agriculture Center, Baton Rouge, LA. Publication 2703. 27 p.; 2008

6 . Nunes, Lina & Cruz, Helena. (2003). Fungal degradation of wood in buildings. 86

7. See note #5

▲ **Fig. 42/** *Historical wood biodegradation types: (A) white-rot, (B) brown-rot and (C) soft-rot (Fukasawa 2021).*

▼ **Fig. 43/** *Classic advanced brown rot fungal decay in a softwood. Source: Goodell, Barry, Jerrold E. Winandy, and Jeffrey J. Morrell. 2020. "Fungal Degradation of Wood: Emerging Data, New Insights and Changing Perceptions" Coatings 10, no. 12: 1210.*

staining fungi will favour the growth of Molds." (Shupe, 2008, 8) These fungi typically develop because of poor lumber-drying practices or excessively wet conditions.

The effects of wood-staining fungal agents, in contrast with wood-destroying fungi, are primarily superficial and non-destructive for strength or texture of timber. Most active agents are mold and stain, which have similar effects of infestation on wood microstructure at an early stage, and may grow into soft rot afterwards, if not treated properly. These types of fungi result in a variety of stain color shades, but also, they can cause chemical stains that derive from chemical alterations within wood cells, usually developed in timber while seasoning. They involve enzymatic or non-enzymatic oxidation of certain organic compounds largely confined to sapwood;

However, another type of alterations - **brown stains** are highly alarming, which render yellow to dark-brown discolorations and decrease the economic value of timber materials.

Insects

Deterioration of wood material can be also caused by several types of xylofagous insects - mostly wood boring coleoptera (anobidae, lictidae, cerambicidae, etc.), termites (Fig. 44, Fig. 45), affecting both - moist wood (digesting cellulose and lignin) and drywood as well.

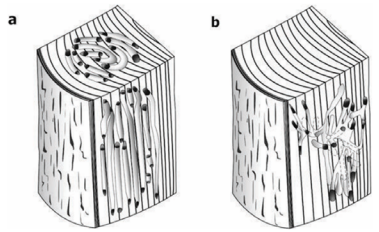
Boring activity, reproduction and development of insects are influenced by trophic[8], abiotic, biotic[9] and anthropogenic factors (Reinprecht 2016). The trophic factors imply organic and inorganic nutrients needed for specimen's growth. "The abiotic factors include temperature, relative humidity, air flow, sunlight and even the electromagnetic field" (Reinprecht 2016). Temperature and wood moisture content (usually exceeding 20%) however are crucial for insect inhabitation. The biotic factors include relationship within and in between species. Anthropogenic factors generally involve created conditions for wood treatment and storing. (Pournou, 428)

8. Trophic - relating to feeding, and to the food necessary for growth. Source: https://www.oxfordlearnersdictionaries.com/

9. "An abiotic factor is a non-living part of an ecosystem that shapes its environment. In a terrestrial ecosystem, examples might include temperature, light, and water. In a marine ecosystem, abiotic factors would include salinity and ocean currents. Abiotic and biotic factors work together to create a unique ecosystem." Source: https://education.nationalgeographic.org/

▲ **Fig. 44/** *Column attacked by beetles. Source: Wang, s.: damage classification to historical wooden structures: a preliminary survey and recommendation for Dong minority drum towers, int. Arch. Photogramm. Remote sens. Spatial inf. Sci., xlvi-m-1-2021, 821–827, 2021 https://doi.org/10.5194/isprs-archives-XLVI-M-1-2021-821-2021*

▼ **Fig. 45/** *(a) The nest of a carpenter ant (Camponotus sp.); (b) The nest of a sphecid wasp (Ectemnius cephalotes) (based on Stokland et al. 2012) Source: Pournou, A. (2020). Wood Deterioration by Insects. In: Biodeterioration of Wooden Cultural Heritage. Springer, Cham. https://doi.org/10.1007/978-3-030-46504-9_7*



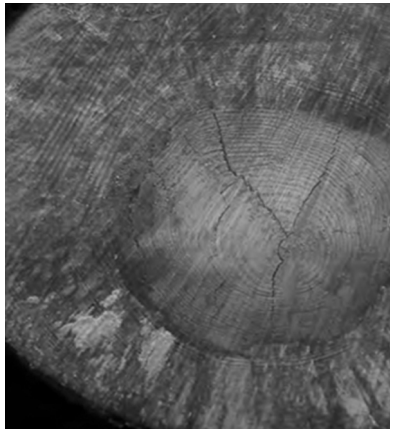


Fig. 46/ *Pith cracks in pine wood. Source: Wdowiak, Agnieszka. Defects in structural timber (Wady drewna konstrukcyjnego). Structure & Environment, 9 (2). pp. 112-122. ISSN 2081-1500*

Various types of insects predominantly feed on cellulose component of cell in sapwood with moisture content of wood material above 15 percent, while some termites digest wood fibers less moisture content.

Defects

Other than xilofagous agents, wood material due to its natural anisotropic and non-homogenous characteristics, often presents some visual and anatomical defects. “Flawless wood is thought to have a cylindrical shape, and be clear, i.e. free from knots, or piths. It should have annual rings of the same width, and also perfectly parallel, with respect to the longitudinal axis, arrangement of fibres. Any deviations from this pattern, however theoretical and approximate it might be, are considered wood defects.”[10] (Wdowiak 2017, 112) Defects might vary according to environmental, storing and other conditions, resulting in irregularities such as: trunk shape defects, (Fig. 46) wooden fibres malformation and external defects. Overall, timber defects can be classified within several major types: **knots, twisted fibres, , ring-shakes, cracks, shape defects, chemical stains, etc**.

Wood **knots** occur in the trunk where the branches were dropped off or cut off and where wood grain waved its way around it. They are common among all species of trees and affect wood quality. Knots are stake-shaped from the pith, with increasing diameters towards the tree girth.

After tensile or shear strength within wooden fibres are exceeded either longitudinally or transversally, tissue inside the lumber collapses, resulting in **crack** formation. Crack development is rare during the fall season due to slow drying of pressured inner layers, on the other hand, fibres closer to the girth with more moisture content allow more cracks and affect overall quality of wood, as much as penetration by rot and insects.

10 . Wdowiak, Agnieszka. Defects in structural timber (Wady drewna konstrukcyjnego). Structure & Environment, 9 (2). pp. 112-122. ISSN 2081-1500

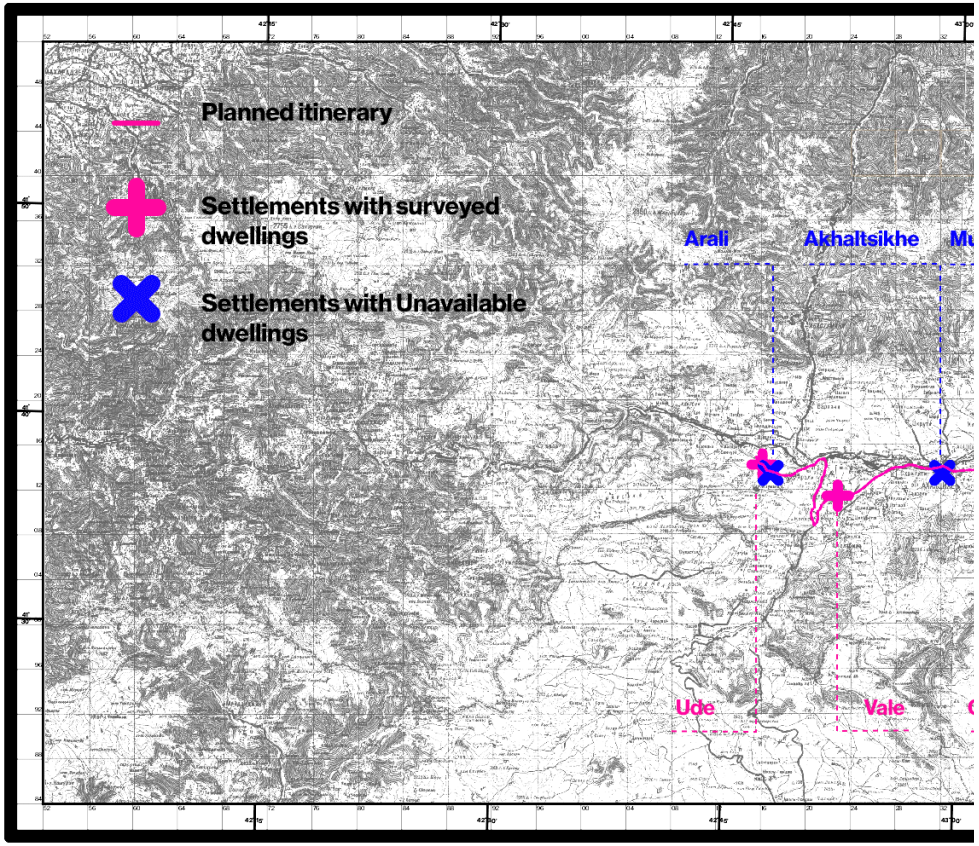
Adopted classification

The hazards within this thesis research for the preliminary appraisal of multiple timber structures, have been grouped according to their character:

1) biological decay, mostly focused on identifying fungal and insect attacks;
2) Mechanical failure and other types of alterations, including chemical decay;
3) defects, derived from either internal or external anomalies.

Aforementioned damage classification within wooden structures have been distributed through the tables, adopted from several studies of historic timber structure deterioration. One of the primary references for this study was the research[11] incorporating all major types of decay and alterations, that can affect wooden assets of cultural heritage. Listed types of deterioration have been sorted by damage levels (mostly varying from mild to severe) with flexible commentaries for each case study. The tables also provide brief information about approximate dimensions of wooden elements.

11. Wang, s.: damage classification to historical wooden structures: a preliminary survey and recommendation for Dong minority drum towers, int. Arch. Photogramm. Remote sens. Spatial inf. Sci., xlvi-m-1-2021, 821–827, 2021



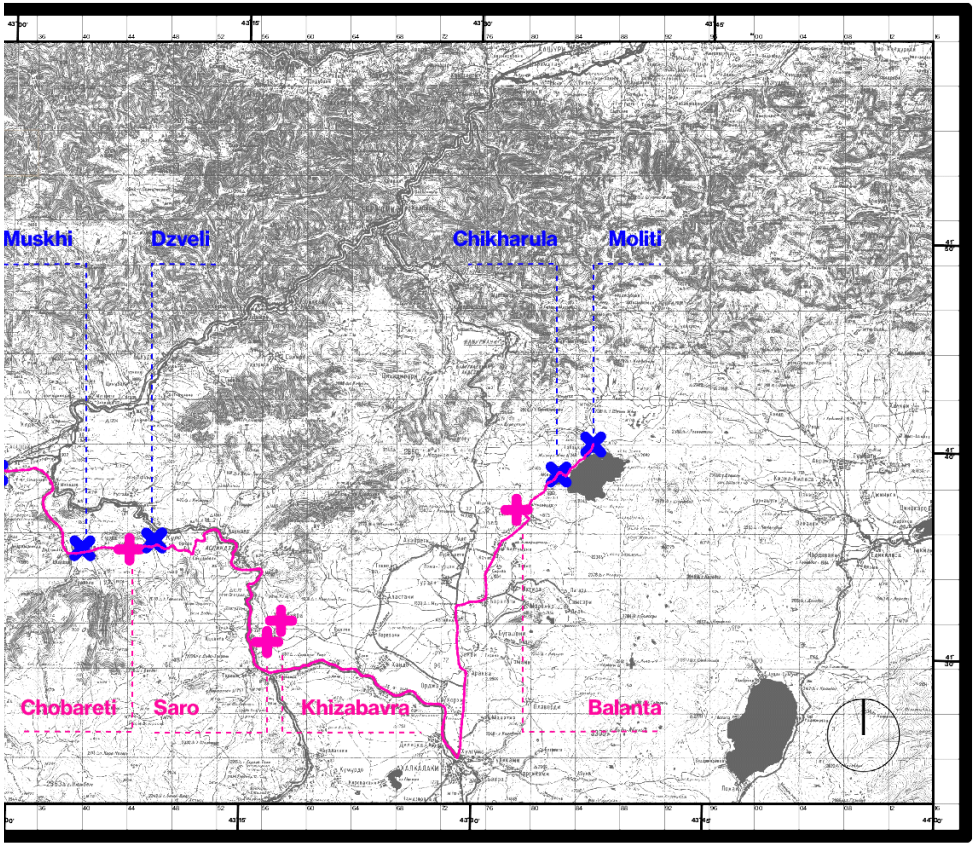
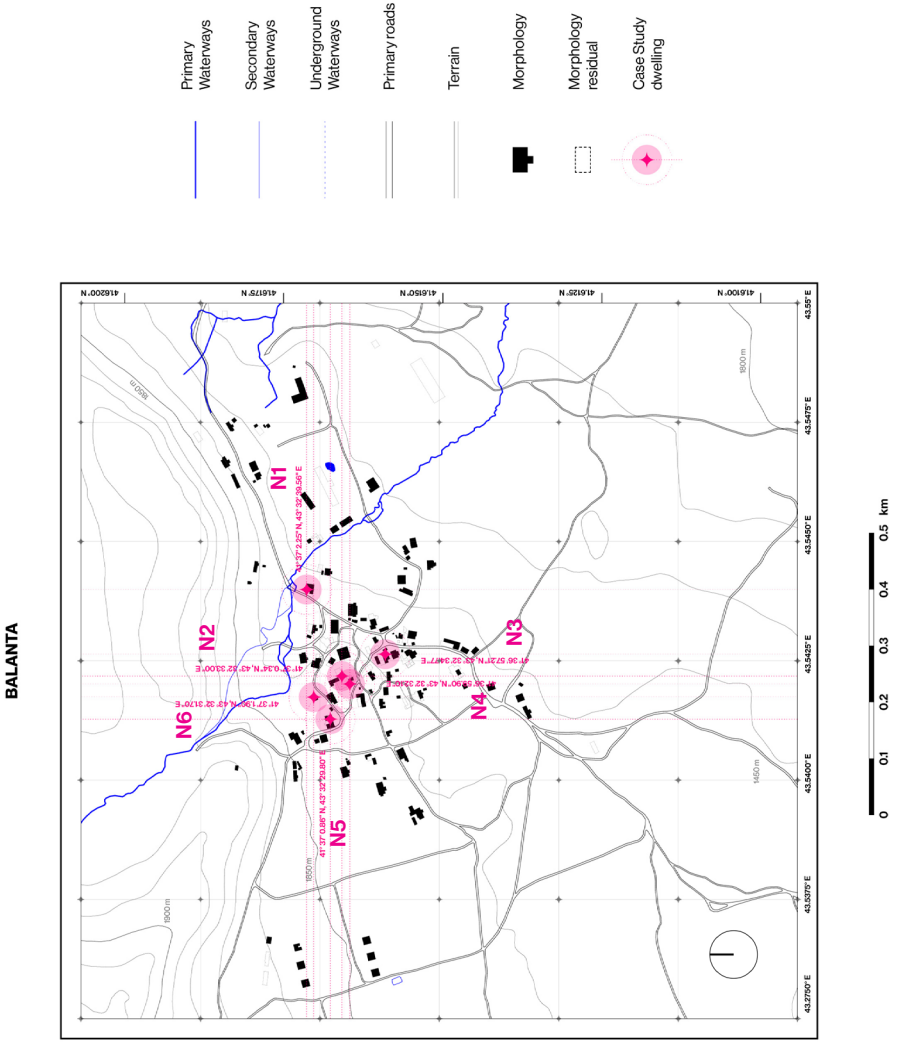


Fig. 47/ *Mapping of the itinerary for the on-site survey in Samtskhe-Javakheti region, showing the villages with surveyed dwellings and the settlmenets, where the structures were collapsed or unavailable at the time*

Balanta

The first village for conducting survey, keeping several *Darbazi*-type dwellings in its core, is a rather small settlement called Balanta, located in Borjomi municipality, Samtskhe-Javakheti region. It stands more than 1800 meters above the sea level in the lower subalpine zone of South Caucasus Mountain range, enclosed by the Veli and Trialeti ridges from the North, Trialeti highland from the West and Samsari ridge in the East.

The settlement is currently sparsely populated mostly by older generation, leaving the youth with multiple layers of socio-cultural challenges, including the civil architectural heritage in this remote area, where the primary source of living derives from subalpine meadows.



N1	IDENTIFICATION DATA
ID	Former Melikidze dwelling
Date of inspection	08.08.2023
Location	Balanta, Borjomi, Samtskhe-JavaKheti, Georgia 41°37'02.0"N 43°32'39.7"E
Date of construction	Beginning of XX century
Altitude	1838 m

ENVIRONMENTAL DATA	8.00 – 9.00 AM
Ambient temperature (°C)	19.8
Relative humidity 2m (%)	67
Soil temperature 7 to 28cm (°C)	17.5
Soil temperature 100 to 255cm (°C)	10.7
Soil moisture 7 to 28cm (m^3/m^3)	0.26
Soil moisture 100 to 255cm (m^3/m^3)	0.33

General information

The initial point of survey turned out to be one housing complex, formerly belonging to the Melikidze family, currently inhabited by unrelated dwellers for almost ten years. It's located near the primary roadway crossing the village and the entrance point to the surveyed chamber is placed in North-west facet.

Spatial organisation and architectural characteristics

The complex consists of two separate zones, one built in early XX century with generic spatial organization – living room, bedding chamber and cattle stall, and second zone adapted to contemporary living requirements built several decades later. The space of our interest is the one for cattle, as others were not physically accessible at the time. Nowadays, it is partially unused or destined solely for storage.

The structural system of the ceiling here belongs to the *Moktseuli*[1] type – a rather simple arrangement of wooden beams with a small central aperture.

Deterioration and structural issues

The visual observations conducted on-site showed some major deterioration, primarily with the secondary beams and planks on lateral wings, one of which is partially sagged and absent. The majority of beams and baulk boards suffer from moderate to severe white rot and soft rot, dust and smoke deposition. Meanwhile, supporting columns also show signs of biological hazard – mild to severe insect and fungi attacks, patches of Mold /mildew and minor longitudinal cracks. Other adjoining rooms are missing considerable parts of wooden roofing elements, which later have been substituted with simple lumber frames and corrugated asbestos cement sheets.

From a structural perspective, the overall framework hardly seems to satisfy the stability requirements, considering the rupture of some rafters and baulk boards alongside with poor biological state of multiple joints and atrophy of several columns.

The table below provides some illustrated information about the overall state of the dwelling, as well as attempts to identify and classification of wooden deterioration.

Since the tree species cannot be identified from the on-site survey, this thesis implies the information gathered from the inhabitants verbally and from previous research. According to the dwellers, the framework might be constructed with Oak material from the **Balanta** dense forest, that was destroyed centuries ago. Therefore, for the village of Balanta, the dendrological outline shows the use of Spruce, Oak and Fir tree species within these historical structures.

Fig. 48/ *Former Melikidze dwelling - Akhori (livestock chamber)*

Fig. 49/ *Skylight-view*

Fig. 50/ *inaccessible Oda room*

1. Moktseuli - relict prototypes of corbelled roofing that integrate four main pillars supporting three rows of horizontally and transversally overlaid timber beams. The roofing is executed in two slopes, evolving into three and four-sloped structures.

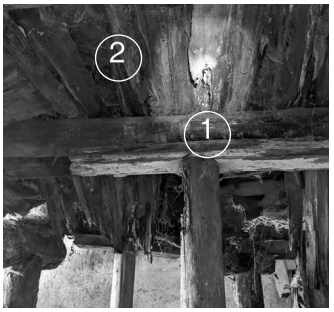
			**Image N**
Mold; Severe Insect attack; (Galleries, exit holes & dust excrements);	Moderate Fungi attack (white rot); Mold; Moderate/severe Insect attack;	Severe Fungi attack (soft rot); Moderate Insect attack;	**Biological decay**
Natural weathering; Alteration (Dust deposition);	Natural weathering; Alteration (Dust/smoke deposition); stains;	Fractures; Transversal rupture of multiple elements; Sagging soil; Lacuna in rear wing; Alteration (Dust/smoke deposition);	**Mechanical failure; Other**
Knots; Stains; Longitudinal fractures;	Longitudinal fractures; Knots;	Knots; fractures;	**Defects**
16-20 cm	24-28 cm	1. 16-20 cm 2. 3x20 cm	**Av. Dimensions of timb. element**

	**Image N**
Moderate Fungi attack (soft rot); Mold; Moderate Insect attack;	**Biological decay**
Partial longitudinal fractures;	**Mechanical failure; Other**
Knots;Stains;	**Defects**
3x24 cm	**Av. Dimensions of timb. element**

N2	IDENTIFICATION DATA
ID	Genadi Maghradze dwelling #5307
Date of inspection	08.08.2023
Location	Balanta, Borjomi, Samtskhe-JavaKheti, Georgia 41° 37' 1.709" N 43° 32' 31.6525" E
Date of construction	End of XIX c. - Beginning of XX c.
Altitude	1849 m

ENVIRONMENTAL DATA	16.00 – 17.00 PM
Ambient temperature (°C)	27.1
Relative humidity 2m (%)	44
Soil temperature 7 to 28cm (°C)	18.9
Soil temperature 100 to 255cm (°C)	10.8
Soil moisture 7 to 28cm (m^3/m^3)	0.25
Soil moisture 100 to 255cm (m^3/m^3)	0.33

General information

The second dwelling within the survey list is located in the North-West part of Balanta village. It is currently inhabited by a family of two, and has had cultural heritage status since 2012 [2] but the family claims that their habitat hasn't been subjected to any kind of restoration/ reinforcement work yet

Spatial organisation and architectural characteristics

The housing consists of three essential parts and six chambers

2. According to the legislative order Leg. N 3/86 20.03.2012 "კულტურული მემკვიდრეობის თვალსაზრისით ღირებული ობიექტებისათვის კულტურული მემკვიდრეობის უძრავი ძეგლის სტატუსის მინიჭების თაობაზე (Regarding granting the status of immovable monument of cultural heritage to valuable objects from the point of view of cultural heritage)"

in total - the historical segment, which is now being kept primarily for storage, including the former living room with *Gvirgvini* ceiling and former stable; active zone for the cattle, constructed with *Moktseuli* system; and adjoining living space, currently utilised by the Maghradze family.

There are several building materials used for construction, which vary according to the space, its destination and current state – firstly, masonry stone and mortar for the bearing walls, local timber for historic roofing and vertical bearing elements, industrial lumber in manually repaired members, soil and hay as insulative/filling layer and lastly, corrugated metal sheets for roof cover.

Deterioration and structural issues

During the survey particular attention was paid to the older section of the house, to capture current state of the ceiling details. The framework in Eastern wing seems structural stable, although some new and informal elements seem to be integrated manually. Also, the slate ceiling in bedding chamber appears substituted with unserviceable materials. Regarding the deterioration and defects in structural elements, we can observe severe fungal infection in *Gvirgvini*, weathering, mould and some depositions on whole wooden corpus, as well as insect attacks in selected beams and columns.

Since the tree species cannot be identified from the on-site survey, this thesis implies the information gathered from the inhabitants verbally and from previous researches. For Maghradze dwelling, the research shows use of Spruce and Oak tree species.

The table below is an attempt to represent several structural elements with typical signs of decay and defects that are most present in the dwelling and emphasize the unsatisfactory conditions these structures are in.

Fig. 51/ *Maghradze dwelling - Easter wing, view on Gvirgvini*

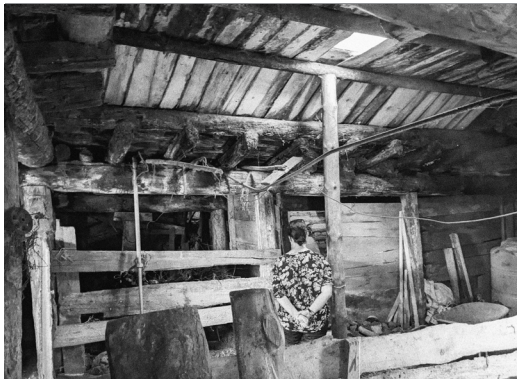


Fig. 52/ *Eastern wing of Maghradze dwelling, view in Akhori chamber.*

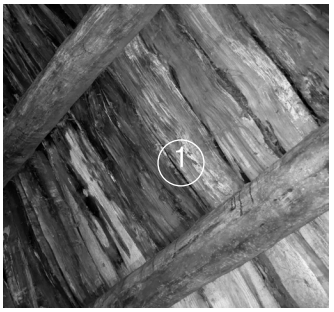
			**Image N**
Severe Insect attack (Galleries, exit holes & dust excrements);	Severe Fungi attack (white rot);	Mold/mildew; Moderate-Severe fungi attack (soft rot);	**Biological decay**
Alteration (Dust deposition); Weathering;	Transversal rupture of several roof elements; Alteration (Dust and smoke deposition);	Multiple fractures;	**Mechanical failure; Other**
Knots; crookedness;	Knots; stains; Longitudinal Cracking;	Knots; stains; Cracking;	**Defects**
20-24 cm	18x20 cm	4x24 cm	**Av. Dimensions of timb. element**

			**Image N**
Severe Fungi attack (white rot);	Moderate Fungi attack (soft rot);	Moderate/severe Fungi attack (soft rot); Moderate insect attack;	**Biological decay**
Alteration (Dust and smoke deposition); Weathering	Minor fractures; Alteration (Dust and smoke deposition);	Transversal rupture of elements; Longitudinal fractures; Alteration (Dust and smoke deposition);	**Mechanical failure; Other**
Knots; Stains;	Knots;	Knots; Stains;	**Defects**
1. 24-28 cm 2. 4x20 cm	19 cm	16-18 cm	**Av. Dimensions of timb. element**

N3	IDENTIFICATION DATA
ID	Maghradze Giorgi Oda dwelling
Date of inspection	09.08.2023
Location	Balanta, Samtskhe-Javakheti, Georgia 41°36'57.9"N 43°32'34.7"E
Date of construction	Appx. mid-XX century
Altitude	1842 m

ENVIRONMENTAL DATA	9.00 – 10.00 AM
Ambient temperature (°C)	26.7
Relative humidity 2m (%)	67
Soil temperature 7 to 28cm (°C)	17.5
Soil temperature 100 to 255cm (°C)	10.8
Soil moisture 7 to 28cm (m^3/m^3)	0.26
Soil moisture 100 to 255cm (m^3/m^3)	0.33

General information

The housing complex was built in the mid - XX century, according to the Maghradze dwellers, who settled here over 35 years ago. It is located a few hundred meters south from Genadi Maghradze dwelling, sharing some architectural characteristics, as well as the family name. This assemble is not present on Georgian Heritage list, probably due to its rather simple architectural language and construction mastery level of the *Gvirgvini* structure.

Spatial organisation and architectural characteristics

This complex is divided into two major sections – the one with historic structures and second erected after mid-XX century. Housing entrance is facing South-East, giving a way to sets of hallways and intermediate storage spaces, which are adjoined to *Modarbazuli* and *Oda* rooms from North. Nowadays, some of these spaces - like *Akhori* (cattle stall), have missing roof structures and are left in ruins; as for the other chambers previously having more noble purpose, they are either misused or are being kept solely for storing needs, which gives a way to natural weathering and deterioration of these historic structures.

Deterioration and structural issues

From the visual survey, we can detect substantial damage within wooden frameworks, such as severe infection by fungi and mould deposition on horizontal bearing elements, moderate to severe insect attacks within the vertical bearing structure, rotting and rupturing of secondary wooden elements, resulting in sagging soil and partial absence of the roof. Alongside with biological deterioration of timber components, it's worth noting their mechanical state – absence, dislocation, cracking and rupturing of separate structural or non-structural members, followed by manual attempts of replacement and strengthening by the owners themselves.

Fig. 53/ *Maghradze dwelling, Akhori chamber*

Fig. 54/ *Maghradze dwelling, Oda chamber*

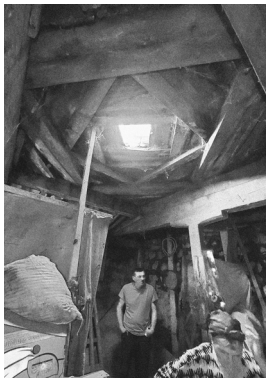
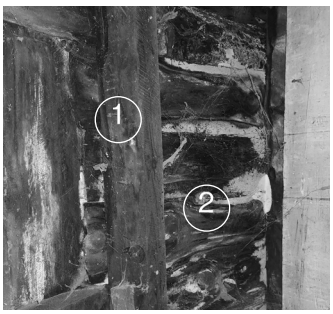


Fig. 55/ *Maghradze dwelling, Darbazi space*

			**Image N**
Severe Fungi attack (white rot; soft rot); Insect attack (Galleries, exit holes & dust excrements)	Severe Fungal attack (white rot); Moderate-severe Insect attack;	Fungal attack (white rot); Minor Insect attack;	**Biological decay**
Transversal rupture of multiple elements; Water leakage; Lacuna; Alteration (Dust and smoke deposition);	Alteration (Dust and smoke deposition); Weathering;	Multiple fractures; Alteration (Dust and smoke deposition);	**Mechanical failure; Other**
Knots; crookedness;	Knots; stains; Longitudinal Fractures;	Knots; stains;	**Defects**
1. 20-26 cm 2. 15-18 cm	16x20 cm	16x18 cm	**Av. Dimensions of timb. element**

			**Image N**
Mold/mildew; Moderate-Severe Insect attack (Galleries, exit holes);	Severe Fungal attack (white rot); Mold/mildew;	Fungi attack (soft rot);	**Biological decay**
Minor fractures; Alteration (Dust deposition); Weathering;	Longitudinal fractures; Weathering;	Longitudinal fractures; Water leakage and Sagging soil; Lacuna in the roof;	**Mechanical failure; Other**
Knots;	Stains; knots;	Knots;	**Defects**
19 cm	1. 18-22 cm 2. 4x20 cm	18-20 cm	**Av. Dimensions of timb. element**

N4	IDENTIFICATION DATA
ID	Shakro Melikidze dwellings #5308
Date of inspection	09.08.2023
Location	Balanta, Borjomi, Samtskhe-JavaKheti, Georgia 41° 37' 0.7039" N 43° 32' 33.8356" E
Date of construction	end of XVIII century - mid-XIX century
Altitude	1849 m

ENVIRONMENTAL DATA	12.00 – 13.00 PM
Ambient temperature (°C)	27.0
Relative humidity 2m (%)	38
Soil temperature 7 to 28cm (°C)	19.9
Soil temperature 100 to 255cm (°C)	10.8
Soil moisture 7 to 28cm (m^3/m^3)	0.25
Soil moisture 100 to 255cm (m^3/m^3)	0.33

General information

The house complex consists of three buildings in total - a separate single hall, a triple-room dwelling, and the expansion carried out in later years (appx. early-20th century). All of them are currently abandoned. However, the historical part of complex has had cultural heritage status since March 2012, but hasn't been subjected to any kind of restoration/ reinforcement works yet.

Spatial organisation and architectural characteristics

While inspecting this place, the primary goal became to capture the ten-tiered crowned ceiling dominating the interior of the first hall, made with processed wooden beams and light decor. This wooden framing, which is rather a characteristic of the city and a rare sight in rural areas, is obviously used to connect all twelve columns in the past.

(fig.7) The second bigger hall has a plainer overall framework, consisting of three different ceilings. The central piece is constructed in coated lumber beams, while in the other two timber logs and boards create mixed patterns. The architectural value of this space is also justified by some supporting columns, bearing decorated capitals with strong archaic character.

A few building materials used for construction - masonry stone with mortar, local wood presented in logs and lumber, soil, filler bricks/ blocks, and rather later addition of asbestos cement roofing sheets.

Deterioration and structural issues

TTo appraise the dwellings through the structural scope, both *Darbazi* halls seem to have retained overall structural integrity, but ruptures of several roofing elements in the big hall (shown in the table below) and biological harm within a few joints might be compromising for retaining it.

As for biological hazards, we can observe mild to moderate fungal attacks on multiple roofing elements in both halls, especially on crude logs and baulk boards within the lateral wing of the main *Darbazi* space and neighbouring chamber. Moreover, we clearly see the pest infestation mainly on vertical structural components. The dwellings are damaged by the humidity and/or water leak, and sagging soil from the roof.

Fig. 56/ *Melikidze house , view on Gvirgvini (smaller hall).*

Fig. 57/ *Melikidze house, view on Gvirgvini (primary hall)*

Fig. 58/ *Melikidze house (view on second Gvirgvini in Primary hall)*

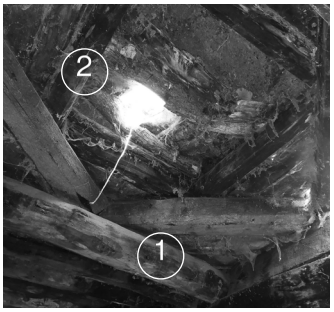
			**Image N**
Mild-moderate fungi attack; (soft rot) Mild-moderate Insect attack; (galleries, exit holes);	Severe fungi attack (white rot);	Mold/mildew; Mild Insect attack;	**Biological decay**
Transversal rupture of multiple elements; Water leakage; Lacuna; Alteration (Dust and smoke deposition);	Partial Fractures; Alteration (Dust and smoke deposition);	Damp column base; Weathering;	**Mechanical failure; Other**
Knots; crookedness; Partial fractures due to nails/spikes;	stains;	Partial fractures due to nails/ spikes; Traces of removed decorations; Stains	**Defects**
1. 20-26 cm 2. 15-18 cm	16x20 cm	16x18 cm	**Av. Dimensions of timb. element**

			**Image N**
Moderate/severe Fungi attack (white rot); Mold/mildew; Mild insect attack;	Moderate-severe fungi attack (soft rot); Mild insect attack;	Moderate-Severe Insect attack (Galleries, exit holes) ;	**Biological decay**
Partial longitudinal fractures; Water leakage; Alteration (dust and smoke deposition); Weathering;	Minor longitudinal fractures; Alteration (smoke deposition);	Alteration (Dust deposition); Weathering; Damp base;	**Mechanical failure; Other**
Stains;	Stains; knots;	Stains; knots; Partial fractures due to nails/spikes;	**Defects**
20x24 cm	28-32 cm	18x18 cm	**Av. Dimensions of timb. element**

N5	IDENTIFICATION DATA
ID	Unaniani dwelling #5306
Date of inspection	09.08.2023
Location	Balanta, Borjomi, Samtskhe-JavaKheti, Georgia 41° 37' 0.7039" N 43° 32' 33.8356" E
Date of construction	End of XIX century – Beginning of XX century.
Altitude	1841 m

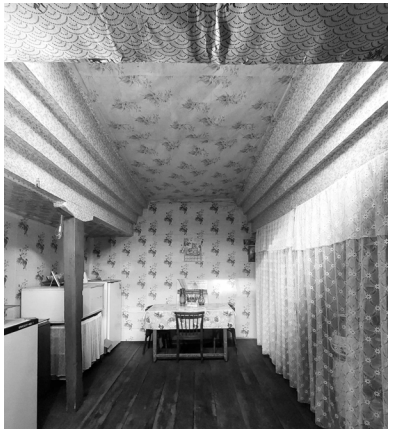
ENVIRONMENTAL DATA	13.00 – 14.00 PM
Ambient temperature (°C)	26.0
Relative humidity 2m (%)	48
Soil temperature 7 to 28cm (°C)	20.2
Soil temperature 100 to 255cm (°C)	10.8
Soil moisture 7 to 28cm (m^3/m^3)	0.25
Soil moisture 100 to 255cm (m^3/m^3)	0.33

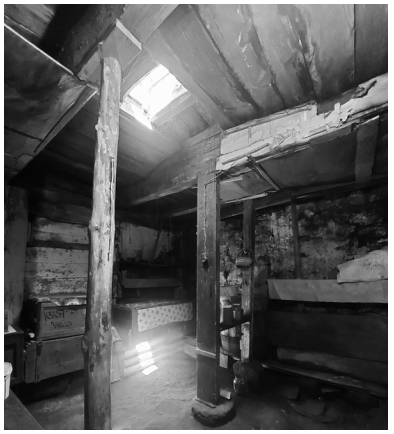
General information

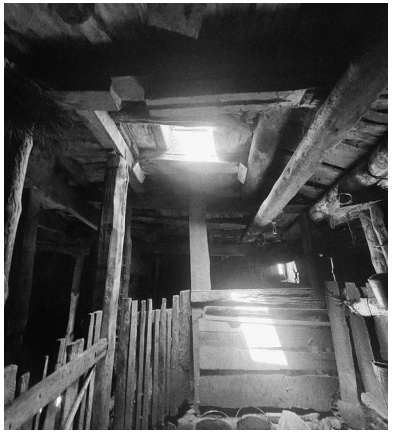
This house, belonging to the family of Unaniani, has been inhabited for decades before. It is located in Western part of the village, neighbouring Maghradze Genadi dwelling. Actually, it is listed on the Georgian heritage account since 2012, but no actions for conservation or repair have taken place, except some manual interventions on the place by the owners themselves.

Spatial organisation and architectural characteristics

Through architectural scope, we can say that housing is divided into two adjoining zones – one that contains several historic parts and another built appendix, most probably during mid-soviet period. The







historical core is partially modified nowadays, (*figure 3.5.1*) but mostly they seem to be structurally intact, as well as their bio conservative state, which is far more desirable than other surveyed dwellings.

Respecting the will of Unaniani family, this survey does not include measurements and further investigations into the architecture of their habitat, therefore, there's no provision for biodegradation and mechanical state assessment below.

▲ **Fig. 59/** *Unaniani dwelling, Takarebiani Oda chamber*

▲ **Fig. 60/** *Unaniani dwelling, Akhori space, view from the hallway*

◀ **Fig. 61/** *Unaniani dwelling, Akhori space, view from the center*

N6	IDENTIFICATION DATA
ID	Unknown family dwelling
Date of inspection	08.08.2023
Location	Balanta, Borjomi, Samtskhe-JavaKheti, Georgia 41° 37' 0.7039" N 43° 32' 33.8356" E
Date of construction	Unknown
Altitude	1843 m

ENVIRONMENTAL DATA	17.00 – 18.00 PM
Ambient temperature (°C)	18.6
Relative humidity 2m (%)	80
Soil temperature 7 to 28cm (°C)	20.2
Soil temperature 100 to 255cm (°C)	10.7
Soil moisture 7 to 28cm (m^3/m^3)	0.25
Soil moisture 100 to 255cm (m^3/m^3)	0.33

Spatial organisation and architectural characteristics

This dwelling came across the survey spots unexpectedly, and since there were no whereabouts of the owner or other inhabitants possessing any kind of information, the introductory part of these ruins is absent.

As concluded from the visual observations, the remaining part of the dwelling can be identified as an *Oda* bedding room, connected to other inaccessible or ruined chambers. Another partially present part of the dwelling is *Karapani* – the entrance, currently nearly inaccessible due to collapsed roofing. It could be easily noticed from the photographs, that this room itself is quite rich in architectural and technological expression, with quality of materials, use of wooden structural elements and decorations, carried out with fine craftsmanship.

Deterioration and structural issues

From the visual survey the structural impairment of the entire dwelling is obvious – absence, dislocation and collapse of multiple roofing components, together with partially crumbled masonry walls. In *Karapani* unit, the wooden log beams are ruptured holding additional weight of sagging soil, overhanging and other elements block the entrance to the main hall.

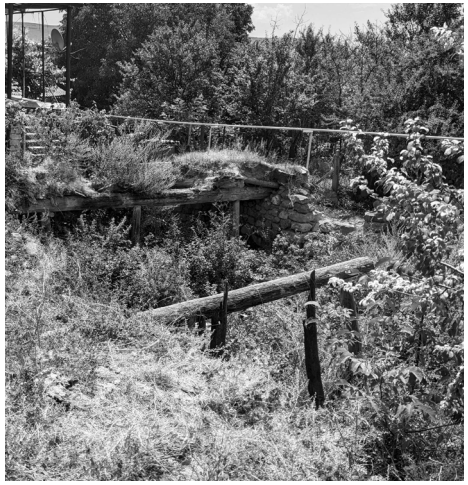
Within remaining part of the structure of the main hall, there is not substantial biological damage, but we can still recognize mild fungi attack on the roof, Mold outgrowths, insect damage and severe weathering of lateral wing components.

Fig. 62/ *Unknown family Oda, view from the entrance point*

Fig. 63/ *2 Unknown family Oda, view on the chamber entrance*

			**Image N**
Moderate/severe fungi attack (soft rot); Mold/mildew;	Mold/mildew; Moderate Insect attack;	Mild- moderate Fungi attack; (soft rot); Mild -moderate insect attack;	**Biological decay**
Natural weathering; Alteration (Dust deposition);	Natural weathering; Alteration (Dust deposition);	Lacuna in the roof; Sagging soil; Longitudinal fractures of wooden beams and planks;	**Mechanical failure; Other**
Knots; Stains; Longitudinal fractures;	Longitudinal fractures; Knots; stains;	Knots; fractures; rupture of elements;	**Defects**
1. 20-24 cm; 2. 4x18 cm	16x20 cm	3x16 cm	**Av. Dimensions of timb. element**

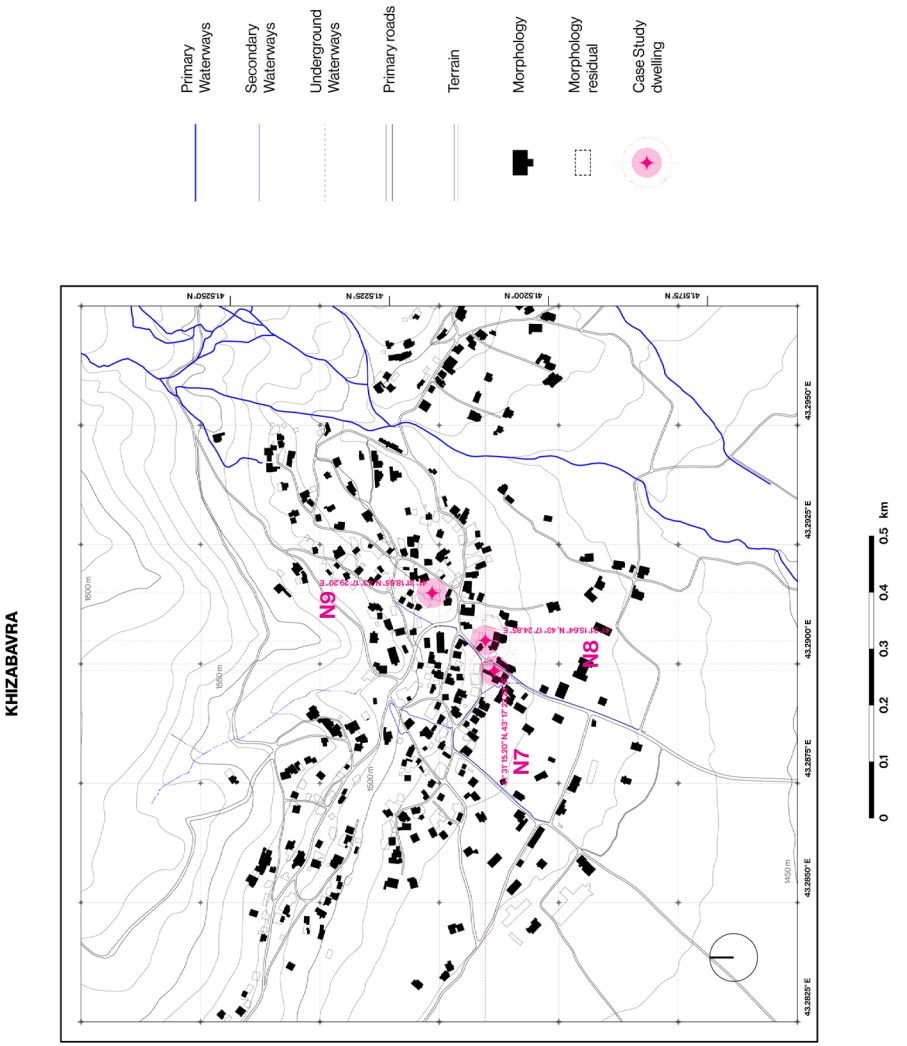
	**Image N**
Mold/mildew; mild-moderate Insect attack;	**Biological decay**
Paint decay; Minor longitudinal fractures; Weathering;	**Mechanical failure; Other**
Knots; Partial fractures due to nails/spikes;	**Defects**
16-20cm	**Av. Dimensions of timb. element**



Khizabavra

Another remote settlement *Darbazi* dwelling discovery is called Khizabavra, placed in Aspindza Municipality, Samtskhe-Javakheti region. The village varies between 1450-1550-meter altitude on Javakheti highland within the Mtkvari alley, in between Trialeti ridge from the North-East and Erusheti mountain range on the South-Western bank.

The population of the village includes all the generations, working locally and outside of the village within various traditional sectors. Having a slight advantage to neighbouring villages with local school, library and Catholic church, Khizabavra renders more potential for further development and probable touristic attraction.



N7	IDENTIFICATION DATA
ID	Datashvili dwelling
Date of inspection	10.08.2023
Location	Khizabavra, Borjomi, Samtskhe-Javakheti, Georgia 41°31'15.2"N 43°17'23.2"E
Date of construction	End of XIX century
Altitude	1489m

ENVIRONMENTAL DATA	12.00 – 13.00 PM
Ambient temperature (°C)	27.0
Relative humidity 2m (%)	38
Soil temperature 7 to 28cm (°C)	19.9
Soil temperature 100 to 255cm (°C)	10.8
Soil moisture 7 to 28cm (m^3/m^3)	0.25
Soil moisture 100 to 255cm (m^3/m^3)	0.33

General Information

The dwelling owned by Platchiashvili Tsira for over 40 years, was originally constructed by the Datashvili family, approximately in the final years of the XIX century. It is placed near the primary roadway crossing the village and currently is being utilised for storage purposes.

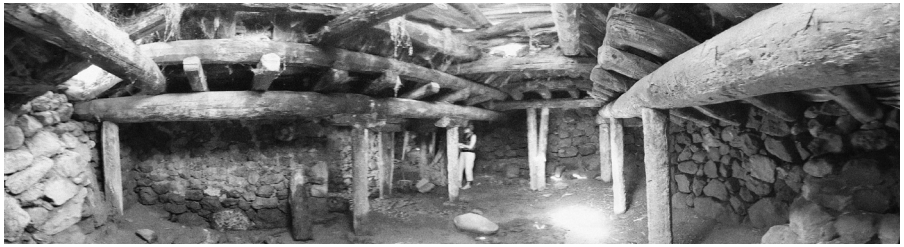
Spatial organisation and architectural characteristics

Habitat is assembled by two primary spatial units – the main hall with *Gvirgvini* roofing and the Akhori room for cattle. We enter the dwelling from the south-eastern side through a short hallway, descending halfway underground, we encounter a myriad of columns and mixed wooden roofing structures assembled with wooden logs and lumber. The geometrical difference within the wooden framework, more specifically the ratio of beam diameter to the supporting column is visually and structurally astounding.

Fig. 64/ *Datashvili dwelling (Darbazi hall).*

Fig. 65/ *Datashvili house (main entrance, outdoor view)*

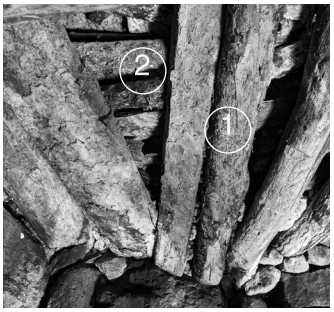
Fig. 66/ *Akhori space, panoramic view*

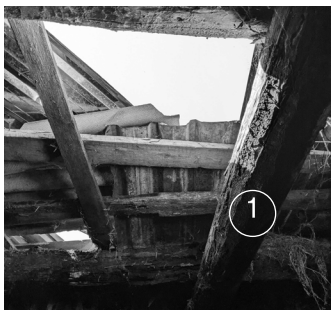


Deterioration and structural issues

As for the current state of the dwelling, the primary issue refers to the partial low-level flooding of both spaces, resulting from recently damaged roofs (for over 2-3 years). The upper part *Gvirgvini* skylight seems to be lacking several beams, while the other roof has substantial damage about 1/3 part of the whole structure. It has been subjected to partial repairs by the owners, with additional lumber beams and corrugated slate sheets. Some of the framework columns in the main *Darbazi* hall are in an unserviceable state, suffering from transversal and longitudinal cracks, and biological deterioration from humidity and insects. The same effects can be noted for the secondary beams and covering wooden plates, alongside with combination of white and soft rot.

Since the tree species cannot be identified from the on-site survey, this thesis implies the information gathered from the inhabitants verbally and from previous research. For the village of **Khizabavra**, the dendrological outline shows the use of Spruce and Beech tree species within these historical structures.

			**Image N**
Moderate fungi attack (white rot); Severe Insect attack (Galleries, exit holes & dust excrements);	Severe Insect Attack (Galleries, exit holes; dust excrements); Mold/mildew;	Mediocre fungi attack (white rot); Mild-mediocre insect attack; Mold/mildew;	**Biological decay**
Deflecting elements; Alteration (Dust and smoke deposition); Weathering;	Weathering; Alteration (Dust and smoke deposition);	Sagging soil on roof top levels; Transversal fractures of several elements; Alteration (Dust and smoke deposition);	**Mechanical failure; Other**
Stains; Multiple knots; Longitudinal fractures;	Knots; stains;	Knots; Stains; Minor longitudinal fractures;	**Defects**
1. 10-14 cm 2. 6-8 cm	1. 34-38 cm 2. 28-32 cm	30-32 cm	**Av. Dimensions of timb. element**

			**Image N**
Moderate/severe fungi attack (soft rot); Mold/mildew;	Mediocre fungi attack (soft rot); Severe Insect attack;	Severe fungi attack (soft rot); Insect attack (Galleries, exit holes & dust excrements);	**Biological decay**
Water leakage from defected roof; Fracture and rupture of elements; Alteration (Dust and smoke deposition);	Minor longitudinal fractures; High moisture content; Lacuna in the roof;	Weathering; Alteration (Dust and smoke deposition); Fracture and Rupture of elements;	**Mechanical failure; Other**
Knots; Stains; Longitudinal fractures; Crookedness;	Longitudinal fractures; Knots; stains;	Knots; Stains;	**Defects**
1. 28-32 cm; 2. 8-12 cm	28-32 cm	4x20 cm	**Av. Dimensions of timb. element**

N8	IDENTIFICATION DATA
ID	Khutsishvili dwelling #5357
Date of inspection	10.08.2023
Location	Khizabavra, Borjomi, Samtskhe-Javakheti, Georgia 41°31'15.0"N 43°17'24.6"E
Date of construction	Beginning of the XIX century
Altitude	1491 m

ENVIRONMENTAL DATA	13.00 – 14.00 PM
Ambient temperature (°C)	31.2
Relative humidity 2m (%)	30
Soil temperature 7 to 28cm (°C)	21.4
Soil temperature 100 to 255cm (°C)	12.0
Soil moisture 7 to 28cm (m^3/m^3)	0.21
Soil moisture 100 to 255cm (m^3/m^3)	0.31

General information

This rather important housing complex is located near Datashvili dwelling across the primary road of the village. It was built at least across two periods of time, the older part in the early XIX century, accompanied by later living spaces of the Sovietisation period of the mid-20th century. The complex has been enlisted as cultural heritage since 2012, but unfortunately stays in the same poor condition and is currently used primarily for livestock and storage.

Spatial organisation and architectural characteristics

Our interest exclusively lies in the older part of the dwelling, which is divided into four main spaces, integrating *Darbazi* hall, large Akhori for cattle keeping, living room/ storage space and Takarebiani Oda chamber for more privacy. The latter room is the most architecturally valuable part

of this complex, alongside the particularly decorated wooden columns of the main *Darbazi* hall.

> "Beyond its somewhat rudimentary crown, attention is drawn to the supportive structure attached to the wall. The columns exhibit relatively intricate profile capitals, alongside Kartli capitals with simpler yet reminiscent astral decorations. The winter shed, or Oda, characterized by its green-painted pitched roof, exemplifies typical yet high-quality construction. Notably, a well-preserved wide throne, known as the *Sakve*[3] , is situated on the right side. The crown of this structure boasts better prestervation compared to other monuments. The architectural significance of Gia Khutsishvili's hall lies in its elaborate column capitals and ornamentation, a rarity in rural examples."[4]

Deterioration and structural issues

Overall deterioration status of the dwelling can be regarded as alarming since the primary *Darbazi* hall with crowned ceiling is in poor condition and a substantial part of framework elements suffer from high moisture content and fungi attack, which can be concluded even from visual observations. Moreover, the retaining stone walls, which have been preserved well in other surveyed dwellings, here in Khutsishvili chambers have a high amount of dust and smoke disposition. Other spaces, such as *Akhori* and *Takarebiani Oda*, have issues with structural integrity due to rupture or total absence of secondary roofing elements, which support the soil cover above, while the primary beams and columns might be assumed structurally stable, with mild-to-mediocre biological decay.

Fig. 67/ *Khutsishvili dwelling, Akhori space view*

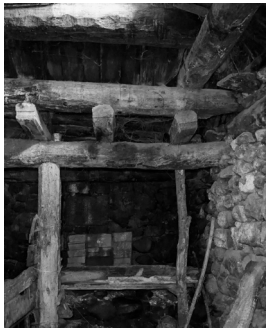


Fig. 68/ *Khursishvili dwelling, Takarebiani Oda view*

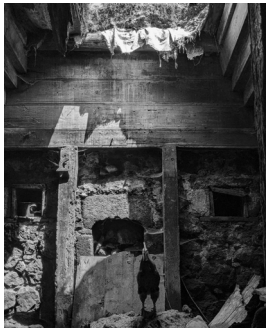


Fig. 69/ *Khutsishvili dwelling, Darbazi hall. Courtesy of G. Khaburdzania*

3. Sakve (საქვე) - embedded bed couch. Source: Javanese dictionary / Giorgi Zedginidze; Ed. Vladimir Zedginidze. - Tbilisi: Saunje: Vazha Tsotskolauri, 2014. - 370 p.;

4. Ministry of Culture and Monuments Protection of Georgia. Accounting card of immovable objects/monuments of cultural heritage. N 3/ 86

			**Image N**
Moderate/severe fungi attack (soft rot); Mold/mildew;	mediocre – severe insect attack; Mold/mildew;	Mediocre-severe fungi attack (white rot);	**Biological decay**
Sogging baulk boards; Weathering; Alteration (dust deposition);	Weathering; Paint decay; Dust/ smoke deposition;	High moisture content; Longitudinal fractures; Alteration (Dust/smoke deposition);	**Mechanical failure; Other**
Stains; Longitudinal fractures;	Longitudinal fractures; Knots; stains;	Knots; Stains;	**Defects**
4x20 cm	20-24 cm	1. 24-28 cm 2. 14-16 cm	**Av. Dimensions of timb. element**

			**Image N**
moderate fungi attack (white rot); Mold/mildew;	Severe fungi attack (soft rot); Mild- moderate insect attack (exit holes);	Mold/mildew; Moderate-severe insect attack;	**Biological decay**
Water leakage from defected roof; Alteration (dust and smoke deposition); Sagging soil;	Sagging of baulk boards and secondary beams; Weathering; Alteration (dust and smoke deposition);	Weathering; Sagging soil; Lacuna in rear wing; Alteration (Paint delamination)	**Mechanical failure; Other**
longitudinal and transversal fractures; Knots;	Longitudinal fractures; Deflection;	ractures due to nails/spikes;	**Defects**
1. 30-34 cm; 2. 4x24 cm	1. 28-32 cm; 2. 4x24 cm	18x22 cm	**Av. Dimensions of timb. element**

N9	IDENTIFICATION DATA
ID	Keghoshvili dwelling #5361
Date of inspection	11.08.2023
Location	Khizabavra, Borjomi, Samtskhe-Javakheti, Georgia 41°31'15.0"N 43°17'24.6"E
Date of construction	End of XVIII century – Beginning of XIX century
Altitude	1499 m

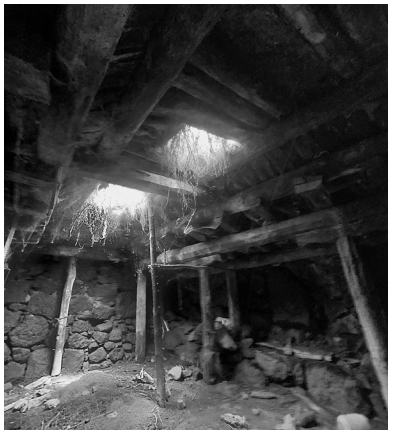
ENVIRONMENTAL DATA	12.00 – 13.00 PM
Ambient temperature (°C)	29.5
Relative humidity 2m (%)	36
Soil temperature 7 to 28cm (°C)	21.8
Soil temperature 100 to 255cm (°C)	12.1
Soil moisture 7 to 28cm (m^3/m^3)	0.20
Soil moisture 100 to 255cm (m^3/m^3)	0.31

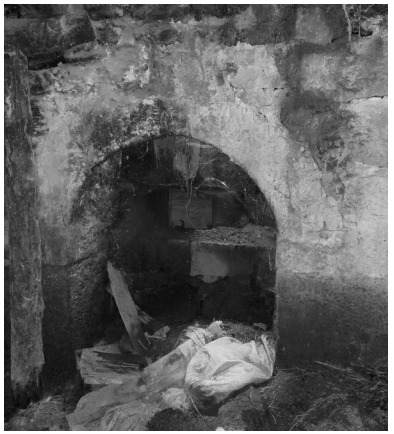
General information

The dwelling is located in the remote village of Khizabavra. The housing complex was primarily built in the beginning of XIX century.

Spatial organisation and architectural characteristics

This dwelling is an excellent example of a Samtskhe-Javakheti-type *Darbazi*. It consists of two rooms with a crowned ceiling and a spacious Oda chamber. The main hall displays an abundance of vertical supports, part of which is obviously added later for manual strengthening. The monumental quadrangular crown has eight rows of crude thick beams, while the main perimetral supports are relatively thin and visually light. The adjacent Oda chamber has an indisputable architectural value due to its grand dimensions, use of archaic construction and structural accuracy. Overall, mastery of wooden frameworks within this dwelling is accurate and fascinating



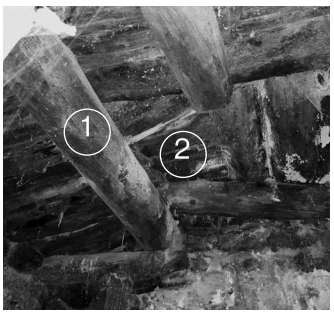
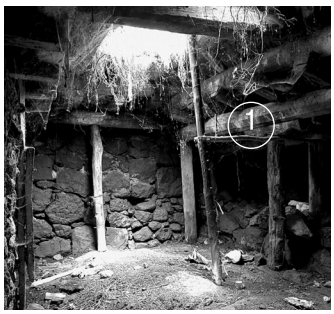


Deterioration and structural issues

The decay status of the building can be identified as alarming, more specifically the absence of lateral cover within the main *Darbazi* hall, as well as the biological deterioration and disposition of multiple columns. The main crown elements have obvious depositions of Mold/mildew and early stages of white rot, effects of severe weathering and mild-to-moderate insect attack. We can identify the bio-deterioration in the Oda chamber in the same manner – signs of white rot, Mold/mildew, dust and smoke deposits on horizontal elements. However, the structural issues in several parts of the wooden cover are more disturbing – the rupture of some elements and the total collapse of the rear and frontal wings facilitate humidity and consequential the buildup of biological decay.

Fig. 70/ *Keghoshvili dwelling, Darbazi hall*
Fig. 71/ *Keghoshvili dwelling , Oda chamber*
Fig. 72/ *Keghoshvili dwelling , Oda chamber, fireplace*

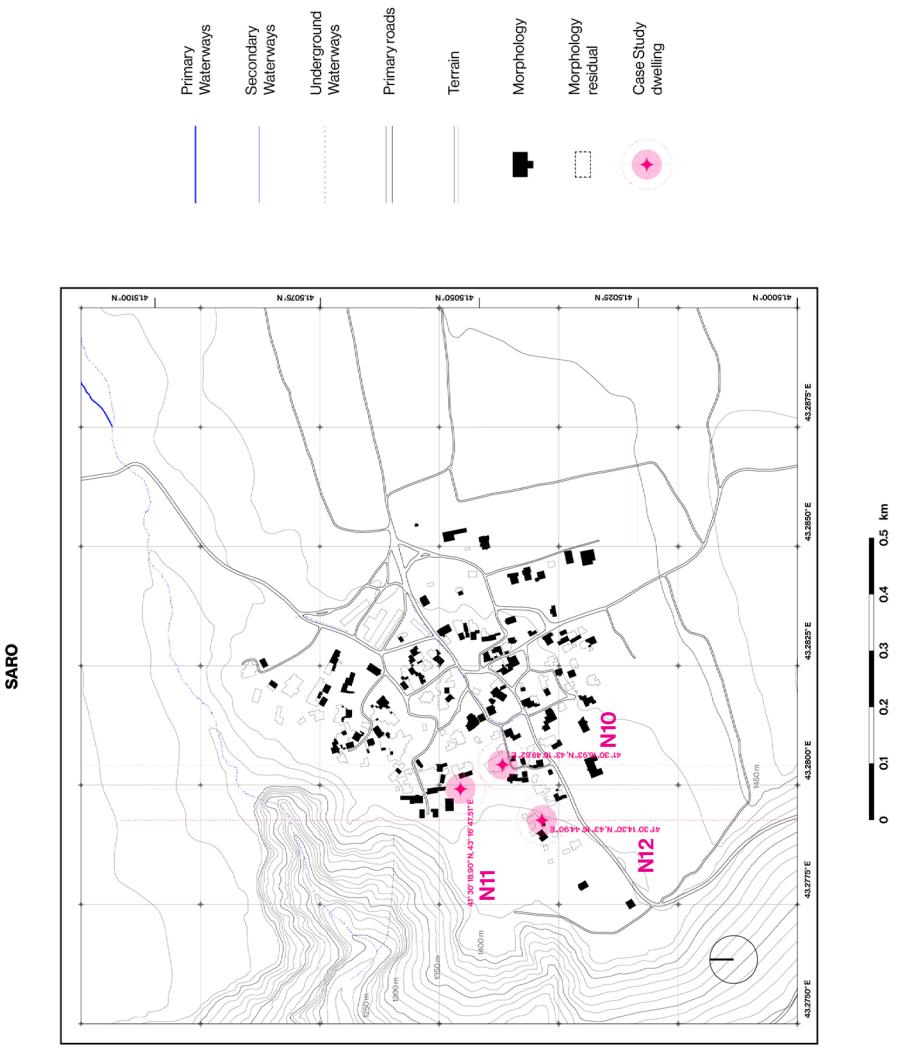
			**Image N**
Severe Insect attack (Galleries, exit holes & dust excrements);	Moderate fungi attack (white rot); Mold; Mild /moderate Insect attack (exit holes);	Moderate fungi attack (white rot); Mold; Mild /moderate Insect attack (exit holes);	**Biological decay**
Weathering; Dust/smoke deposition; damp base;	Weathering; Dust/smoke deposition;	Lacuna in the rear wing; Buckling and rupture of pillars;	**Mechanical failure; Other**
Longitudinal fractures; fractures due to nails/spikes;	Longitudinal fractures;	Longitudinal fractures; Knots;	**Defects**
20x24 cm	1. 30-34 cm 2. 4x24cm	28-32 cm	**Av. Dimensions of timb. element**

			**Image N**
Severe fungi attack (white rot); Mold/mildew; Moderate Insect attack (exit holes);	Mild fungi attack (white rot); Mild /moderate Insect attack (exit holes);	Moderate Insect attack (galleries; exit holes);	**Biological decay**
Weathering; Dust/smoke deposition;	Lacuna in the frontal and central part; Sagging soil; Dust/smoke deposition;	Weathering; Dust/smoke deposition; Damp base;	**Mechanical failure; Other**
Longitudinal fractures;	Longitudinal fractures;	ractures due to nails/spikes;	**Defects**
1. 30-32 cm; 2. 4x24 cm	30-32 cm;	22-24 cm	**Av. Dimensions of timb. element**

Saro

Third and probably the most vital destination on the survey list is village Saro – a modest settlement in Aspindza Municipality, a few kilometres southwest from village Khizabavra, Samtskhe-Javakheti region, with undisclosed underground treasure, ready for a new era of rediscovery. The village is positioned between 1400 – 1450 meters asl. on Javakheti highland within the Mtkvari alley, in between Trialeti ridge from the North-East and Erusheti mountain range on the South-Western bank.

The settlement is currently sparsely populated mostly by older generation, leaving the youth with multiple layers of socio-cultural challenges, including the civil architectural heritage in this remote area, where the primary source of living derives from subalpine meadows.



N10	IDENTIFICATION DATA
ID	Aspanidze dwelling #5340
Date of inspection	10.08.2023
Location	Saro, Borjomi, Samtskhe-javaKheti, Georgia 41°30'16.7"N 43°16'49.3"E
Date of construction	Beginning of XIX century
Altitude	1437 m

ENVIRONMENTAL DATA	17.00 – 18.00 PM
Ambient temperature (°C)	23.7
Relative humidity 2m (%)	58
Soil temperature 7 to 28cm (°C)	23.0
Soil temperature 100 to 255cm (°C)	12.6
Soil moisture 7 to 28cm (m^3/m^3)	0.21
Soil moisture 100 to 255cm (m^3/m^3)	0.31

General Information

The Aspanidze housing complex was primarily built at the beginning of the XIX century . It stands close to the entrance of the remote village Saro, located a few kilometres southwest of Khizabavra, overseeing the river Mtkvari gorge. The owners left the habitat many years ago and resettled in a newer *Darbazi* complex close by, which is listed as cultural heritage as well, but unfortunately was unavailable for inspections during the time.

Spatial organisation and architectural characteristics

The housing entrance is facing northwest, a large part of which lays in ruins nowadays, leaving us with the main hall with *Gvirgvini* and remains of adjoining *Oda* chamber.

This *Darbazi* hall is undoubtedly one of the most impressive among the dwellings visited during the amateur expedition. Whilst entering the space, the neat assembly of large-spanned lumber beams, leaning solely on the perimeter and its clean geometry provides us with a feeling of spaciousness and grandeur. One of the notable characteristics of this house is its high level of wood and stone masonry craftsmanship, as we can observe from the treatment of existing building materials, their quality at first, then the organization and decoration, especially within Oda part, which was inaccessible for spatial survey.

Deterioration and structural issues

From a structural point of view, the overall integrity of the dwelling complex is compromised, but separately the remaining frameworks of some chambers meet the basic requirements. The space we encounter first, which supposedly used to be the main entrance, currently lays in masonry ruins. (Fig. 75) Otherwise, the main hall, in contrast to the adjacent Takarebiani Oda chamber, remains mostly intact considering the wooden framework, but lacks thermal integrity due to partially collapsed stone masonry walls and cover within tandoor section.

As for the decay of the timber elements within the building, main issues are attributed to the fungal growths (mild to moderate stage of Mold and mildew, as well as the white and brown rot) both on vertical and horizontal bearing structures. We can spot mild/moderate insect attack on *Gvirgvini* system, while lateral structures display much further stages of decay (fungal attack with combination of pest infestation).

Since the tree species cannot be identified from the on-site survey, this thesis implies the information gathered from the inhabitants verbally and from previous research. For the village of **Saro**, the dendrological outline shows the use of Spruce and Beech tree species within these structures.

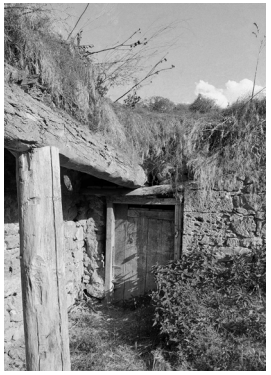
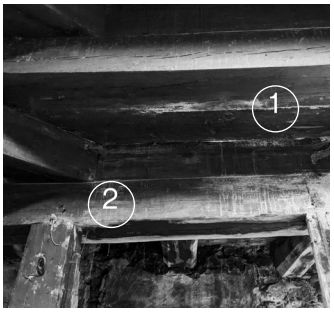
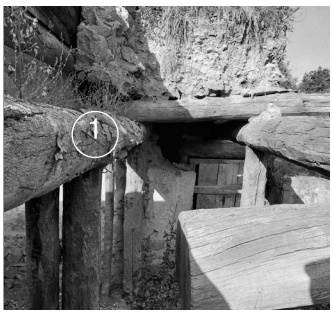


Fig. 73/ *Aspanidze dwelling. View on Karapani (portico)*

Fig. 74/ *Aspanidze dwelling. View on Takarebiani Oda chamber (inaccessible)*

Fig. 75/ *Aspanidze dwelling. View on main Gvirgvini crown*

			**Image N**
Moderate fungi attack (white rot); Mold; Mild/moderate Insect attack (exit holes);	Moderate/severe fungi attack (white rot, soft rot); Mold; Mild Insect attack (exit holes);	Mold; Mild Insect attack (exit holes);	**Biological decay**
Weathering; Dust/smoke deposition;	Weathering; Dust/smoke deposition; Sagging elements;	Weathering; Dust/smoke deposition;	**Mechanical failure; Other**
Longitudinal fractures;	Knots; Longitudinal fractures;	Longitudinal fractures;	**Defects**
1. 20x24 cm 2. 20x20 cm	1. 30-34 cm 2. 4x24cm	1. 20x20 cm 2. 20x24 cm	**Av. Dimensions of timb. element**

			**Image N**
Mild Insect attack (exit holes);	Severe Insect attack (galleries; exit holes);	Mold; Mild Insect attack (exit holes);	**Biological decay**
Absence of the roof; Sagging soil; Dust/smoke deposition;	Lacuna in the roof; sagging soil; Weathering;	Weathering; Dust/smoke deposition;	**Mechanical failure; Other**
Knots; longitudinal fractures;	Knots; longitudinal fractures;	Knots; fractures due to nails/ spikes;	**Defects**
24-30 cm	28-34 cm	20x24 cm	**Av. Dimensions of timb. element**

N11	IDENTIFICATION DATA
ID	Londaridze dwelling #5344
Date of inspection	10.08.2023
Location	Saro, Borjomi, Samtskhe-javaKheti, Georgia 41°30'19.1"N 43°16'48.1"E
Date of construction	Mid-XIX century
Altitude	1438 m

ENVIRONMENTAL DATA	18.00 – 19.00 PM
Ambient temperature (°C)	24.6
Relative humidity 2m (%)	51
Soil temperature 7 to 28cm (°C)	23.0
Soil temperature 100 to 255cm (°C)	12.6
Soil moisture 7 to 28cm (m^3/m^3)	0.21
Soil moisture 100 to 255cm (m^3/m^3)	0.31

General Information

The dwelling is located within walking distance from the previous house, almost hiding behind the ruins and cluster of overgrown plants. It belonged to the ancestors of the Aspanidze family and is more than 150 years old, but it is currently just a reminiscence of the village's foundation.

Spatial organisation and architectural characteristics

Despite the time shortage for acquiring proper data from this historical structure, it is one of the most archaic but spectacular places in this research journey.

We start the path into the dwelling from the Southeast façade: after entering the large hallway with curvilinear retaining walls built with massive boulders and a somewhat raw wooden structure, we observe an adjacent ruined chamber, currently taken over by vegetation. Followed by

the spacious Akhori, constructed with the Kvantebiani roofing principle, we finish our itinerary in the main hall with an octangular *Gvirgvini* ceiling and not one but two in-wall-embedded fireplaces. Despite the lack of decoration and overall crudeness of construction materials, the thrilling architectural sensation caused by this place is undeniable.

Deterioration and structural issues

The current state of the dwelling is not satisfactory, as there are several issues including a partial collapse of the Akhori roofing structure in lateral and rear wings and major damage to the hallway cover coupled with its retaining wall. The main *Darbazi* hall seems structurally stable and with no major deterioration. However, biological attack on these wooden elements needs attention. For instance, massive beams within the crown structure display some signs of pest infestation, mould and smoke/ dust deposition. Additionally, we observe insect attack and longitudinal cracking mostly on the vertical bearing elements in other chambers and medium-to-severe Mold deposits on horizontal elements of wooden framework.

Fig. 76/ *Londaridze dwelling. Darbazi hall (panoramic view)*

Fig. 77/ *Londaridze dwelling. Darbazi hall, view on Gvirgvini*

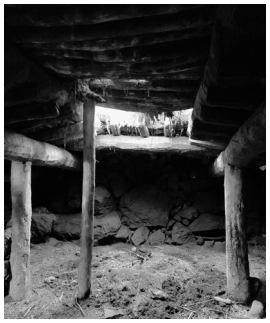


Fig. 78/ *Londaridze dwelling. Akhori chamber*

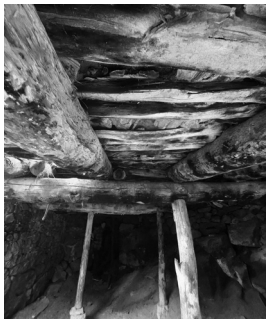
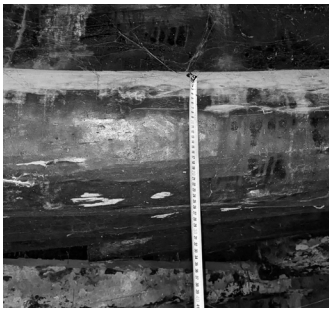
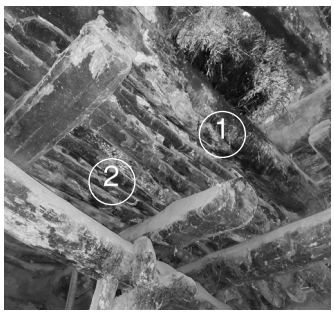


Fig. 79/ *Londaridze dwelling. hallway, view from the entrance.*

			**Image N**
Mild fungi attack (white rot); Mold; Mild/moderate Insect attack (exit holes);	Mild Insect attack (exit holes); Mold;	Mild Insect attack (exit holes);	**Biological decay**
Weathering; Paint decay; Dust/ smoke deposition;	Weathering; Paint decay; Dust/ smoke deposition;	Weathering; Dust/smoke deposition;	**Mechanical failure; Other**
Knots; fractures due to nails/ spikes;	Knots;		**Defects**
20 cm	1. 30-34 cm 2. 22x24cm	34 cm	**Av. Dimensions of timb. element**

			**Image N**
Severe Insect attack (galleries, exit holes);	Severe Insect attack (galleries, exit holes & dust excrements);		**Biological decay**
Weathering; Rupture of elements;	Weathering; Lacuna in roof; Dust/ smoke deposition	Absence of roofing elements; Sagging soil;	**Mechanical failure; Other**
Knots; fractures due to nails/ spikes;	Knots; longitudinal fractures;	Beam deflection; Transveral fractures; Rupture;	**Defects**
28-32 cm	1. 28-30 cm; 2. 4-8 cm		**Av. Dimensions of timb. element**

N12	IDENTIFICATION DATA
ID	Maghradze dwelling #16075
Date of inspection	11.08.2023
Location	Saro, Borjomi, Samtskhe-javaKheti, Georgia 41°30'14.3"N 43°16'44.9"E
Date of construction	mid-XIX century
Altitude	1430 m

ENVIRONMENTAL DATA	14.00 – 15.00 PM
Ambient temperature (°C)	29.9
Relative humidity 2m (%)	35
Soil temperature 7 to 28cm (°C)	22.9
Soil temperature 100 to 255cm (°C)	12.7
Soil moisture 7 to 28cm (m^3/m^3)	0.20
Soil moisture 100 to 255cm (m^3/m^3)	0.31

General information

Maghradze dwelling is located in the Southern part of Saro village and represents Meskhian-type *Darbazi*, primarily built in the mid-XIX century. According to the report[5] , the complex has been uninhabited for years since 2003. Now it is partially ruined and abandoned, with only attention from local tour guides and various visitors. Maghradze *Darbazi* has been enlisted as a cultural heritage since 2017.

Spatial organisation and architectural characteristics

The entrance starts from *Karapani* facing South, leading visitors through the transitional hallway, then through Akhori space to the main hall with *Gvirgvini*. Additionally, on the right wing, we find the small size pantry.

All chambers are covered with various superimposed timber structures. For clarity, the Akhori space is roofed with a Kvantebiani cover structure finished with a central skylight. As for the *Darbazi* hall, its ceiling represents an octangular crown, erected with accurately hewn lumber beams and traditionally decorated columns. On the lateral wing, the hall incorporates a tandoor section Satone. The value of this dwelling lies in a high level of craftsmanship.

5. *Ministry of Culture and Monuments Protection of Georgia. Accounting card of immovable objects/monuments of cultural heritage. N 2/44*

▲ **Fig. 80/** *Maghradze dwelling. Hallway*

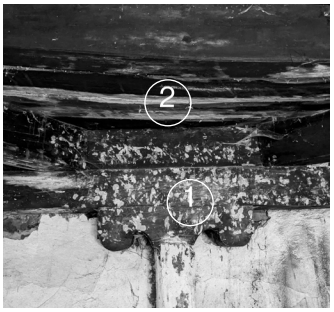
▲ **Fig. 81/** *Darbazi hall*

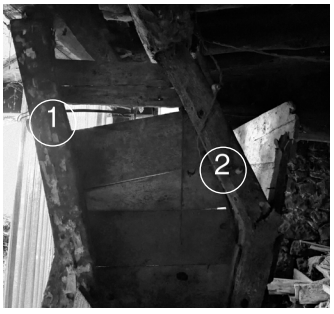
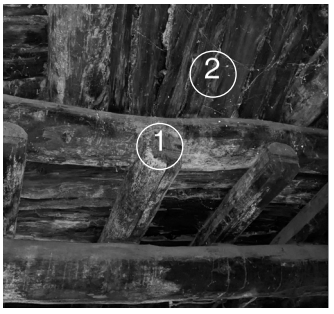
▼ **Fig. 82/** *Darbazi hall. view on Gvirgvini*

Deterioration and structural issues

Unfortunately, after the ultimately conducted scientific report, the integrity of the dwelling structure has been compromised, specifically in the lateral tandoor section, where the roofing elements have collapsed along with the soil layer, and additionally, in hallway space, where the left part of the wooden baulk boards have ruptured, most probably due to heavy rainfalls and lack of maintenance.

Overall, a major part of wooden elements does not meet the requirements of serviceability. The beams and columns have severe damage from insects and wood-decay fungi. Aside from biological deterioration, we need to mention the mechanical state of particular elements – dislocation, cracking, sogging and rupturing of separate structural or non-structural members, with a few replaced and extra elements for manual strengthening.

			**Image N**
Moderate/severe fungi attack (white rot); Mold; Mild Insect attack (exit holes);	Moderate Fungi attack (white rot); Mold; Moderate/severe Insect attack;		**Biological decay**
Weathering; Dust/smoke deposition;	Weathering; Dust/smoke deposition;	Sagging soil and Water leakage from defected roof; lacuna in rear wing	**Mechanical failure; Other**
Multiple fractures due to nails/ spikes;			**Defects**
1. 20x18 cm; 2. 20x24 cm	18-22 cm		**Av. Dimensions of timb. element**

			**Image N**
Moderate fungi attack (white rot); Mold; Mild Insect attack (exit holes);	Severe Insect attack (galleries, exit holes & dust excrements);	Moderate/severe fungi attack (white rot); Mold; Mild/moderate Insect attack (exit holes);	**Biological decay**
Weathering; Rupture of elements;	Damp base; Weathering; Buclking;	beam deflection; Weathering; Dust/smoke deposition; Sagging soil;	**Mechanical failure; Other**
fractures due to nails/spikes;	Knots;	Knots; Crookedness;	**Defects**
1. 20x22 cm; 2. 20x20 cm	24-28 cm	1. 28-30 cm; 2. 4x20 cm	**Av. Dimensions of timb. element**

N13	IDENTIFICATION DATA
ID	Khitarishvili dwelling
Date of inspection	20.08.2023
Location	Vale, Akhaltsikhe, Samtskhe-Javakheti, Georgia 41° 37’ 3.36” N, 42° 52’ 36.31” E
Date of construction	XX century, 70s
Altitude	1202 m

General information

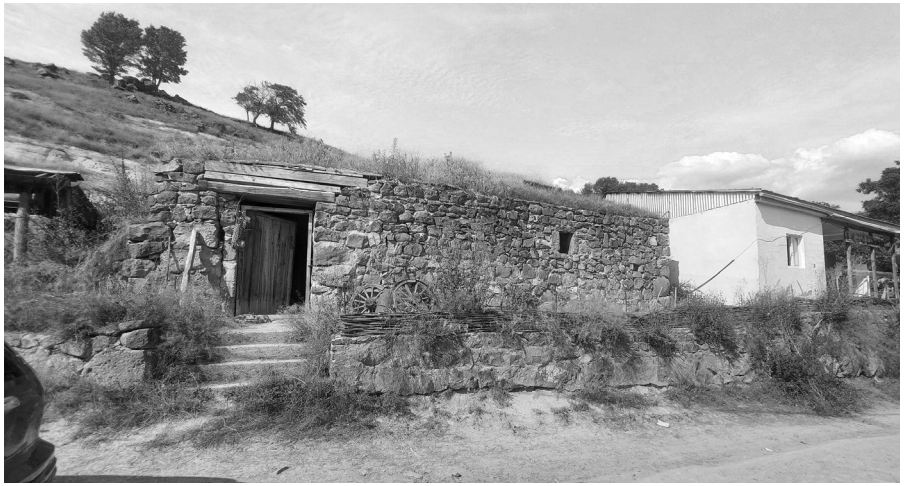
This dwelling found in **Vale** town is out of ordinary survey list due to its date and type of construction. It belongs to late-soviet suburban housing type, with the special exception of one living room with *Gvirgvini* ceiling carried out in late 1970s. According to the owners, this scale of vernacular expressions within civilian dwellings were unusual during the time, but due to abundance of wooden material, they have decided to revive their dwelling with this wooden crown.

Fig. 83/ *Khitarishvili dwelling. main hall*

Fig. 84/ *View on Gvirgvini*

Another distant settlement on the inspection list is **Chobareti** village, succumbed in the river Mtkvari gorge, between *Trialeti* ridge and *Erusheti* mountain range, raised around 1400 meters above sea level. The village seems to be wrapped around the south slope of a hill, overseeing the agricultural bricolage below.

The village seems to be drained in social aspect, meaning that most of the inhabitants have migrated to other urban settlements, while the rest are primarily preoccupied with agricultural labour.



N14	IDENTIFICATION DATA
ID	Jvaridze (Former Inasaridze dwelling) #5349
Date of inspection	21.08.2023
Location	Chobareti, Aspindza, Samtskhe-Javakheti, Georgia , 41° 34' 44.12" N, 43° 7' 45.24" E
Date of construction	Second half of XVIII century
Altitude	1438 m

ENVIRONMENTAL DATA	15.00 – 16.00 PM
Ambient temperature (°C)	28.8
Relative humidity 2m (%)	61
Soil temperature 7 to 28cm (°C)	22.1
Soil temperature 100 to 255cm (°C)	12.8
Soil moisture 7 to 28cm (m^3/m^3)	0.27
Soil moisture 100 to 255cm (m^3/m^3)	0.37

General information

The dwelling is placed on the upper terrace of the foothill – the northern borderline of Chobareti village. It was built back in the XVIII century, belonging to the Inasaridze family, but has been repurposed as a folk house and restaurant by the new owners recently.

Spatial organisation and architectural characteristics

The building complex, adjoining foothill from the North and South-oriented from the entrance, includes three main spaces, the hallway, kitchen (probably), which is being renovated and, finally, the partially rehabilitated main hall, with approximate dimensions of 5x7 meters.

This dwelling does not incorporate *Gvirgvini* ceiling structure, but belongs to *Kvantebiani Oda* type and resembles aforementioned *Akhori*

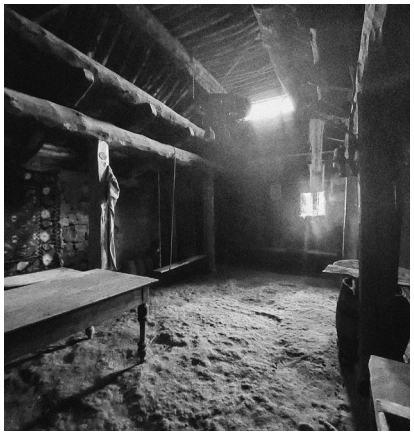
spaces, executed in rather raw and massive manner – large span crude framework with sets of wooden logs. The interior appears quite spacious due to the total height and progressively elevating central ceiling structure.

Deterioration and structural issues

The overall wooden framework of dwelling seems structurally stable, since it has been repaired rather recently, but still counts number of deteriorated elements, especially on lateral wings within rafters and purlins, displaying mild to severe pest infestation and dust/smoke disposition, part of them are ruptured, fractured and misplaced. There are some general issues within the wooden framework - mild fungal attack (such as Mold and mildew), dust and smoke deposition - spotted on the primary and secondary beams, while vertical bearing elements show signs of congenital and external defects, medium insect attack and weathering.

Fig. 85/ *Jvaridze dwelling. Main chamber*

Fig. 86/ *view on the main skylight*



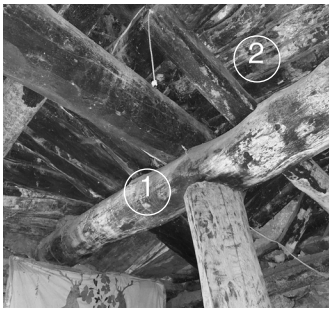
			**Image N**
Severe Insect attack; (Galleries, exit holes);	Mild Fungi attack (white rot); Mold; Mild Insect attack (exit holes);	Moderate/severe Fungal attack (white rot); Moderate-severe Insect attack (Galleries, exit holes);	**Biological decay**
Weathering; Dust/smoke deposition;	Weathering; Dust/smoke deposition;	Weathering; Dust/smoke deposition;	**Mechanical failure; Other**
Knots; Partial fractures due to nails/spikes;	Knots;	Knots; Crookedness;	**Defects**
22 cm	28-30 cm	1. 28-34 cm; 2. 24-28 cm	**Av. Dimensions of timb. element**

	**Image N**
Severe Fungal attack (white rot); Moderate-severe Insect attack;	**Biological decay**
Multiple fractures; Transversal rupture of multiple roof elements; Cracking; Sagging soil and Water leakage from defected roof; lacuna in Eastern wing	**Mechanical failure; Other**
Knots; Crookedness;	**Defects**
16-20cm	**Av. Dimensions of timb. element**

N15	IDENTIFICATION DATA
ID	Gvirdjishvili dwellings #5347
Date of inspection	21.08.2023
Location	Chobareti, Aspindza, Samtskhe-Javakheti, Georgia 41° 34' 44.14" N, 43° 7' 40.42" E
Date of construction	end of XVIII century – mid-XIX century
Altitude	1443 m

ENVIRONMENTAL DATA	15.00 – 16.00 PM
Ambient temperature (°C)	29.4
Relative humidity 2m (%)	36
Soil temperature 7 to 28cm (°C)	22.3
Soil temperature 100 to 255cm (°C)	12.8
Soil moisture 7 to 28cm (m^3/m^3)	0.27
Soil moisture 100 to 255cm (m^3/m^3)	0.37

General information

This couple of pit houses in Chobareti is placed near Jvaridze dwelling, on the edge of the foothill. According to the eldest living member of the Gvirdjishvili family, the first dwelling on the Eastern wing must have been erected by the end of XVIII century, whereas the second one belongs to a later period of early XIX century.

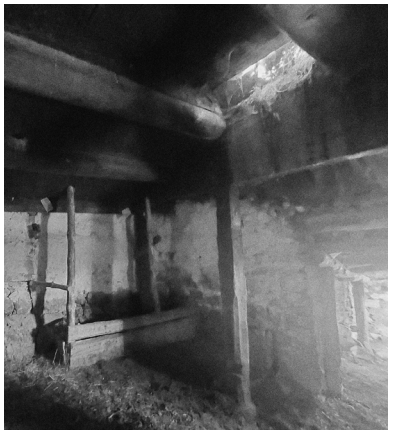
Spatial organisation and architectural characteristics

Due to family expansion almost 100 years ago, these dwellings are built near each other, also the primary entrances (*Karapani*) for both are placed on Southern façade. From older chambers, we were able to visit solely the living room – *Kvantebiani Oda*, leading to other inaccessible spaces; within more recent dwellings we observed the main hall of

▲ **Fig. 87/** *Gvirdjishvili dwelling N1. view on Karapani*

▼ **Fig. 88/** *Oda chamber. View on main skylight.*

▼ **Fig. 89/** *Gvirdjishvili dwelling N2*



Takarebiani Oda which has been used as a cattle stall at the moment. The long hallway also gives access to two other chambers, unfortunately, laying in ruins nowadays

Deterioration and structural issues

Both dwellings have obvious damage and deterioration, but the older unit seems to suffer more within the structural aspect. The primary issue occurs in absent major roofing element, uncovering the main hall and leaving it vulnerable to environmental conditions. The biological condition of the remaining wooden elements hardly seems to meet the requirements for retaining structural integrity. The major part of secondary bearing elements, which can be identified as rafters , are ruptured or heavily fractured , with sogging soil above. A major part of the wooden framework requires thorough examination for insect attack and further interventions.

As for the second dwelling, the roofing system of the main chamber appears in satisfactory condition, with no major decay, but traces of Mold and weathering. However, frontal pillars have noticeable defects and damage, such as longitudinal cracks and pest attacks. If we shift backwards to the entrance, we can observe wooden logs used as primary and secondary beams that suffer from severe pest infestation, at the extent of sapwood ring damage. Moreover, the adjacent chambers are totally destroyed and some cavities within a few masonry walls.

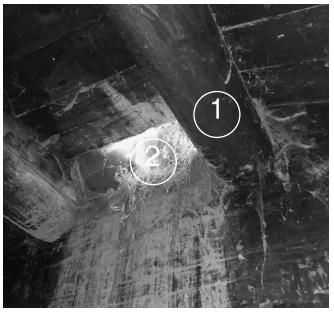
			**Image N**
Mild fungi attack (white rot); Mold; Moderate/severe Insect attack; (exit holes);	Severe Insect attack (Galleries, exit holes & dust excrements);	Mild Fungal attack (soft rot); Moderate-severe Insect attack;	**Biological decay**
Transversal fractures ; total rupture; Dust/smoke deposition;	Longitudinal fractures; Cracking;	Dust/smoke and guano deposition;	**Mechanical failure; Other**
Crookedness; Knots; Partial fractures due to nails/spikes;	Crookedness; Knots; Partial fractures due to nails/spikes;	Knots;	**Defects**
24-28 cm	28-36 cm	1. 30-32 cm; 2. 4x24cm;	**Av. Dimensions of timb. element**

			**Image N**
Mild fungi attack (white rot); Mold; Moderate/severe Insect attack; (exit holes);	Mold; Moderate/severe Insect attack (exit holes);	Mild Fungal attack (soft rot); Moderate-severe Insect attack;	**Biological decay**
Transversal fractures ; total rupture; Dust/smoke deposition;	Longitudinal fractures; Cracking; Dust/smoke deposition;	Multiple fractures; Cracking; Dust/smoke deposition;	**Mechanical failure; Other**
Crookedness; Knots;		Knots; Partial fractures due to nails/spikes; Traces of removed decorations;	**Defects**
6-10 cm	32-36 cm	30-32 cm	**Av. Dimensions of timb. element**

N16	IDENTIFICATION DATA
ID	Maisuradze (former Obolashvili) dwelling #5224
Date of inspection	22.08.2023
Location	Ude, Adigeni, Samtskhe-javaKheti, Georgia 41°38'29.6"N 42°47'37.1"E
Date of construction	XX century, 20s
Altitude	1173 m

ENVIRONMENTAL DATA	16.00 – 17.00 PM
Ambient temperature (°C)	26.4
Relative humidity 2m (%)	43
Soil temperature 7 to 28cm (°C)	23.1
Soil temperature 100 to 255cm (°C)	13.9
Soil moisture 7 to 28cm (m^3/m^3)	0.14
Soil moisture 100 to 255cm (m^3/m^3)	0.19

General information

The final destination of this survey is located in the village of Ude, Adigeni municipality, elevated between 1100-1300 meters asl. The settlement seems to be densely inhabited and more urbanised than other survey destinations, thus leaving room for very few vernacular dwellings. A charming example of these remains is the Maisuradze brothers' housing, formerly belonging to the Obolashvili family, now reconstructed and revived by the owners.

Spatial organisation and architectural characteristics

We can start the journey through the Maisuradze dwelling through the North-East facet, walking past the hallway and living room with historic fireplace (Fig. 91), we are presented with a central part of the dwelling – *Darbazi* hall with multilayered *Gvirgvini* ceiling (Fig. 92), the upper half of which has been recently reconstructed and renovated by the owners. Next, we continue our path to the adjoining *Oda* space with a freshly reconstructed traditional oven.

Upon stepping inside, the vertically driven arrangement of clean wooden beams and the precise geometry of the whole framework evoke a sense of vastness and magnificence. A prominent feature of this residence is the exceptional craftsmanship evident in its wood and stone masonry, demonstrated by the treatment and quality of the materials used initially and during the reconstruction, as well as the meticulous organization and adornment, particularly within the *Oda* section.

Maisuradze *Darbazi* hall with its elevated *Gvirgvini* crown, as well as the whole housing complex, stands out as one of the most remarkable examples of both – existent *Darbazi* structures and reconstructive works encountered during my amateur journey. The process involved within this dwelling can easily become a basis for restoration principles of these vernacular buildings, especially serving as a medium between civilian and governmental involvement in national cultural heritage.

Deterioration and structural issues

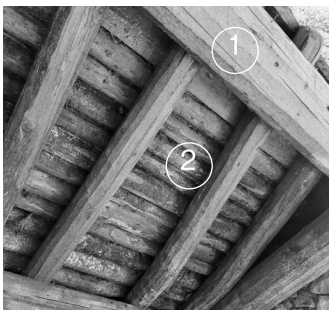
The structural and biological sanitary state of the dwelling (according to the data of August 2023) is satisfactory, but not excellent, mostly due to the *Akhori* space, which lacks the central part of the cover, has some minor issues with vertical supports, and some decayed areas in the living room, as well as its secondary walls, carried out with non-traditional and unhealthy materials during the 20th century (as seen in the table below).

Fig. 90/ *Maisuradze dwelling. view on the entrance*

Fig. 91/ *Darbazi hall. view on fireplace. Courtesy of P. Maisuradze*

Fig. 92/ *Darbazi hall. view on Gvirgvini structure*

			**Image N**
White Mold;	Mild fungi attack (white rot); Mold/mildew; ild Insect attack;		**Biological decay**
Fractures of woven fabric; Decay of mortar; Weathering;	Sagging of primary beams;	lacuna in Central wing	**Mechanical failure; Other**
Stains;	Stains; Knots;		**Defects**
	20-24 cm		**Av. Dimensions of timb. element**

		**Image N**
Mild fungi attack; Mild – moderate Insect attack (Galleries, exit holes;);	White Mold; (Galleries, exit holes);	**Biological decay**
Weathering; Longitudinal fractures;	Weathering; Transversal fractures; Rupture of some elements;	**Mechanical failure; Other**
fractures due to nails/spikes;	Knots;	**Defects**
30-32cm	1. 18-22cm; 2. 12-15cm;	**Av. Dimensions of timb. element**

Summary

The case studies listed above collected from several villages in Southern Georgia give us the general idea about the state of these structures, substantial part of which are listed[6] as cultural heritage from 2012. Considering the age and peculiar architectural character of these habitats, as well as their role in cultural and ethnographical history, their physical state must be thoroughly examined and monitored, as stated in the national law[7] on cultural heritage protection.

As mentioned before, the preliminary visual observations conducted on-site focuses on the understanding of the structural layout and on identifying and classifying gathered data about the decay, deterioration and mechanical deformation of the wooden elements. This data suggests that primary issues within the case studies are biological attackers, such as various forms of fungi (mostly white rot) and insects, accompanied with some chemical damage and mechanical defects and/or deformation.

In order to have a better overall picture of common problematics, the surveyed data have been grouped in accordance with separate municipalities and districts. To begin with, in Balanta village, we observed five to six dwellings with similar defects and decay status of wooden structures, some of the reasons might be the lack of maintenance, deficiency of wooden resources and/or financial hardship. They suffer from mild to severe fungi attack, usually found within beams and purlins, as well as the insect damage, mostly on vertical bearing elements. There is an overall tendency of fracture and damage of the seal, supporting the roofing soil cover, and intermediate insulation layer, altogether resulting in water leakage, rise of moisture content within masonry and wood , thus degenerating these materials.

Similarly, in Saro and Khizabavra settlements, three dwellings, which are being used as storage units, cattle stalls or are completely misused, undergo same process of deterioration, with biological attack and structural issues rendered in fracture of wooden elements, partial rupture of soil cover and substantial damage of retaining stone masonry walls. In addition, the housings in Khizabavra village have suffered some heavy rainfall consequences, followed up by increase of moisture content and humidity levels within these structures. These natural events have obviously escalated the deterioration processes, meaning that the proper monitoring and interventions should be conducted in near future.

Meanwhile, in Chobareti village, two of the surveyed houses are in complete disuse, suffering from major loss of the built spaces and mild biological decay; while the third dwelling has been substantially restored by the owners in recent times, but it's still lacking proper maintenance and restoration/replacement of deteriorated secondary structural elements.

In summary, to decide on the intervention appropriate for each dwelling, it is very important to carefully analyze the decay types that are found in *Darbazi* wooden structures, as much as the origins of decay. As per our information, the wood moisture content above 20% could result in biotic decay. The research incorporates some dwellings, that display damp areas within wooden elements, and with masonry walls as well. Additionally, according to the dwellers, heavy rainfalls during spring and summer of 2023 resulted in partial or total collapse of the roofing structures.

These environmental disasters alongside the typically tough climate, improper or insufficient care, might be the cause for bad conservation state of timber structures in the Samtskhe-Javakheti region. However, there are a couple of essential rules to mitiage these problems, such as constant inspections, maintenance, repair of eventual leaking from the roof and proper ventilation.

6. "Order No. 3/86, #56433 Concerning the Granting of Immovable Cultural Heritage Monument Status to Objects of Cultural Value." March 20, 2012. Cultural Heritage Agency of Georgia. https://memkvidreoba.gov.ge/Files?id=56433_FDB32C78-E0AF-49FA-9161-A39CE99BD44B.

7. "Law of Georgia on Cultural Heritage." The Legislative Herald of Georgia, June 8, 2007. https://matsne.gov.ge/ka/document/view/11932?publication=5

Chapter III
Preservation/ Restoration Proposals

Preservation and restoration of historic structures is a complex process, which incorporates versatile tasks carried out across multiple stages, such as exploration of historic layers and estimation of the structure's value and authenticity through documentary evidence.

We need to declare, that this thesis represents an exploratory step for comprehensive analysis of the wooden built heritage in Samtskhe-Javakheti region, and it does not cover all the necessary stages and tools for further assessment, due to the scope and scale of research and lack of workforce and accessibility to professional diagnostic tools. In our case, we have examined the general principles of technological systems within Darbazi structures through previous literature[1], conducted the preliminary survey and produced basic documentation, mostly focusing on material examination of wooden elements.

However, these structures need deeper analysis for further understanding, including more detailed on-site assessment (geometrical and photographic survey, NDT (Non-destructive Testing)) and , if necessary, eventual laboratory testing, performed by multidisciplinary specialists.

Structural health assessment

Some of the initial steps in evalutating the condition of timber structures is examination of an assemblage through existing studies and visual inspections. Assessment of structural behaviour comes at first from understanding the arrangement and characteristics of the elements both individually and as a unified system. Understanding the structural arrangement, the functions of various components, and how their assemblage is crucial to grasp.

After exhausting visual inspection, we can continue the examination using non-destructive (when wood remains intact) or semi-destructive (when wood is locally penetrated or stressed) diagnostic methods. This multi-disciplinary approach, involving different professional figures as architects, engineers, historians, wood technologists, dendrochronologists, is important for further decision-making in maintenance/ rehabilitation or replacement of these artefacts.

We can look at a local example of VAADS (School Of Visual Art, Architecture And Design) utilising some modern tools for augmented

1. Scholarship discussed within the Bibliographic Odyssey (State of art). Substantial part of which is based on the monograph: Sumbadze, Longinoz -

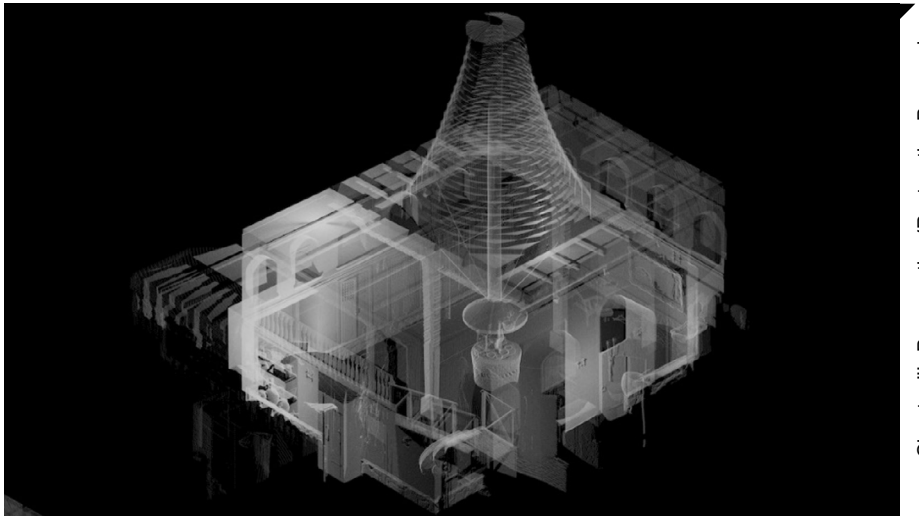


Fig. 93/ *Porakishvili Darbazi, 2023. Source: "Darbazi Dialogues . Discussions of a traditional house-type that reveal more than structure". EastEastworld, 2024. https://easteast.world/posts/513*

visual comprehension of *Darbazi* structures. This school at The Free University of Tbilisi has conducted fieldwork using what is known as laser scanning technology to record the buildings and landscapes of Meskheti with great attention. The fieldwork results and essence of the *Darbazi* dwelling itself are thoroughly discussed within the online article[2]. The equipment records these dwellings with great detailing of shape, texture, and even the tiniest elements such as spider webs. However, the technology does not depict some technical aspects of built structures such as materiality, wall thickness, and gaps, thus producing visual opacities and imperfect renderings of these buildings' essence. (Fig. 93)

One of the first steps to assess the state of conservation of an historic timber structure is the identification of wood species which can be carried out by analysing with microscope a very small sample of wood. This identification is essential for the future steps of the conservation/ restoration process. Another eventual analysis that can be carried out concerns the dating of the timber elements. In some case it is possible to do it with historic documents, or with data carved on the wooden surface. In other cases dendrochronological analysis can be carried out as well as rediocarbon dating.

2. Jesse Vogler, Giorgi Margishvili, Ramaz Kiknadze. "Darbazi Dialogues . Discussions of a traditional house-type that reveal more than structure". EastEastworld, 2024 https://easteast.world/posts/513

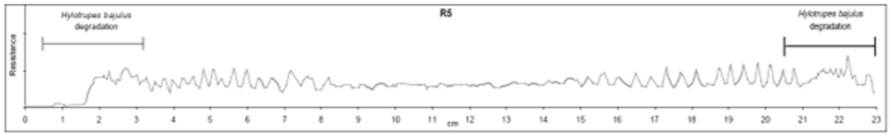


Fig. 94/ *example for Profile of the Resistograph® measurement in a degraded wooden piece. Source: Patrícia C. et al. , aINEGI, Faculty of Engineering, University of Porto, Rua Dr. Roberto Frias, 4200-465 Porto, Portugal. "Non-Destructive Structural Wood Diagnosis of a Medieval Building"*

Important tools for obtaining data about wood material structural health are traditional hammer and chisel, but also modern devices like resistance drilling[3] and Wood hygrometer[4]. They allow non-destructive inspection of wooden elements without endangering their structural integrity, which is vital for data-collection of historic timber structures. While traditional tools like hammer can give us general idea of wood material health by sound of impact, modern tools such as resistograph provide exact information about localised material degradation, which cannot be detected solely by visual inspection. "It allows to obtain a graphic of the density variation along the cross section of the wood, due to the resistance that the wood impose to the drill "[5]. Some other methods for extracting information from structural wood are listed below:[6]

3 Resistograph® is a resistance drill for detecting decay in wood, and is a sophisticated electronically controlled drill that provides accuracy.

4 Wood hygrometer - an instrument for measuring the wood moisture content. This measurement can provide a basis for the need for continued drying.

5 Patrícia C. Raposoa,b,, Michael Andradec, José A.F.O. Correiaa,b, Maria E. Salavessac, Cristina Reisa,b,c, Carlos Oliveiraa,d, Abílio de Jesusa, aINEGI, Faculty of Engineering, University of Porto, Rua Dr. Roberto Frias, 4200-465 Porto, Portugal. "Non-Destructive Structural Wood Diagnosis of a Medieval Building"*

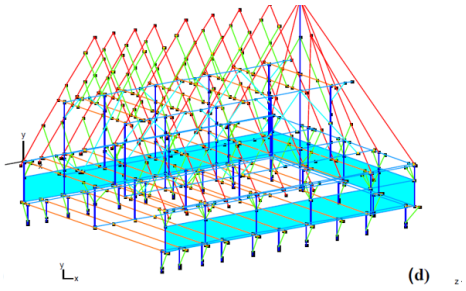
6 Table from the Master thesis, p. 15. Magnus, Lia. "Historic Timber Roof Structures: Construction Technology and Structural Behaviour." Master's thesis, Catholic University of Leuven, Faculty of Engineering, Department of Civil Engineering, 2008.

	Method	**Information**	
I	Visual inspection	Geometry, rate of growth, natural and mechanical defects,	ND
	X-ray Visualisation	Internal knots and voids, structural defects, decayed wood	ND
	Optical scanning	Surface knots, decayed wood,...	ND
	Infrared thermography	Internal knots and voids, structural defects, decayed wood,...	ND
	Videoscopy	Internal knots and voids, structural defects, decayed wood,...	SD
II	Stress wave technique	The dynamic modulus of elasticity, internal defects	SD
	(Ultra)-sonic technique	The dynamic modulus of elasticity, internal defects	ND
	Static bending test	Load-deflection relationship leads to the static modulus of elasticity	SD
III	Extraction of Samples	Wood density, moisture content, decay, strength characteristics	SD
	Screw withdrawal test	Density, shear strength and surface damage	SD
	Rod penetration (Pilodyn ®)	Density and surface damage	SD
	Resistance drilling (Resistograph ®)	Density and defects	SD
Legend: ND – non-destructive test; SD – semi-destructive test			

For extensive analysis the rate of decay of wooden materials should be estimated, considering every type of mechanical, biological and chemical effect.

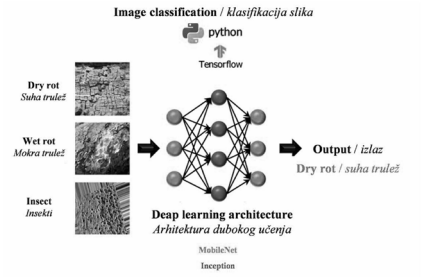
After conducting aforementioned procedures, numerical analysis can take place (Fig. 95), with the aim to reproduce as realistically as possible the complex strucural behaviour of the building, taking into account that the *Darbazi* dwellings have relatively intiricate constructional systems, both at the *Gvirgvini* roofing level - where paradoxically connections based on seemingly simple devices such as dowels, slats and friction contacts require very refined modeling choices - and at the lower levels where special care is needed for analysing the connections between the retaining walls and the the interior wooden framework.

Understanding and evaluating wooden deterioration involves complex and time-consuming set of tasks. However, the aspect of visual survey and examination is so significant for the safeguard and conservation of historic buildings, that some scholars are trying to employ



▲ **Fig. 95/** *Example of Numerical analysis structural model for Church of Drăuşeni - 3D View. Source: Magnus, Lia. "Historic Timber Roof Structures: Construction Technology and Structural Behaviour." Master thesis, p. 39*

▼ **Fig. 96/** *Framework for wood damage detection using pre-trained neural network. Haciefendioglu et al. "Automatic Damage Detection on Traditional Wooden Structures with Deep Learning-Based Image Classification Method." Drvna industrija 73, br. 2 (2022): 163-176.*



modern technologies and enhance traditional learning approach. Damage mapping systems, notably surface and colour change detection, and biological degradation, should be included in the evaluation of the condition of wooden structures for the planning of sustainable strategies for their repair.

On this matter, an interesting methodology has been introduced for obtaining maximum information from decayed wooden structures and optimising the multidisciplinary analysis. Haciefendioglu[7] et al. show the innovative tools for automatic damage assessment, which mostly incorporates visual learning artificial intelligence model. (Fig. 96) Several types of pre-trained machines are deployed to focus on wet and dry rot, insect damage detection, data transfer and final classification of decay.

Even though most of the studies in this field are in progress, adaptive technological tools are still vital in future optimisation of structural health monitoring of historic buildings. We need to mention, that the specific anatomical structure of wood material makes each structure unique, so it is more difficult to adopt/develop such technologies in comparison to other building materials.

7 Haciefendioglu, Kemal, Hasan Basri Başaga, Murat Emre Kartal i Mehmet Ceyhun Bulut. "Automatic Damage Detection on Traditional Wooden Structures with Deep Learning-Based Image Classification Method." Drvna industrija 73, br. 2 (2022): 163-176. https://doi.org/10.5552/drvind.2022.2108

Intervention recommendations for selected dwellings

The physical state of conservation of most *Darbazi* dwellings in Samtskhe-Javakheti region varies from moderate to critical levels. From the report in the previous chapter, we can observe how some structures suffer from major damage and therefore, are abandoned, some others can still be referred as serviceable, but need proper repair and maintenance.

As much as we admit the importance of adaption and implementation of vernacular conservation/ reconstruction techniques within the artefacts of cultural heritage and adhere traditional functions to each one of them, we need to carefully consider possibilities of modern technology. The tendency to utilise wooden material for economically and environmentally responsible building is increasing in contemporary world, while the traditional knowledge developed over the centuries linked to building techniques has already embedded these smart solutions within *Darbazi* dwellings centuries ago.

Therefore, the decision making needs to be comprehensive of both traditional and "futuristic" approaches in order to achieve optimal restoration results and enhance the durability of *Darbazi* structures. This part of thesis is based on fundamental texts from Georgian scholars who have gathered knowledge about traditional craftsmanship into their monographs, but also examines multiple articles regarding experimental treatment of structural wood and guidelines for appropriate interventions within cultural heritage assets.

Traditional approach

In order to maintain assets of cultural heritage traditional conservation techniques and methods should be considered first. Generally, following international experience is considered obligatory. However, due to a lack of institutionalized knowledge and specialised organisations within the field of wooden preservation in Georgia, we are considering deploying some sources of localised expertise.

As we mentioned above, region of Samtskhe-Javakheti in Southern Georgia has always been rich with **forestry** (Fig. 97), especially around the villages visited during this thesis survey. However, due to some historical events[8], some wooden resources went extinct among

8 massive burndown raids of mountain forests by Turkish conquerors before XVIII century (confirmed by numerous local inhabitants during the interviews)

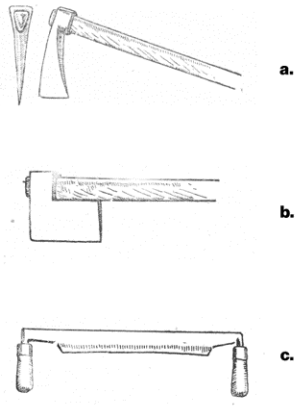
particular zones. According to the national data[9], the amount of forest in this region accounts for 122.2 thousand square hectares with a regenerated area of 371.5 hectares in 2023, relatively low to other sectors within the country. Access to quality **wooden resources** is vital for the maintenance and reconstruction of built heritage, therefore, considering the dendrological diversity in the Southern Caucasus, with the enforcement of European legislation for forestry protection and proper utilisation, these zones should be a rich wooden material repository, because of the important role that forest reserves have in the self-sustaining processes of maintenance and restoration of historic wooden buildings.

Gasitashvili[10] stresses that Borjomi gorge[11] has been an active hearth of **woodworking** or *Khit-khuroba*[12] for centuries with plentiful of conifer forests, distributing wood materials through whole country and beyond. There has been an accumulated knowledge among "the men of forest" about chopping and storing thoroughly selected trees, (Gasitashvili 1962, 15-32) small part of which must have been transferred to the modern generation. One of a few

Ranking	Country	Forest designated primarily for social services	
		% of total forest area	% of forest area
1	Singapore	12.2	78
2	Brazil	139 394	28
3	Republic of Moldova	76	20
4	Ukraine	1 450	15
5	Belarus	1 290	15
6	Brunei Darussalam	50.8	13
7	Senegal	1 044	13
8	Iceland	6.67	13
9	Georgia	348	12
10	Poland	1 021	11

▲ **Fig. 97/** *Top ten countries for the proportion of total forest area designated primarily for social services, 2020. Source: FAO. 2020. Global Forest Resources Assessment 2020: Main report. Rome.https://doi.org/10.4060/ca9825en*

▼ **Fig. 98/** *Gasitashvili, Guram, A few types of Georgian woodworking tools (a. Tsuli, b. Najakhi, c. double-sided knife), "Folk Methods of Wooden Craftsmanship", 1962*



9. LEPL National Forestry Agency and National Statistics Agency of Georgia, data of 2022-2023.

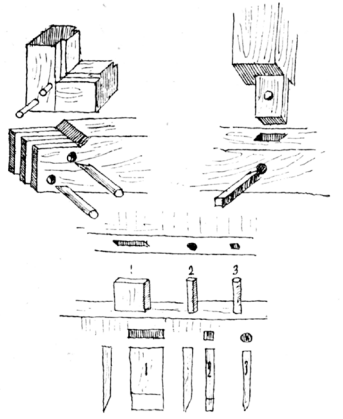
10. Gasitashvili, Guram. "ხის დამუშავების ხალხური წესები" (Folk methods of wooden craftsmanship. Tbilisi: Sakartvelos SSR metsnierebata akademiis gamomtsemloba. 1962

11 Borjomi gorge includes Mtkvari river bank in between Trialeti and Meskheti ranges within lesser Caucasus Mountains.

12 Khit-khuroba – "khit" meaning wooden, "khuroba" meaning craftsmanship in Georgian language. Source: http://www.nplg.gov.ge/

▲ **Fig. 99/** *Chubinashvili, Niko, Otsindale wooden carving, Georgian Medieval Artistic Woodcarving of the 10th-11th Centuries, 1958.*

▼ **Fig. 100/** *Garakanidze, Mikheil, variety of wooden Nageli (pins/dowels), Georgian wooden architecture, 1959*



useful examples has been provided by a selection of Georgian and Norwegian scholars[13]. They guide us through complex processes behind fostering traditional woodworking, including restoration techniques and workflow management for achieving authentic and quality results. A substantial part of acquiring this knowledge is through practical expertise, arranging in-situ surveys, educational visits with local craftsmen and adopting traditional tools like *Najakhi*, *Tsuli*,[14] (Fig. 98) etc. These instruments have a long history and are still in use to this day.

For exploring more intricate levels of wooden craft, some scholars have collected traditional examples of Georgian architectural decorations in wood. Such is "Georgian medieval artistic wood carving"[15] (Fig. 99) Sumbadze has included numerous photographed or sketched examples of wooden decoration from Samtskhe-Javakheti and Kartli regions on *Darbazi* dwellings.

Some local sources have also been thoroughly explored within

13. Shoshitashvili, Nodar, et al. ხითხუროობის ტრადიციული ხერხები და სამუზეუმო რესტავრაცია-კონსერვაციის პრაქტიკა [Traditional Methods of Carpentry and Museum Restoration-Conservation Practices]. Tbilisi: National Museum of Georgia, 2015. ISBN 978-9941-9380-3-0. Accessed August 8, 2024. National Parliamentary Library of Georgia.

14. Types of Georgian woodworking tools similar to axe

15. Chubinishvili, Niko. Грузинская средневековая художественная резьба по дереву (Перелома X-XI вв.) [Georgian Medieval Artistic Woodcarving of the 10th-11th Centuries]. Tbilisi: National Parliamentary Library of Georgia, 2021. Accessed August 8, 2024.

Garakanidze's book[16], where he gathers information about vernacular woodworking tools and methods, handy craftsmen, variety of wooden species and their distribution. We can also learn about joinery (Fig. 100) within wooden structures, particular to each region and building style. (Garakanidze 1959, 112-123)

As per our information, a few other attempts for continuing the tradition of wooden architecture have been made in Georgia. A good example is the Oni School - a collaborative project focused on investigating, enhancing, and developing the wooden architectural traditions of one Georgian region. It serves as a teaching and research platform, providing a dedicated space for hands-on activities such as building, crafting, inhabiting, testing, and producing. (Fig. 101) This initiative endorses students to learn the traditional wooden technology for physical applicaton.

Another local case of maintenance was found in Ude village (case study N16) conducted by Maisuradze brothers, who restored the whole dwelling, including the intricate wooden ceiling system with their hands (Fig. 102). Despite the lack of details about wooden species and techniques used, this *Gvirgvini* seems like a fine representation of the local restoration abilities.

The legacy of wooden craftsmanship is still present in

16. Garakanidze, Mikheil. "საქართველოს ხით ხუროთმოძღვრება" (Georgian wooden architecture). Tbilisi: Khelovneba; Sabchota Sakartvelo. 1959

▲ **Fig. 101/** *Darbazi structure model at Oni school. Source: https://www.instagram.com/p/CdiDmPSMnXb/?utm_source=ig_web_copy_link*

▼ **Fig. 102/** *Gvirgvini in Maisuradze dwelling, before and after restoration. Photos provided by Pavle Maisuradze*

moden Georgia, but the craftsmen themselves are scarse and localized, their expertise is not institutionalized and spread properly. However, the effective management and employment of locally available woodworkers can result in the important practical methodological repository, that can be utilised within the rehabilitation of historical wooden structures and the construction of new ones.

Modern materials and technologies

At international level some alternative ways of reinforcing historic heritage from international expertise are explored. These ways have being explored for decades, but before adopting them, it is important to consider the guidelines by ICOMOS: Principles for the Conservation of Wooden Built Heritage, which states that the use of modern materials and technologies needs to be carried out in a very controlled manner, only when their durability and structural performance have been proven over time. Utilities shall be installed in such a way as to respect the tangible and intangible significance of the structure, and should not alter significant environmental conditions, such as temperature and humidity. The use of chemical preservatives shall be strictly controlled, verifying that they produce a clear benefit, are not harmful to public or environmental safety, and offer long-term improvement in this regard. (GA 2017, 6-3-4, sec. 23-26)

The anisotropic character of wood poses a lifelong challenge in rendering impeccable solutions within conservation and reinforcement of timber elements. We've tried to explore some innovative studies in this chapter, that mostly cover synthetic aid materials. Nevertheless, satisfactory results of symbiosis between existing and additional elements depend on multiple variable characteristics of wood, environmental conditions, industrial factors, etc.

Within this study we review multiple scholarly articles about polymer material use for strengthening and preserving archaeological timber. One of the methods for structural aid is **FRP** (Fibre-reinforced polymer) reinforcement. According to research, that has been conducted for years now, these fibres facilitate load-bearing capacity, shear and flexural strengthening of structural elements and protection of wooden natural fabric due to its fire-resistant and non-corrosive characteristics.

In the research paper[17], Satheeskumar et al. discuss recent developments within the application of FRP materials. It is classified into

17. Satheeskumar, N., Kajanan, S., Darshana J., Pathmanathan R., Jay S. Applications of natural and synthetic fiber reinforced polymer in infrastructure: A suitability assessment, Journal of Building Engineering, Volume 66, 2023

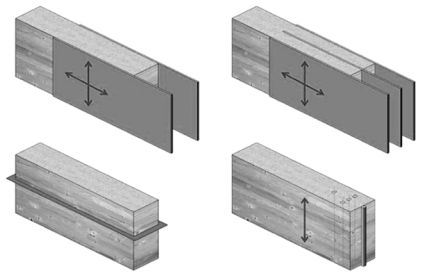


Fig. 103/ *Schematic example of FRP reinforcement using polymer rods and plates. Source: Kasal and Yan, "Fiber-Reinforced Polymers as Reinforcement for Timber Structural Elements," in Reinforcement of Timber Elements in Existing Structures, ed. Branco, Dietsch, and Tannert (Cham: Springer, 2021), 45.*

three types: with **natural, synthetic and hybrid fibres**. Most commonly used reinforcement within timber structures is synthetic (SFRP) and natural (NFRP) fibres, which are briefly discussed below.

Back in 2012 Motlagh et al[18] conducted experiments using FRP materials on different specimens of wood, resulting in significant increase in strength and stiffness. Another study has tested FRP technology on wooden element imperfections, more specifically – knots. Since we have already observed case study timber dwellings within this thesis and their natural defects, considering the number of knots, adapting the strategy of M. Corradi[19] and his peers should be resourceful. The paper focuses on rehabilitation of local defects using epoxy-glued FRP through bending tests and stress-strain calculations on timber beams.

Schober et al.[20] elaborate that for structural reinforcement, two forms of FRP (pultruded rods or plates and fabrics) are used[21] (Fig. 103). This study showed significant improvement in structural performance within timber-on-timber reinforcements.[22]

Natural fiber reinforced polymers (NFRP) (Fig. 104) are an alternative to synthetic reinforcement materials and are more advantageous due to their sustainable nature and light weight. "Further, these natural fibre composites have the potential to mitigate the issue related to thermal and acoustic when used as insulating materials", as stresses Satheeskumar. As some studies have shown, various natural fibers perform better in tensile strength and ductility, than their synthetic peers. On the other hand, the fire resistance of these materials has proven to be low, alongside with the exposure issues with humid conditions.

Overall, these methods are being tested positively due to low intervention intensity and cost-effectiveness, thus FRP treatment can be advantageous within historical reconstruction. However, during the initial phase the construction market of Caucasus region should be appraised accordingly for maintaining cost-benefit equilibrium of cultural heritage asset projects.

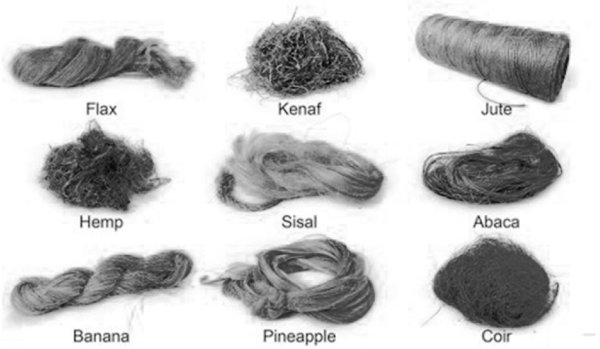


Fig. 104/ *Example of natural fibers. Source: International Fiber Journal, "Natural Fiber Composites: A Practical Guide for Industrial Utilization," https://www.fiberjournal.com/natural-fiber-composites-a-practical-guide-for-industrial-utilization/.*

Aside from the research of "traditional" fiber reinforcement techniques, captivating studies have been conducted within past years exploring resistance of wooden material against **biological decay.** As mentioned above in chapter II, the main types of biological attackers within this thesis subjects are **fungus** and **insects**, they inhabit the surface of

18 Motlagh, Batebi & Gholipour, Yaghob & Ebrahimi, G.H. (2012). Experimental investigation on mechanical properties of old wood members reinforced with frp composite. Wood Research. 57. 285-296.

19. Marco Corradi, Chandra Mouli Vemury, Vikki Edmondson, Keerthan Poologanathan, Brabha Nagaratnam, Local FRP reinforcement of existing timber beams, Composite Structures, Volume 258, 2021, 113363, ISSN 0263-8223

20. Kay-Uwe Schober, Annette M. Harte, Robert Kliger, Robert Jockwer, Qingfeng Xu, Jian-Fei Chen, FRP reinforcement of timber structures, Construction and Building Materials, Volume 97, 2015, Pages 106-118

21. Kasal, B., Yan, L. (2021). Fiber-Reinforced Polymers as Reinforcement for Timber Structural Elements. In: Branco, J., Dietsch, P., Tannert, T. (eds) Reinforcement of Timber Elements in Existing Structures. RILEM State-of-the-Art Reports, vol 33. Springer, Cham.

22. Kay-Uwe Schober, Annette M. Harte, Robert Kliger, Robert Jockwer, Qingfeng Xu, Jian-Fei Chen, FRP reinforcement of timber structures, Construction and Building Materials, Volume 97, 2015, Pages 106-118, ISSN 0950-0618, https://doi.org/10.1016/j.conbuildmat.2015.06.020.

wood and if not terminated in a certain time, the whole structural element will degenerate and no longer be in serviceable state.

Zhou et al[23] give us a vibrant example of fighting fungal intruders with hybrid sols. Their paper discusses silicon-based inorganic consolidants in several ways, such as preservation and enhancement of hydrophobic features of wood, whilst reinforcing the decayed fibers through on-site nondestructive healing techniques. For their experiment the authors used one structural member of the historical Chinese temple, focusing on mechanical behavior. Fortunately, treatment results of decayed wood specimens with these solutions meet fundamental mechanical requirements, in addition to aesthetic aspect, which is highly important in conservation of cultural heritage assets.

Other concordant, but separate studies[24] have been made in Research Institute of Wood Industry in China and Poland, where hexadecyltrimethoxysilane (HDTMS) and other materials were successfully used on wooden tissues *in-situ* for testing its fungal deterioration resistance. The treated specimens displayed increased durability in high temperature and humid conditions due to their acquired hydrophobic features, while eliminating white and brown rot fungi. Same type of biological attackers and their inhibitor agents were chosen by Broda and Plaza[25] for their research on archaic wood deterioration, out of which one conservative compound [26] contributed the most with elimination of fungal growth.

A couple of fascinating studies have been made in Czech Republic and Finland about fungi elimination from wooden tissues with help of biological residues. For instance, Barbero-L´opez[27] and his colleagues experimented on using hydrothermal liquefaction (HTL), which signifies depolymerization process of wet biological products. During the research,

23 Kunpeng Zhou et al., The organic–inorganic hybrid sol for the consolidation of decayed wood in architectural heritage, Construction and Building Materials, Volume 372, 2023, 130847, ISSN 0950-0618, https://doi.org/10.1016/j.conbuildmat.2023.130847.

24. Chuang Shao, et al., In-situ growth of hexaconazole/polydopamine/ hexadecyltrimethoxysilane in multi-scale structured wood to prepare superhydrophobic wooden materials with decay resistance, Chemical Engineering Journal, Volume 476, 2023, 146396, ISSN 1385-8947, https://doi.org/10.1016/j.cej.2023.146396.

25. Magdalena Broda, Nayomi Z. Plaza, Durability of model degraded wood treated with organosilicon compounds against fungal decay, International Biodeterioration & Biodegradation, Volume 178, 2023, 105562, ISSN 0964-8305, https://doi.org/10.1016/j.ibiod.2022.105562.

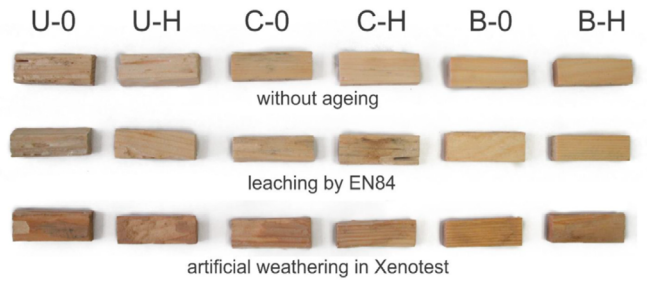
26. DEAPTMDS - Bio-silicon - Bis(diethylamino)-3-propoxypropanol)-1,1,3,3-tetramethyldisiloxane)

27. Aitor Barbero-López et al., Characterization and antifungal properties against wood decaying fungi of hydrothermal liquefaction liquids from spent mushroom substrate and tomato residues,Biomass and Bioenergy, Volume 181, 2024, 107035, ISSN 0961-9534, https://doi.org/10.1016/j.biombioe.2023.107035.

the authors tested specific sorts of residual HTL from mushroom and tomato industrial production against several types of wood-degrading fungi for wood-preservative purposes. The results indicated that certain organic acids within these agricultural products strongly mitigate fungal deterioration, while having non-toxic environmental effects. The second research by Simunkova et al[28] focuses on environmentally friendly characteristics of wood, including an unfavorable property of biodegradability and vulnerability to natural attackers. For this reason, they study caffeine compounds used against brown-rot fungi and insect attacks within indoor wooden structures. The brief line of methodology included long-term caffeine dipping, accelerated weathering of specimen, resistance and chemical analysis. (Fig. 105)

In the end, the testing results were successful and "treatment with caffeine had no negative impact on the compression strength and colour of the spruce wood, while it improved surface wetting important for potentially follow-up coating or adhesive applications."

Fig. 105/ *Photo of tested spruce wood samples after 6 weeks of termite exposure. U e Untreated spruce, C e Caffeine in spruce, B e Biocide Bochemit QB in spruce, O e Without hydrophobic paint, H e with hydrophobic paint. Source: Kristýna Šimůnková et al., "Caffeine – Perspective Natural Biocide for Wood Protection Against Decaying Fungi and Termites," Journal of Cleaner Production 304 (2021): 127110,*



28. Kristýna Šimůnková et al., "Caffeine – Perspective Natural Biocide for Wood Protection Against Decaying Fungi and Termites," Journal of Cleaner Production 304 (2021): 127110, https://doi.org/10.1016/j.jclepro.2021.127110.

Application on the case study

Now that we've discussed some methodologies for the restoration of wooden built heritage, it is time to apply them to a selected case study structure. We can consider several criteria for choosing the proper dwelling for detailed analysis and consequent restoration proposal:

1. Historical significance – a structure, that counts more than 100 years of construction, incorporating the eventful historical background.

2. Architectural value – a dwelling, which displays major characteristics of Georgian architecture and decoration, alongside the structural achievements of Darbazi roofing systems.

3. Range of decay types – the variety of decay displayed inside the structure, that are typical for most of the case studies within this research.

4. State of conservation – general state of inhabitance, maintenance, heritage protection, etc.

5. Survey materials – the amount and quality of materials collected within this on-site survey, allowing comprehensive appraisal of the structure.

6. Future potential – a case study, that appears the most prospective for future adaptation and interventions.

For these reasons, we've considered that the abandoned dwelling of Melikidze family has met all the necessary requirements, with more than 200 years of history, intricate decorative and structural features, by being the valuable asset on the cultural heritage protection list, but having the range of typical decay signs, alongside the structural issues. This dwelling is a fine representative of Darbazi dwellings. Therefore, we've included the analysis of current state of conservation of this structure and some proposals for treating major deterioration adapted from previously overviewed studies without exploring in detail the constructional precautions involved in the replacement or reinforcement of elements that are mutually interconnected.

Fig. 106/ *Case study N4. Primary hall of Melikidze dwelling. Isometric scheme displaying the main components of structural system*

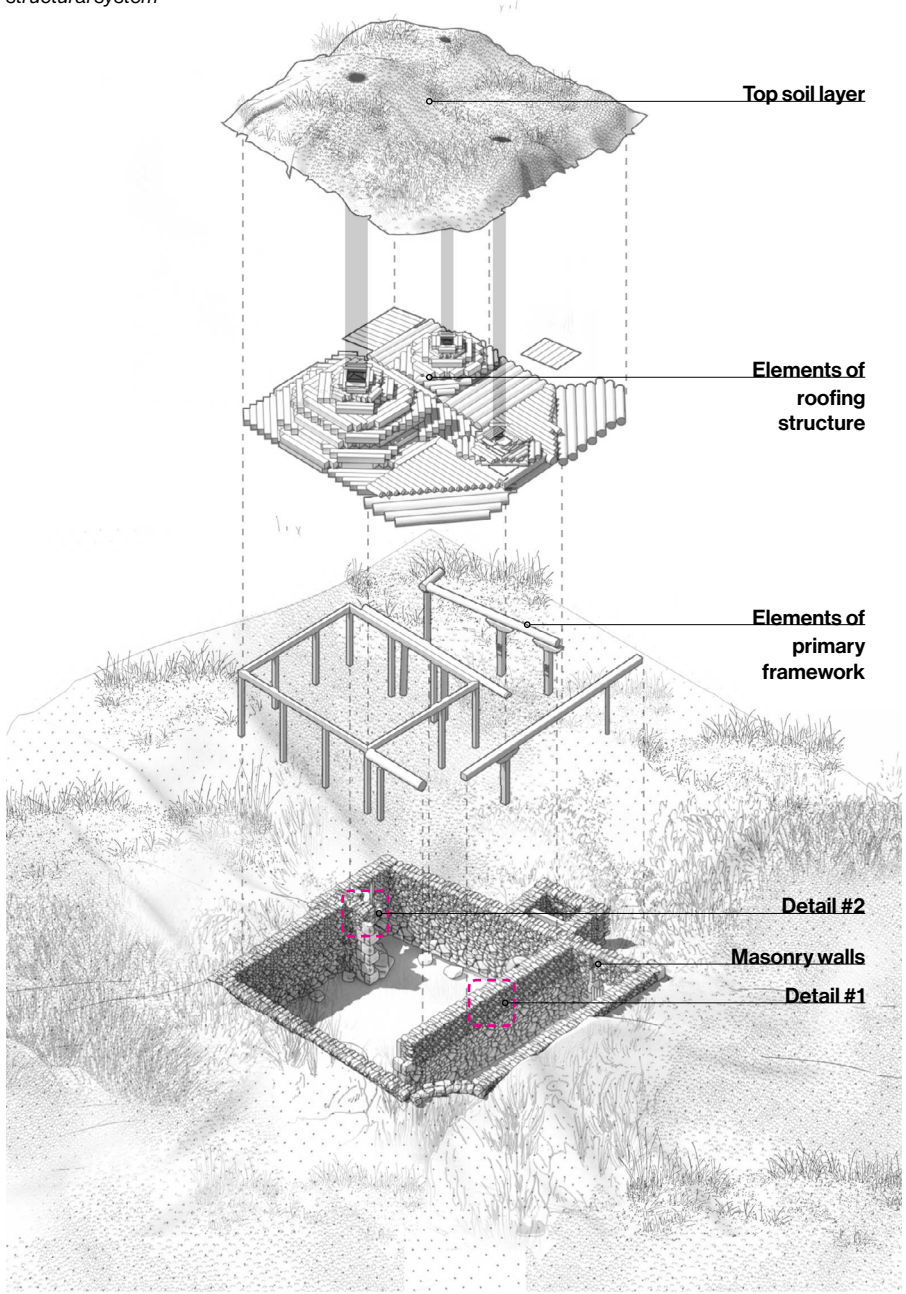


Fig. 107/ *Case study N4. Primary hall of Melikidze dwelling. Construction detail of Gvirgvini crown, showing the main components*

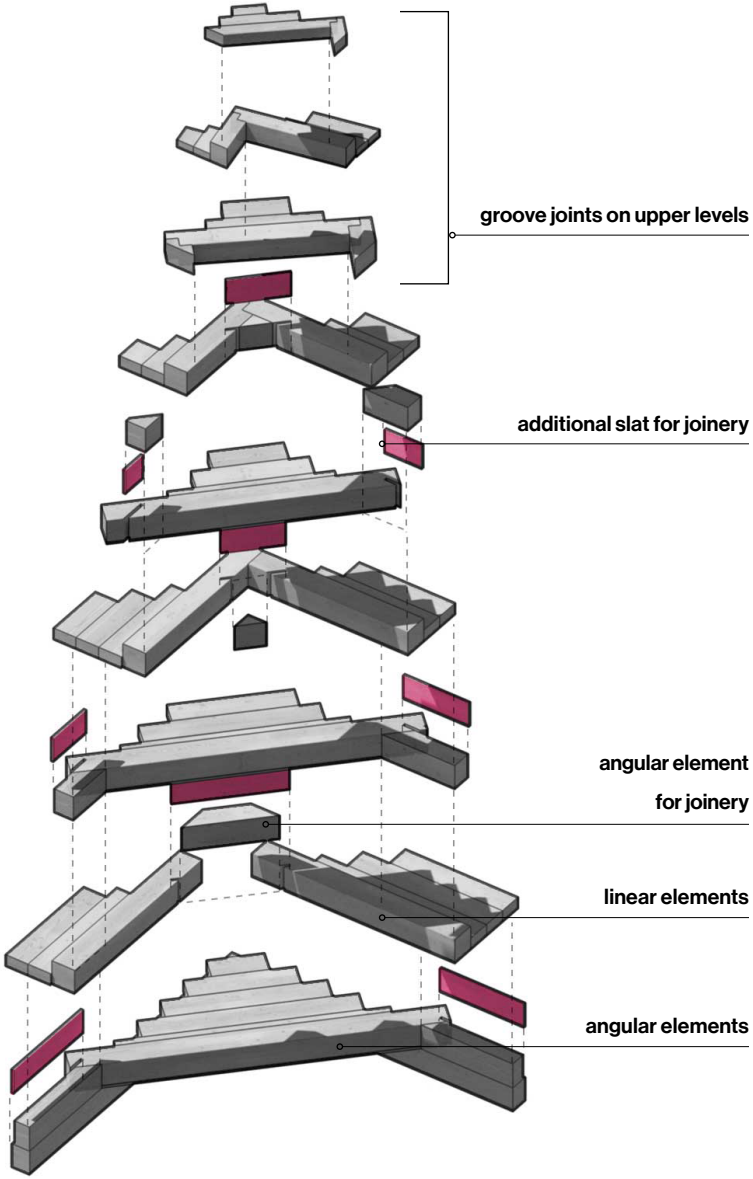


Fig. 108/ *Case study N4. Primary hall of Melikidze dwelling. Joinery detail of Gvirgvini crown*

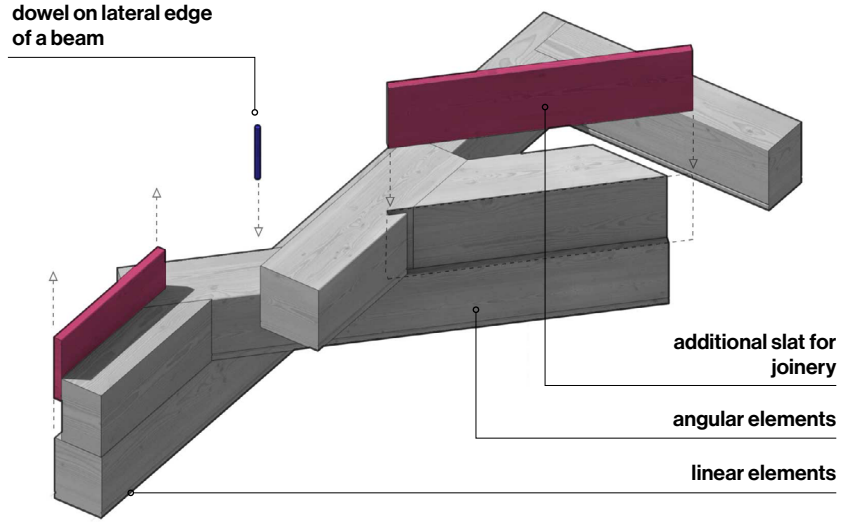
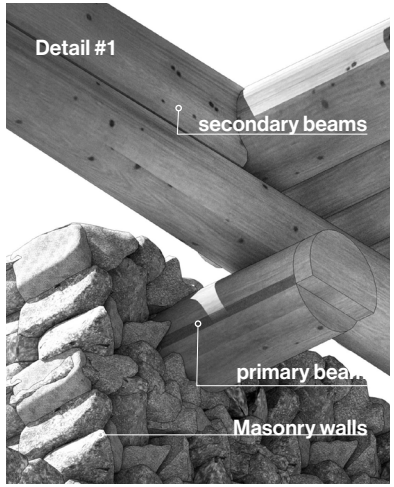


Fig. 109/ *Case study N4. Primary hall of Melikidze dwelling. Details of wooden frame in relation with masonry walls*



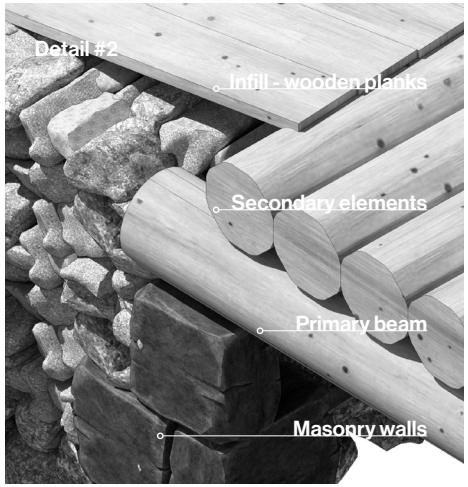


Fig. 110/ *Case study N4. Primary hall of Melikidze dwelling. Current state of the structure. ISometric scheme showing elements of primary Gvirgvini crown with typical decay and mechanical failure*

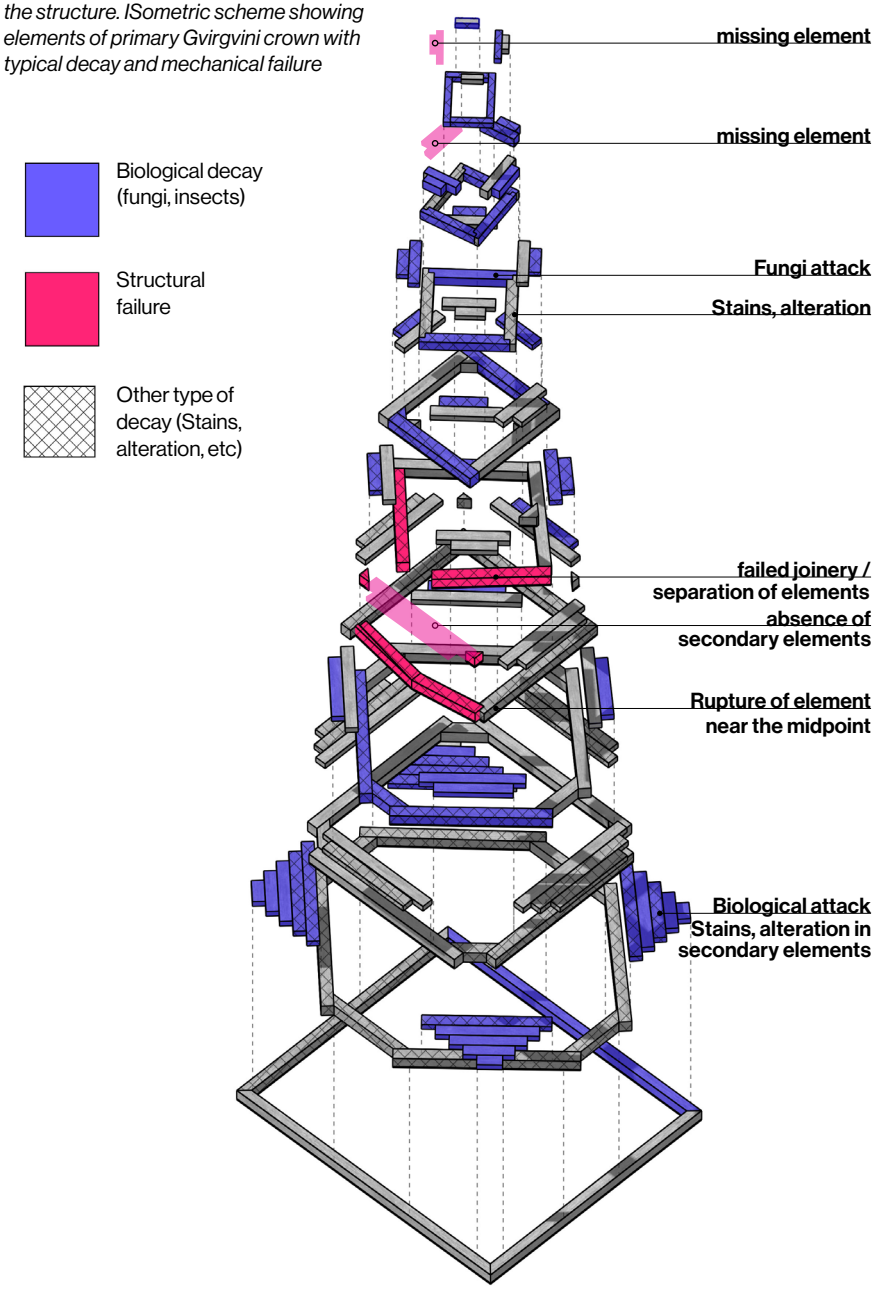
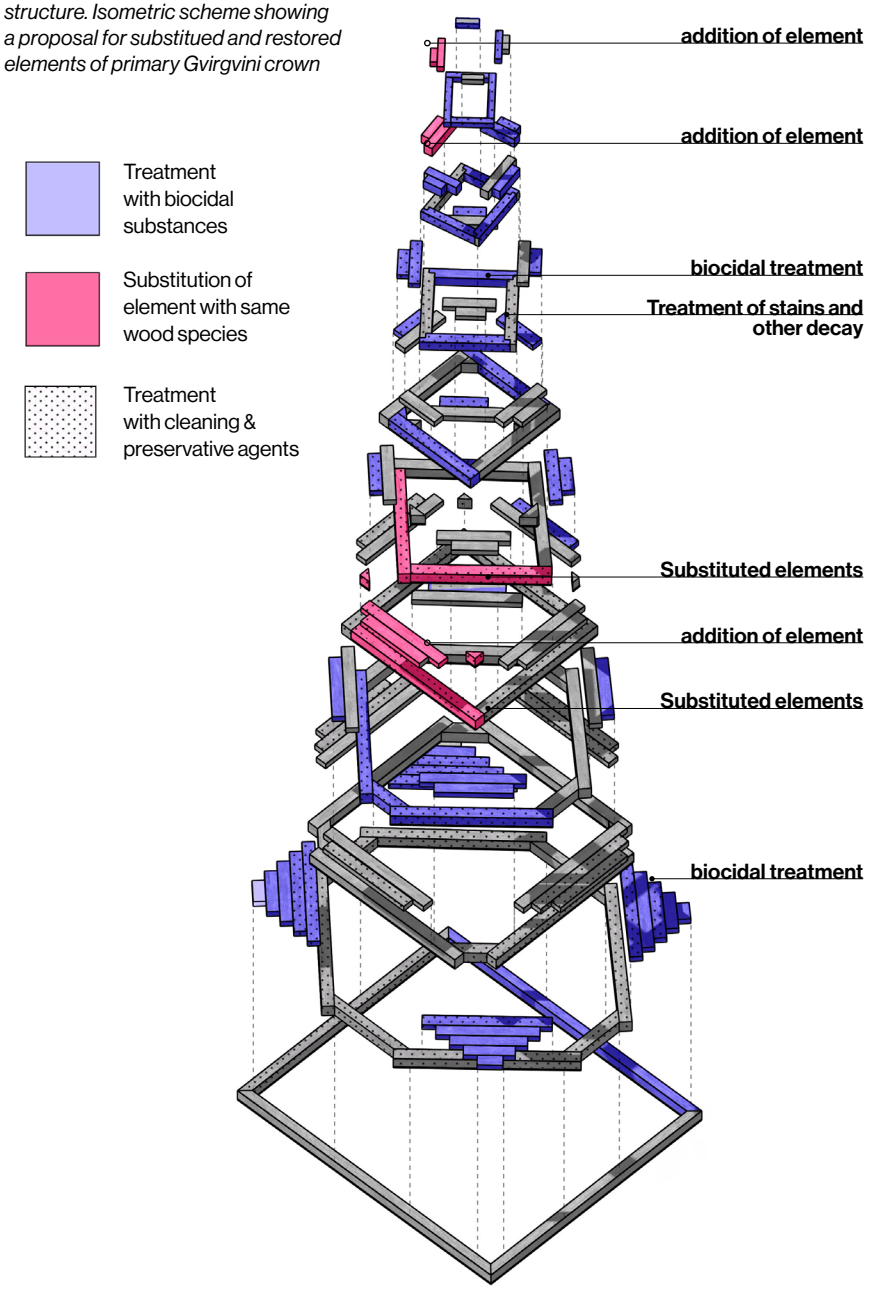


Fig. 111/ *Case study N4. Primary hall of Melikidze dwelling. Design state of the structure. Isometric scheme showing a proposal for substitued and restored elements of primary Gvirgvini crown*



Conclusion

The principal question at the beginning of this thesis was about the importance of *Darbazi* house types, their value and their feasibility for safeguard. For this reason, we decided it was crucial to analyse and evaluate historical, technological and sociological background of Georgian vernacular architecture. Therefore, the majority of acquired literature about *Darbazi* dwellings has been put through retrospective scope and discussed within this research.

Aside from the technological analysis and physical restoration of these dwellings, there are multiple topics needed addressing, such as rehabilitation of the villages in Samtskhe-Javakheti region, which might include enhancement of infrastructure, management of economical resources for cultural heritage protection and promotion of these areas for touristic purposes, etc. However, the scope of this thesis does not cover exploring and solving these problems, but recognizes their importance within the holistic conservation strategy.

As we observed, this type of architecture can be sophisticated in geometrical and technological aspects, but it does not have much national and international exposure and publicity. Thus, the knowledge about these "primitive", but efficient and extraordinary building techniques might be valuable nowadays, as it can tackle some sustainability issues and might as well augment modern architectural imagination.

The main goal of this thesis – finding the proper modes of preservation and restoration of vernacular subterranean dwellings of Samtskhe-Javakheti - has been partially achieved by:

1. Preliminary survey to better understand the technological system and how the different wooden elements are connected, and on-site inpections with basic tools focusing on the visual assessment of timber decay and deterioration within multiple structures. Overall, we've analysed 16 and visualised 13 historical houses or separate chambers, specifying their biological state and mechanical deformities.

2. An overview of further steps that need to be taken for the comprehensive assessment of *Darbazi* dwellings, including structural and biological health appraisal tools, 3D reconstruction techniques and virtual reality adaptation. These methods, which need dedicated economic and human resources, are crucial for knowledge development and physical state improvement of cultural heritage assets.

3. Deploying traditional and contemporary restoration methodologies, following the major guidelines of ICOMOS Principles for the conservation of wooden built heritage. We have overviewed multiple scientific articles showing the importance of modern solutions and improvements for the treatment of decayed and damaged wood, however, they can be used after exhausting the traditional repair techniques.

Now that we've understood the importance and value of Darbazi dwellings, it is time to act accordingly and mitigate their current state. The basic steps taken within this research are not enough for complex systemic problems, that need great attention of multidisciplinary professionals providing holistic solutions.

It's vital to provide the elementary glossary of specific architectural terms and names in Georgian language, some of which might have been adapted to English. One of the most important contributors to this vocabulary is M. Garakanidze, who put an effort into analysing the etymology of multiple Georgian building terms in his book, referring to works of some great scholars like Ivane Javakhishvili and Sulkhan-Saba Orbeliani.

Primary

დარბაზი [*Darbazi*] – synonym of Palati; the hall; the largest room of the house; Name of Georgian dwelling type.
ოდა [*Oda*] – Turkish expression meaning the room.
გვირგვინი [*Gvirgvini*] – corbelled ceiling structural part of *Darbazi* dwelling
ოდა-სახლი [*Oda-sakhli*] - a type of Georgian vernacular dwelling, mostly constructed in wood and elevated from the ground.
სახლი [*Sakhli*] – House, home. The word has various branches and additions within the language.

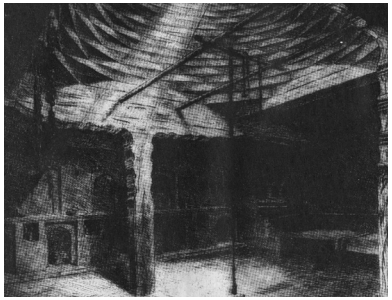


Fig. 112/ *Longinoz Sumbadze,* ***Darbazi*** *in Karagadji. Interior, engraving by the author, "The Architecture of the Georgian Folk Dwelling Darbazi", 1984*

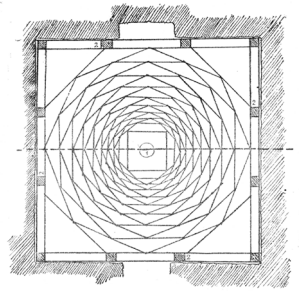


Fig. 113/ *Makalatia, Sergi,* ***Gvirgvini*** *plan within Darbazi, Meskhet-Djavakheti (Historic-Ethnographic Essay). 1938*

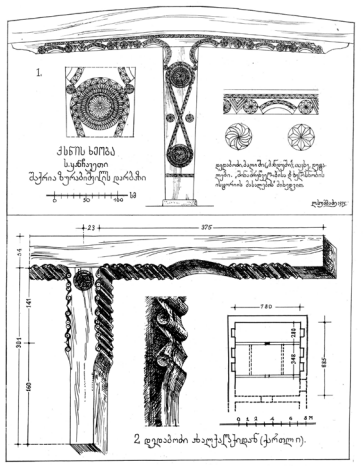


Fig. 114/ *Longinoz Sumbadze,* ***Deda-bodzi*** *from Georgian villages by N. Severov, "The Architecture of the Georgian Folk Dwelling Darbazi", 1984*

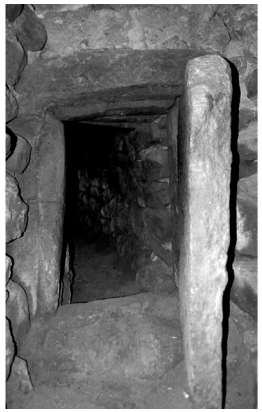


Fig. 115/ ***Darani*** *in Lebisi, Georgia. Source: https://memkvidreoba.gov.ge/objects/immovable/immovableObject?id=16459*

ახორი[1] [*Akhori*] - Winter-time building for livestock independent from residential house.
აფრა [*Apra*] – Pendentive, any of several spandrels, in the form of spherical triangles, forming a transition between the circular plan of a dome and the polygonal plan of the supporting masonry
ბოსელი [*Boseli*] - same as *Akhori*
დარანი [1] [*Darani*] - Underground settlement, a kind of defensive complex under the ground, including dwellings, agricultural warehouses, cattle stables, connected by tunnels. They were divided into districts, water was drawn, and during the war it became an invisible shelter.
დედა-ბოძი [*Deda-bodzi*] – "Mother" pillar; primary load-bearing and decorative pillar in *Darbazi* framework mostly spread in Eastern Georgian regions.
დერეფანი [*Derepani*] – portico; hallway
ერდო [2][*Erdo*] - the straight roof of a house

1. Source: ქართული მატერიალური კულტურის ეთნოგრაფიული ლექსიკონი, (Ethnographic Dictionary of the Georgian Material Culture). Tbilisi: Meridiani, 2011. Project by Eldar Nadiradze; edited by Roin Metreveli; compiled by Gvantsa Archvadze, Marina Bokuchava, Tamar Geladze, et al. Published by the Georgian National Museum. ISBN 978-9941-10-489-3.

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ჯარგვალი [*Jargvali*] – a type of wooden log hut in Georgia
ყავარი [*K'avari*] – Wooden roofing shingles
კარაპანი[3] [*Karapani*] - A shed placed iat the entrance of the house for shade and some storing dishes.
კერა [*Kera*] - an iron hearth placed at the center of each dwelling and symbolizing family strength, unity, and continuity, embracing magical traditions of protection.
მიწური სახლი [*Mitsuri Sakhli*] – a type of wooden dwelling predominantly constructed underground.

Fig. 116/ *Darbazi dwelling showing the top part of* ***Erdo****. Source: https://kvirispalitra.ge/article/57941-erdogvirgviniani-darbazuli-sakhlebi/*

მოქცეული [*Moktseuli*] - Ancient examples of corbelled roofing include four primary pillars holding up three layers of horizontal wooden beams, with the roof changing from two to three or four slopes.
პალატი [*Palati*] – a room in a palace-type dwelling place destined mostly for accommodating guests and preparing feasts.
პალატიანი-ოდა-სახლი [*Palatiani-oda-sakhli*] – Oda Sakhli with Palati space under the main wooden dwelling structure.
ფაცხა [*Patskha*] – a type of wooden log hut in Georgia
სადგომი [*Sadgomi*] – Dwelling place, cattle stall
საქვე [*Sakve*] - embedded bed couch.
სავანე [*Savane*] – same as Sakhli, home
თაკარებიანი ოდა [*Takarebiani Oda*] - a type of subterranean space with parallel corbelled structure.
თავხე [4] [*Tavkhe*] - The main coil, which is laid to hold the roof of the house
წალი [*Tsali*] – a type of woodworking tool in Georgia, similar to an axe

3. Giorgi Zedginidze, Javakhuri Dictionary, ed. Vladimer Zedginidze (Tbilisi: Saunje: Vazha Tsotskolauri, 2014)

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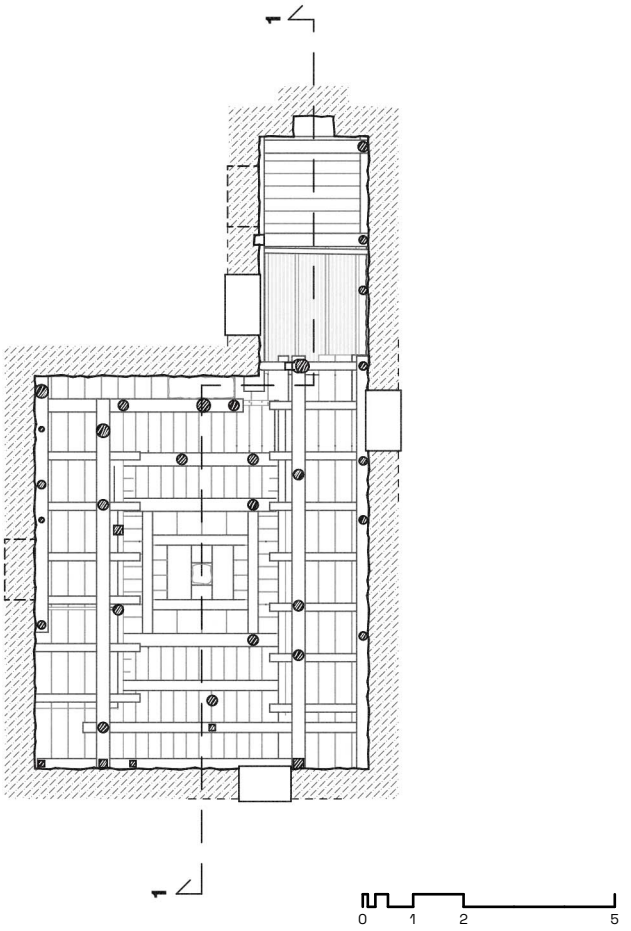
5. UNI 11119:2004 - Beni culturali - Manufatti lignei - Strutture portanti degli edifici - Ispezione in situ per la diagnosi degli elementi in opera
6. საქართველოს კანონიკულტურული მემკვიდრეობის დაცვის შესახებ "Law of Georgia on Cultural Heritage." The Legislative Herald of Georgia, June 8, 2007.
7. "Order No. 3/86, Concerning the Granting of Immovable Cultural Heritage Monument Status to Objects of Cultural Value." March 20, 2012. Cultural Heritage Agency of Georgia.
8. "Law of Georgia on Cultural Heritage." The Legislative Herald of Georgia, June 8, 2007.

Annex

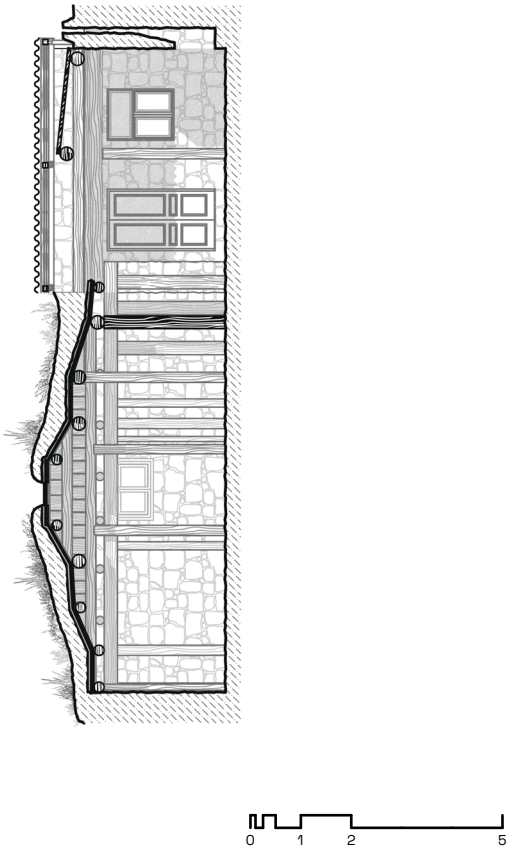
This survey contains series of visual records, which are comprised of **schematic drawings** of the case studies. Measurements were conducted utilizing simple equipment such as a measuring tape and a digital laser. Analyzing the geometry and construction techniques of the examined residences is essential for a complete understanding.

The axonometric drawings, overhead plans, and sections presented aim to showcase the distinct characteristics of the buildings under study, emphasizing especially on the roofing structures. The drawings are arranged in the annex section, in accordance with the order of the research projects, including the layouts of 14 out of 16 case studies.

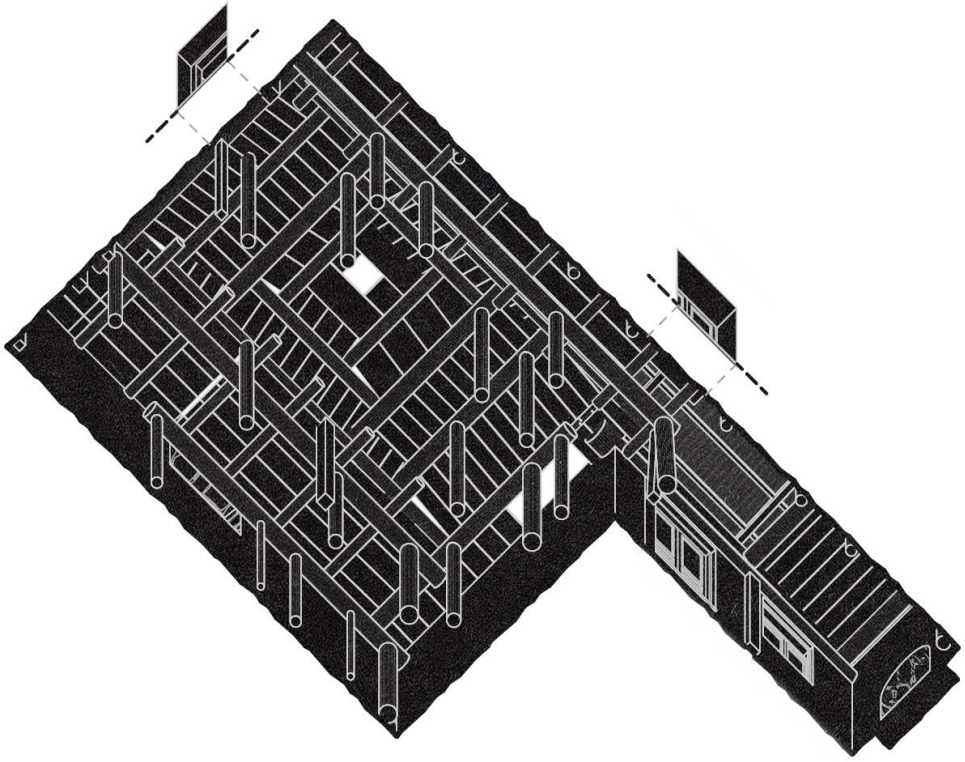
It is important to point out that these sketches are mainly schematic and may have minor dimensional discrepancies.

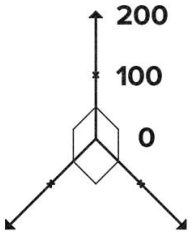


Case study N1
Reflected ceiling plan

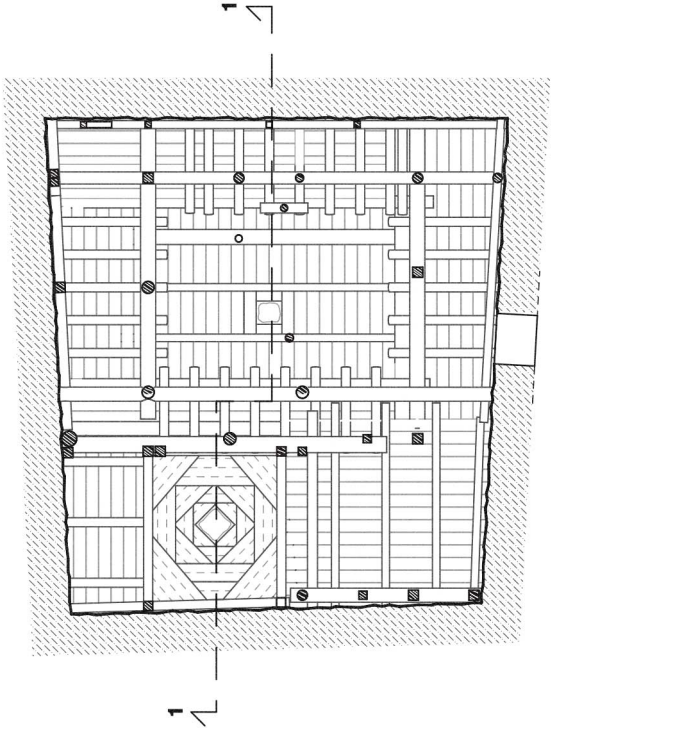


Case study N1
Section 1-1

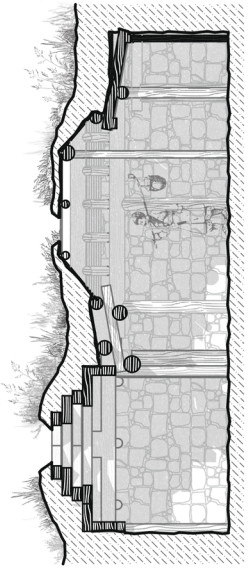




Case study N1
Axonometric scheme



Case study N2
Reflected ceiling plan



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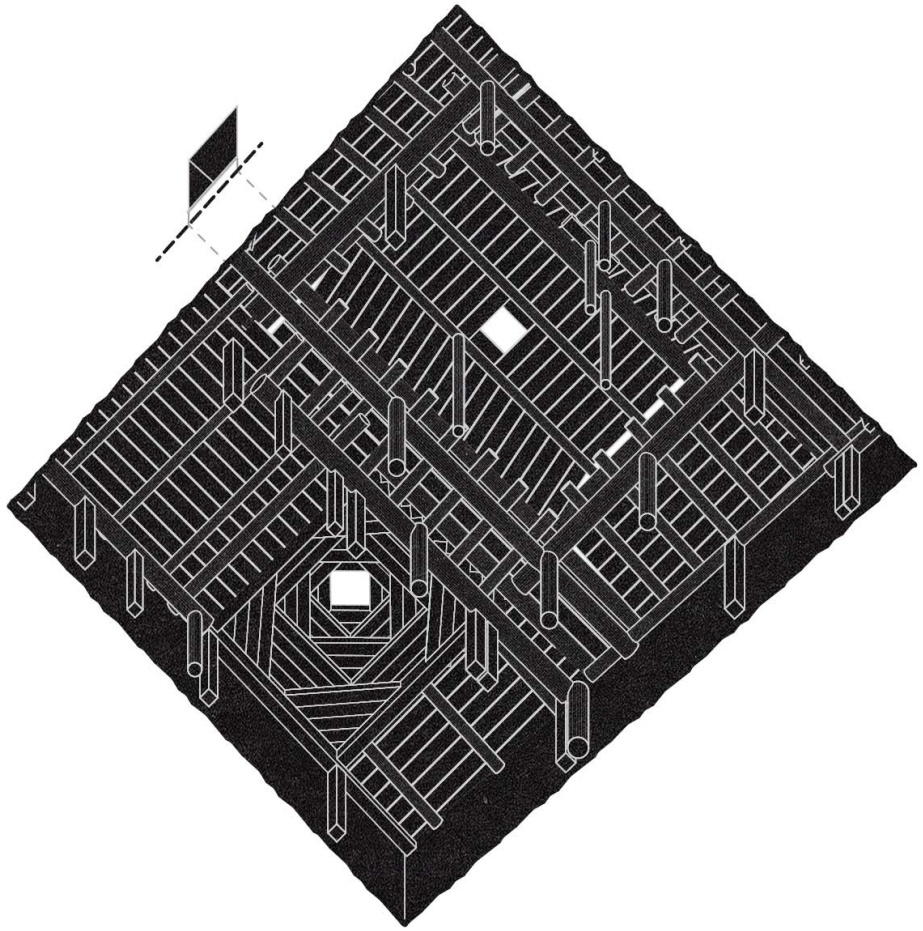
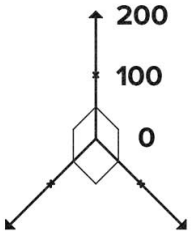
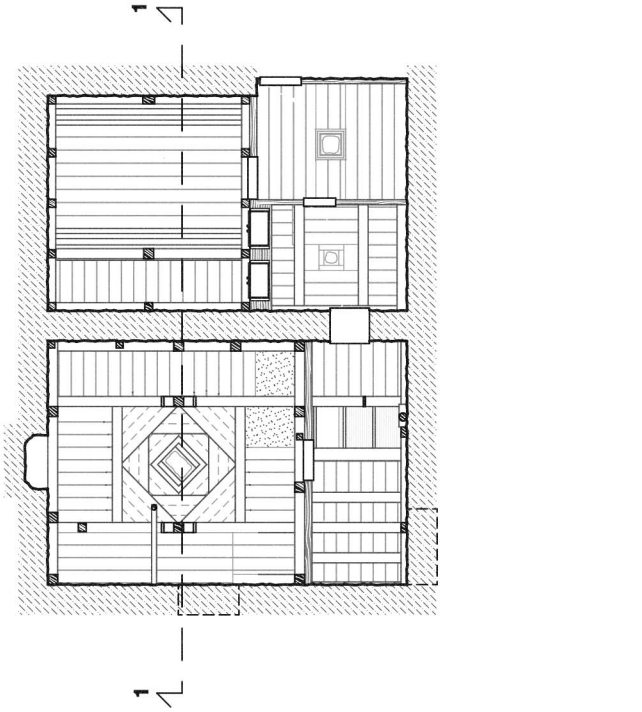
Section 1-1





Case study N2
Axonometric scheme



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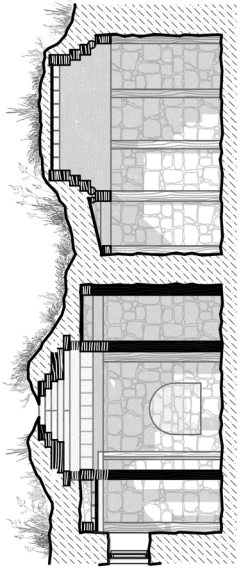
Reflected ceiling plan



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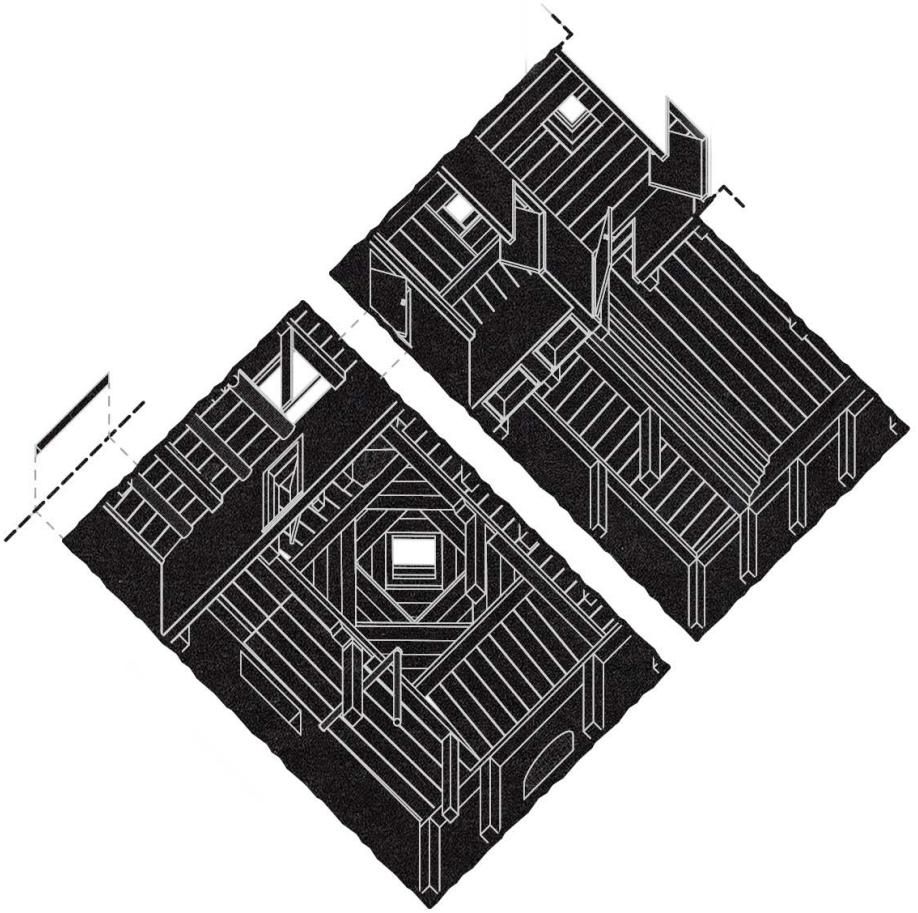
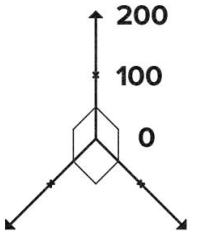
Section 1-1





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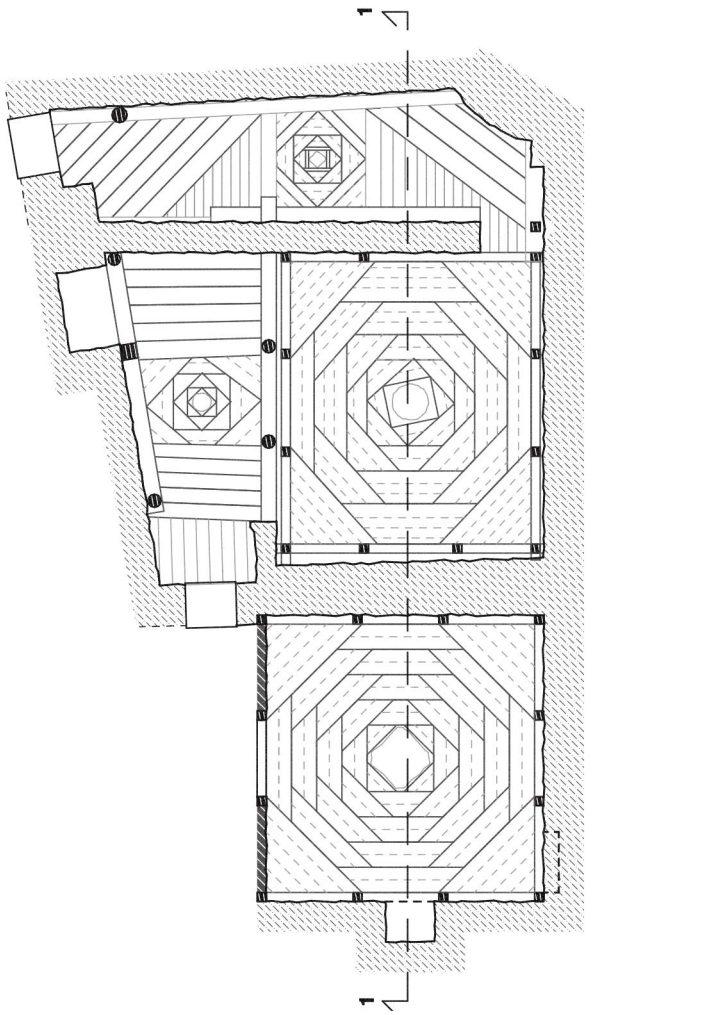
Axonometric scheme



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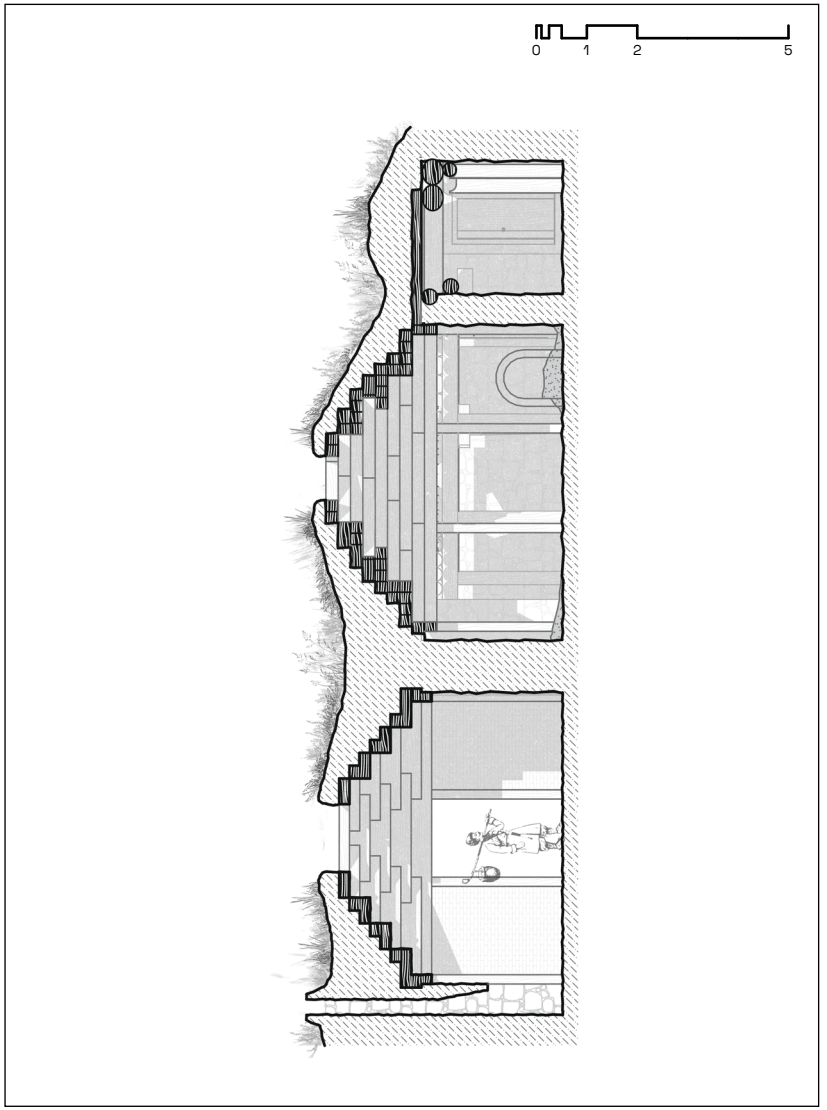
Reflected ceiling plan



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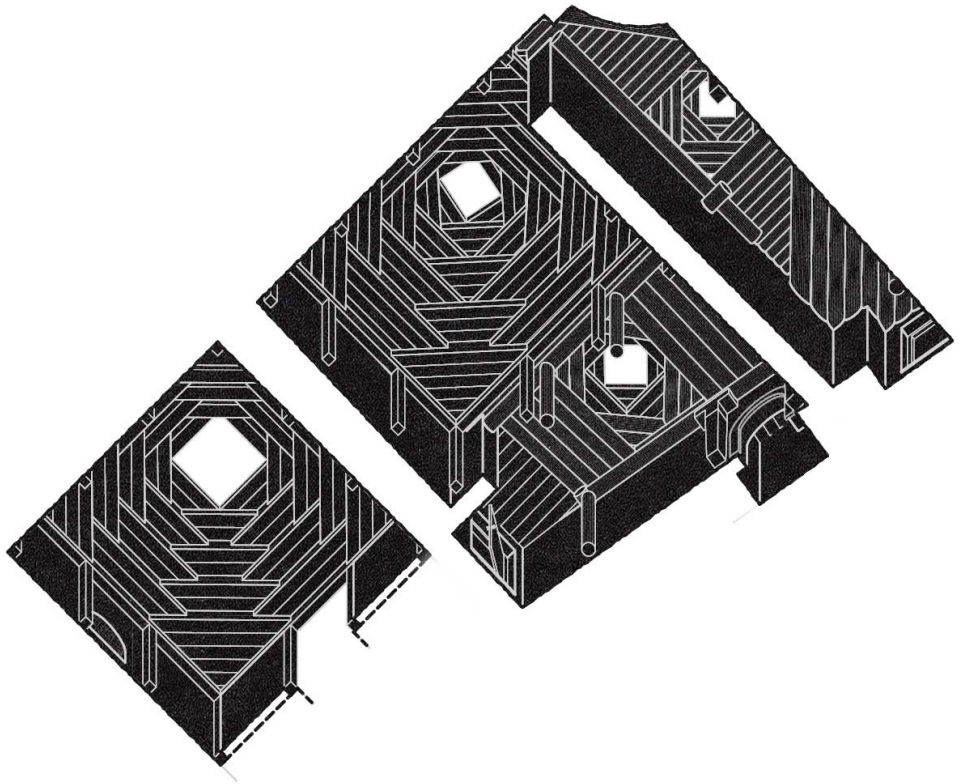
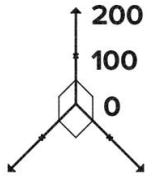
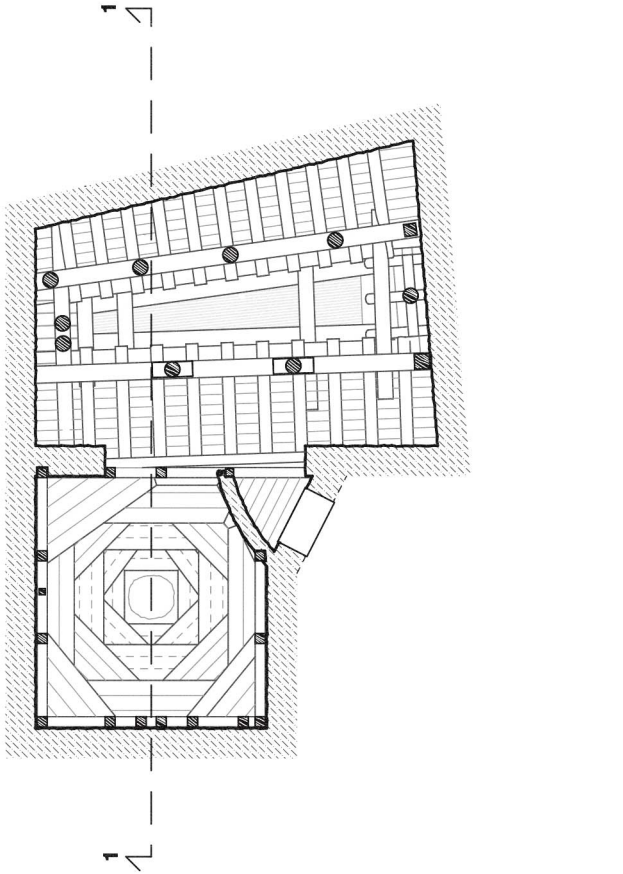
Section 1-1

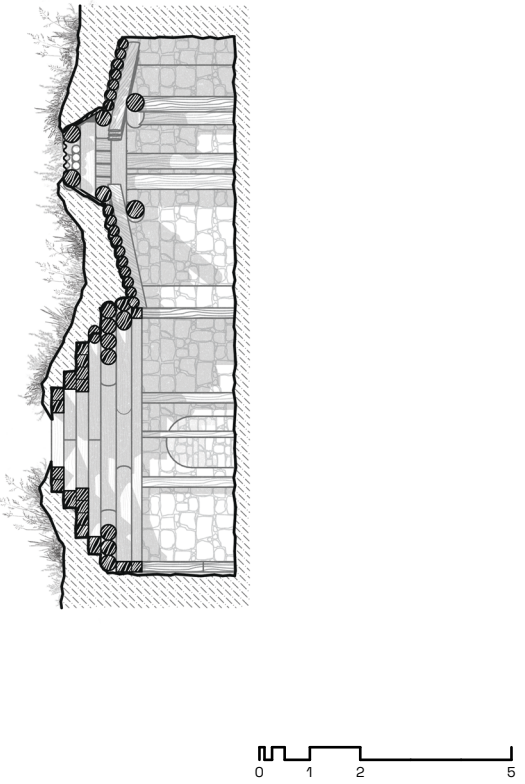




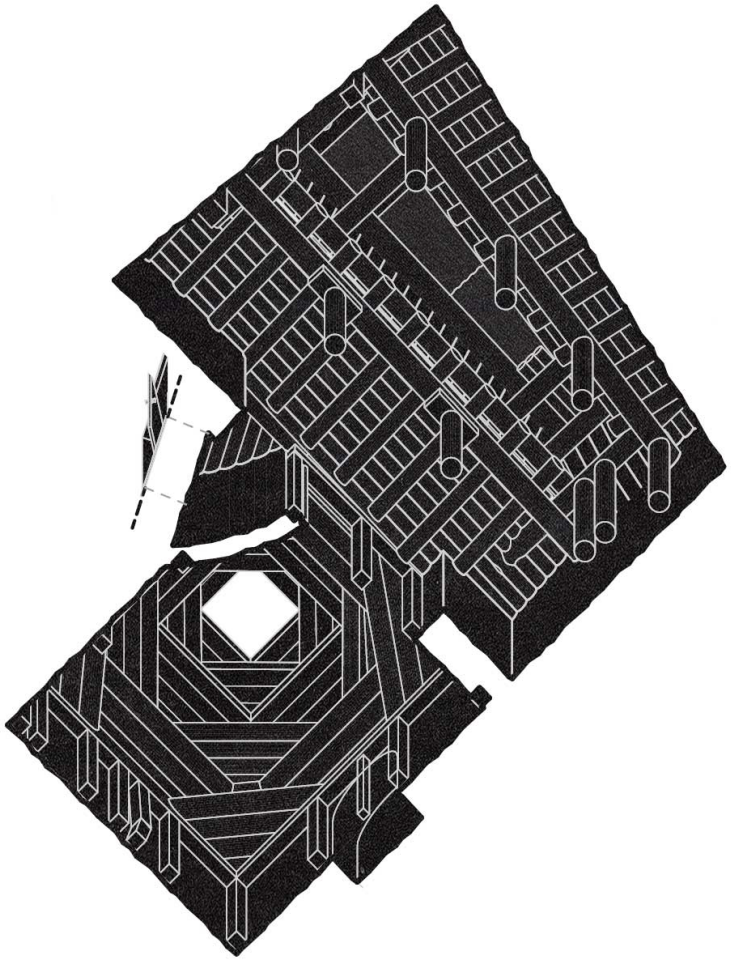
Case study N4
Axonometric scheme

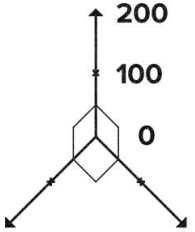


Case study N7
Reflected ceiling plan



Case study N7
Section 1-1





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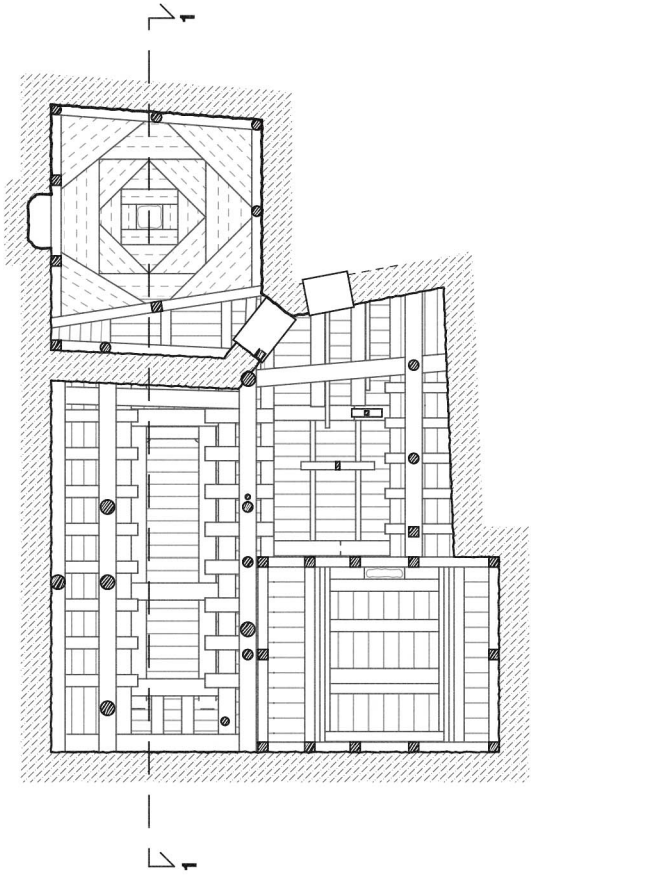
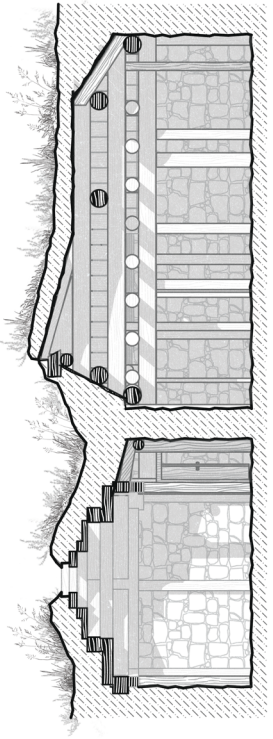


Case study N8
Reflected ceiling plan



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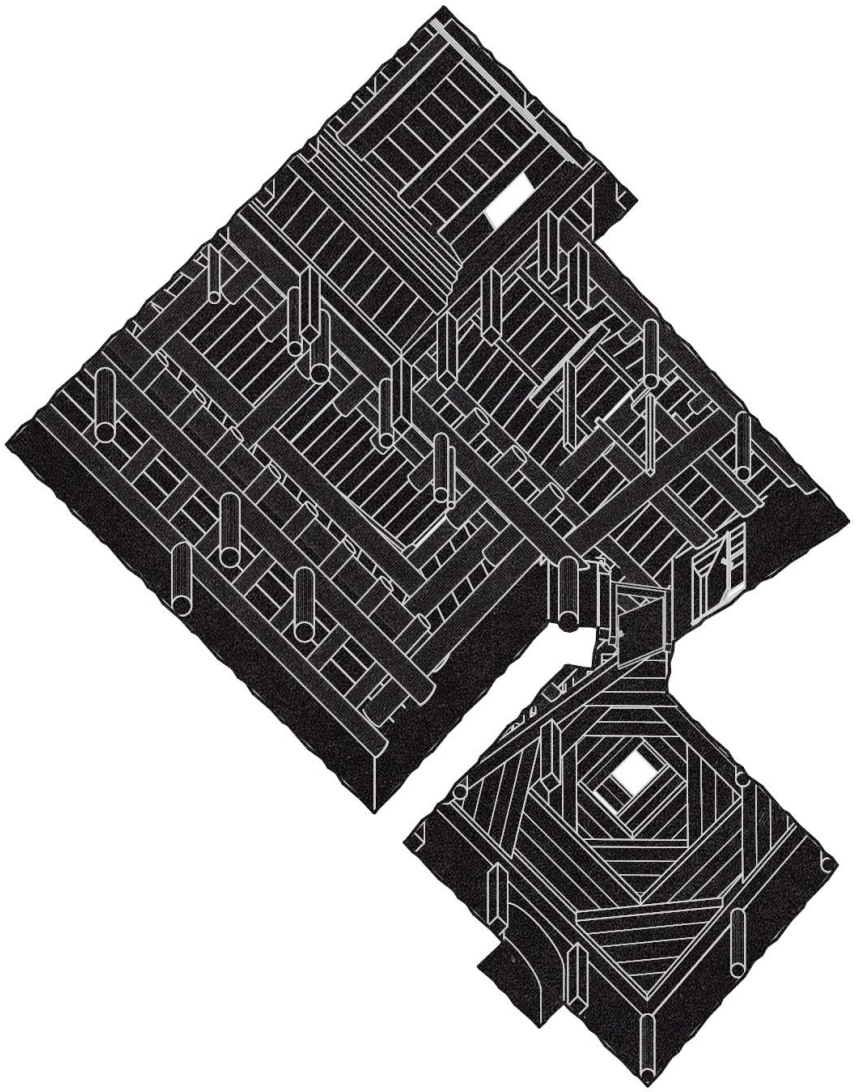
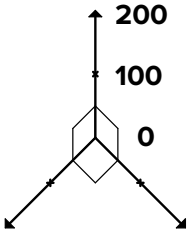
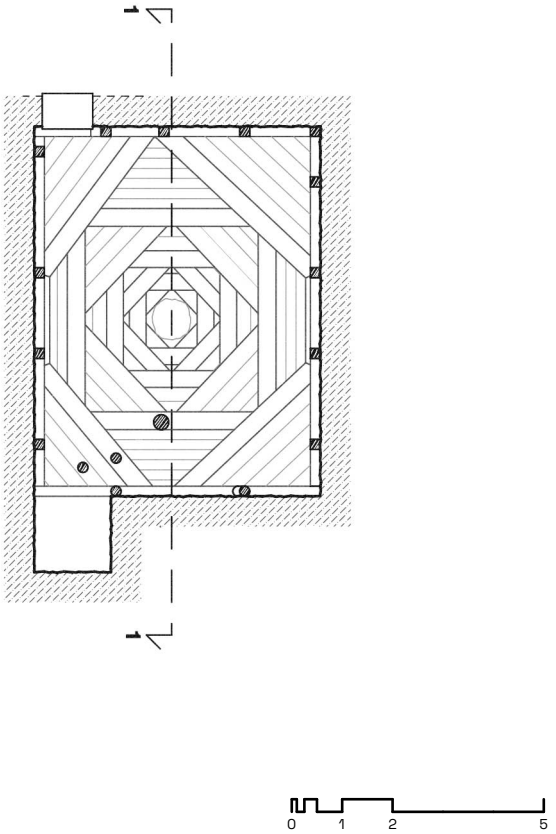
Section 1-1

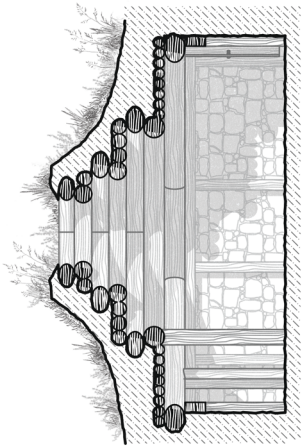




Case study N8
Axonometric scheme



Case study N9
Reflected ceiling plan



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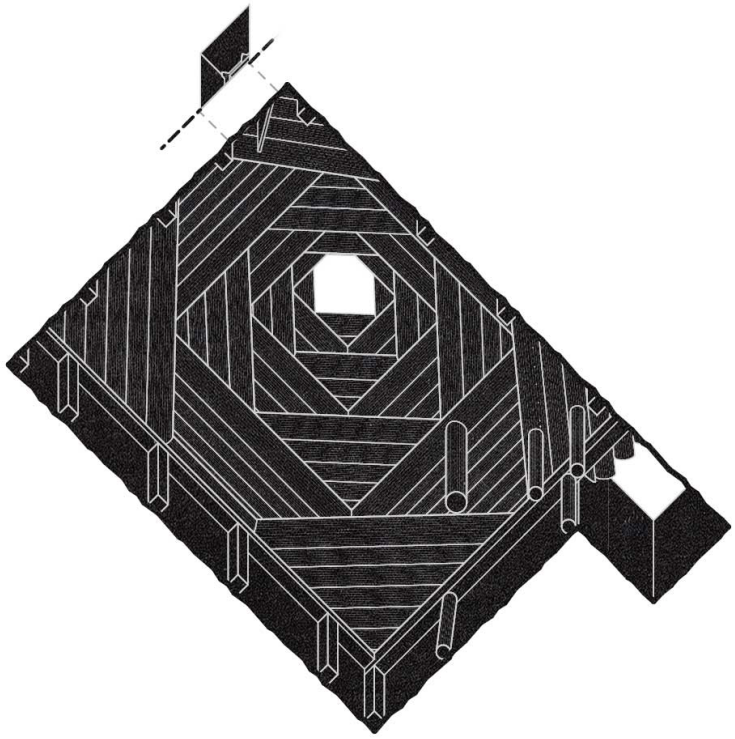
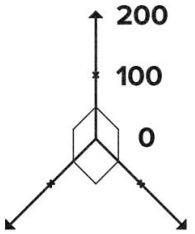
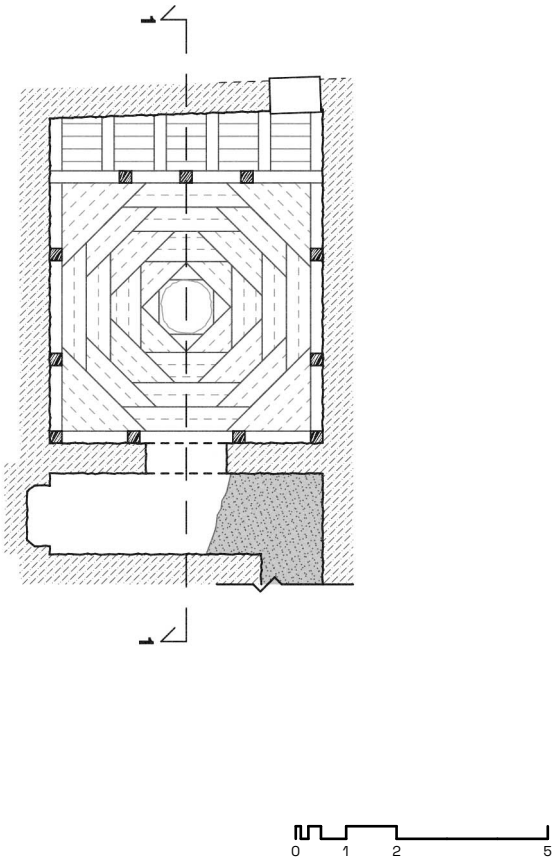
Section 1-1

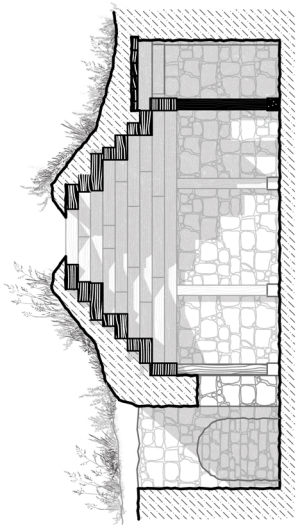




Case study N9
Axonometric scheme



Case study N1 0
Reflected ceiling plan



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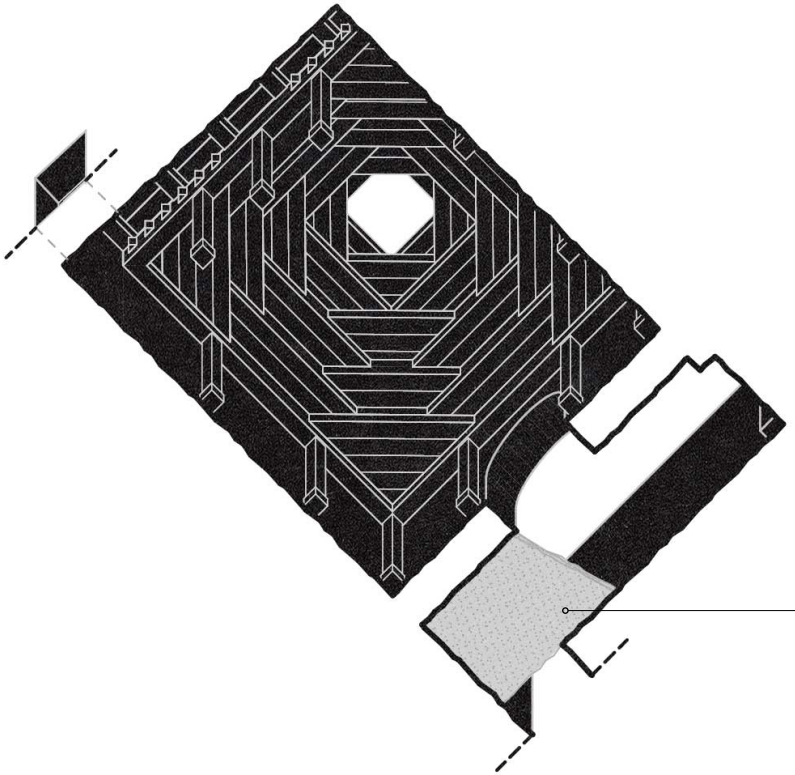
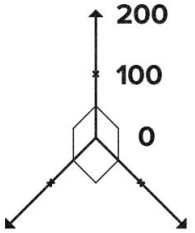
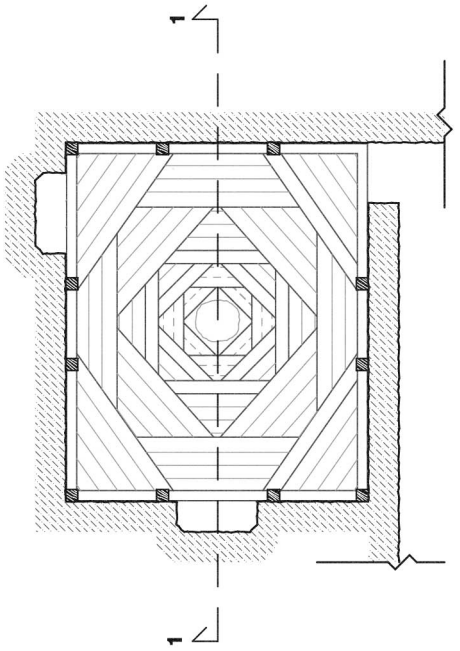
Section 1-1



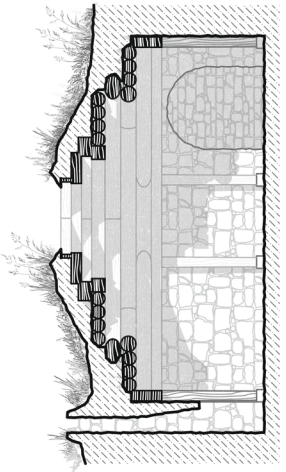


Case study N10
Axonometric scheme



0 1 2 5

Case study N11
Reflected ceiling plan



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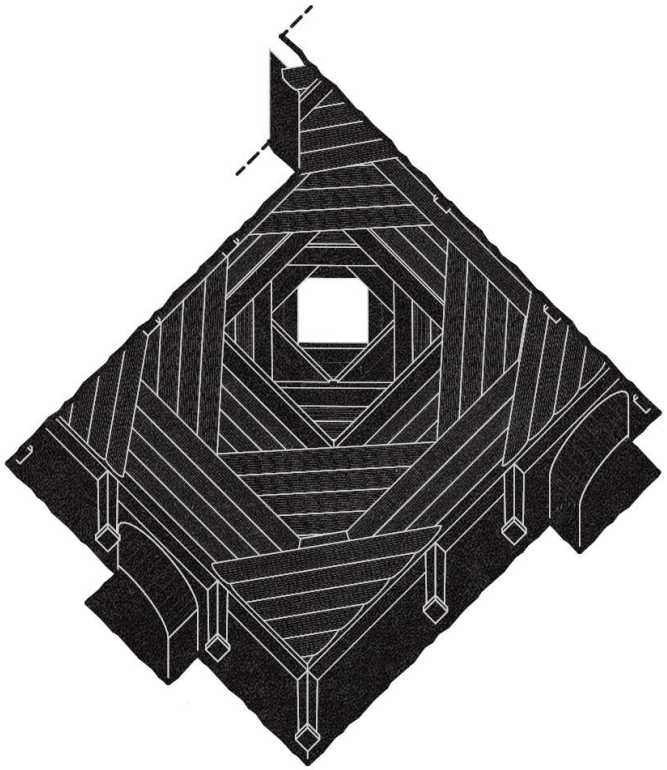
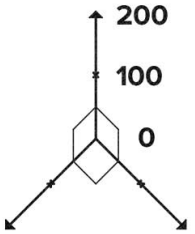
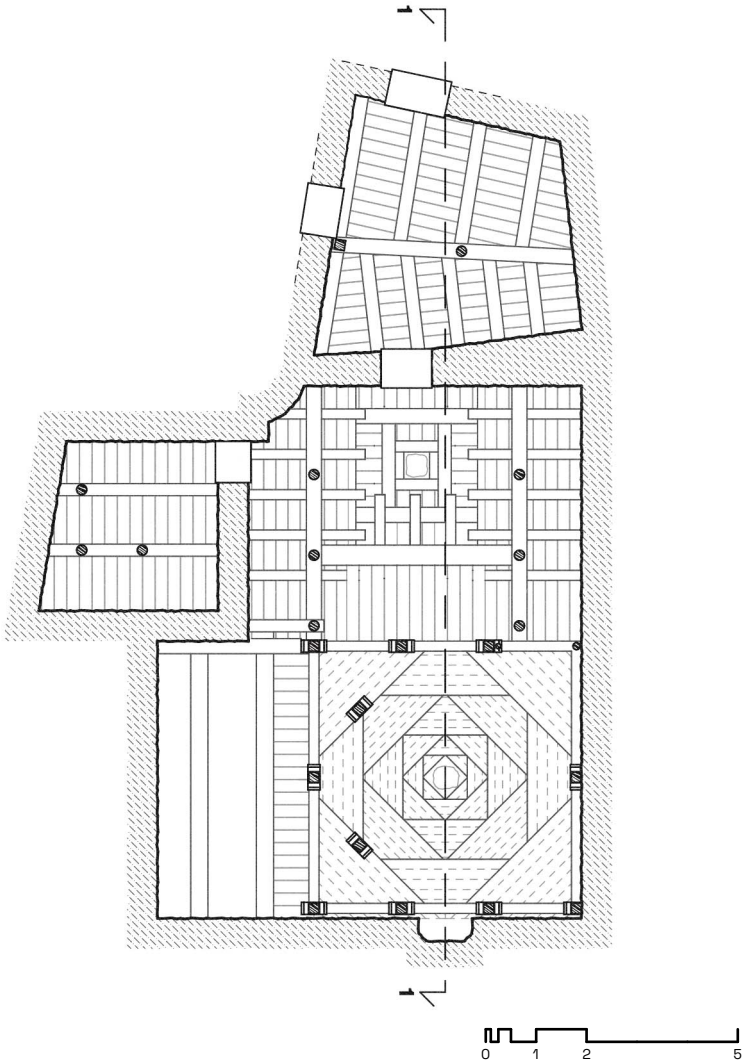
Case study N11
Section 1-1

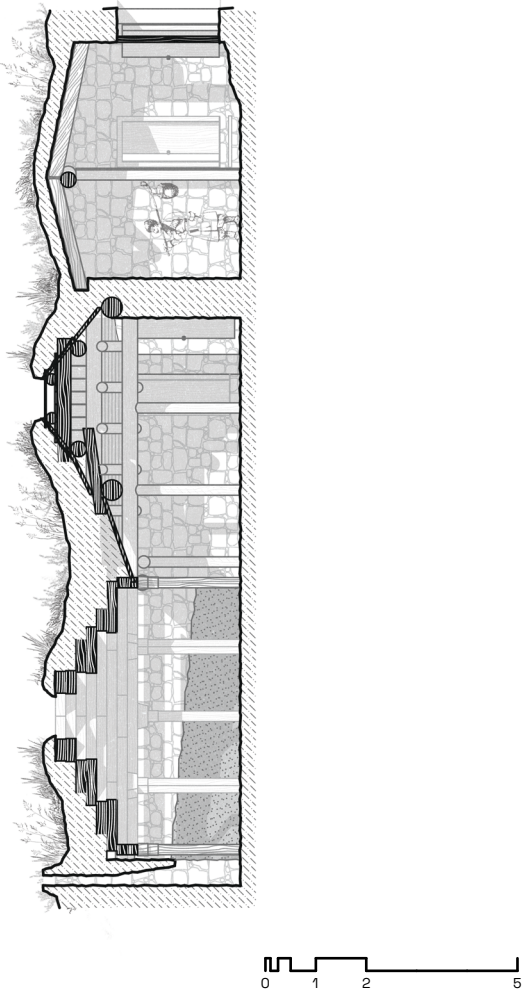




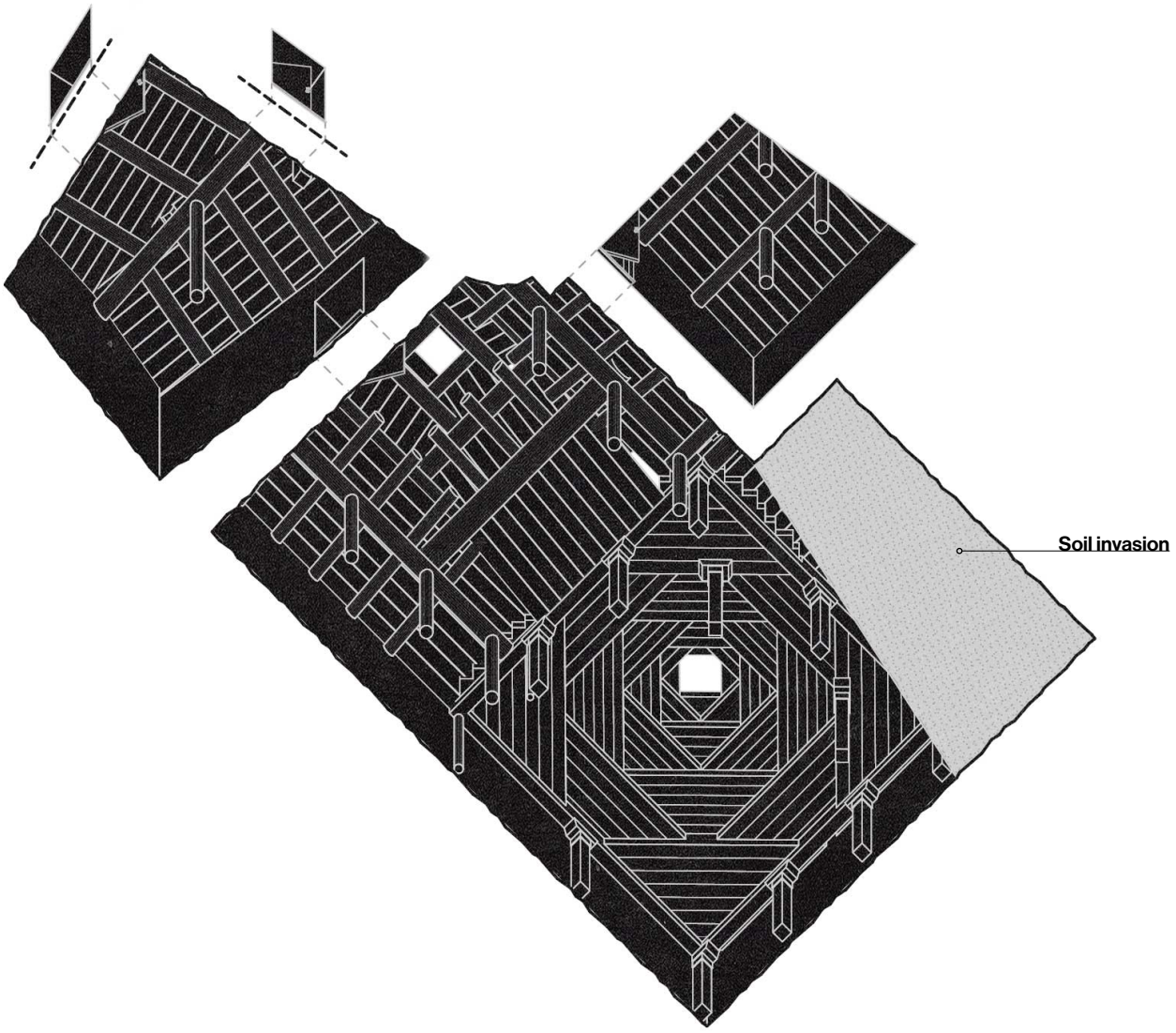
Case study N11
Axonometric scheme

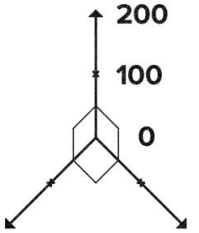


Case study N12
Reflected ceiling plan

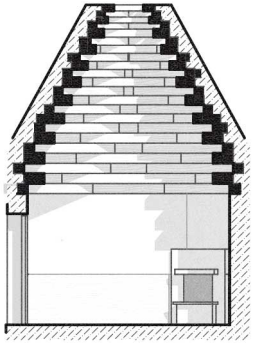


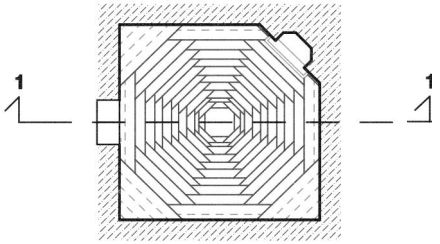
Case study N12
Section 1-1

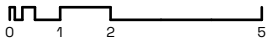




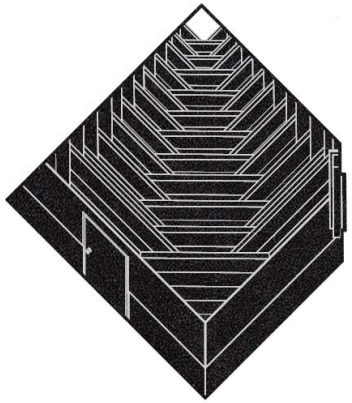
Case study N12
Axonometric scheme

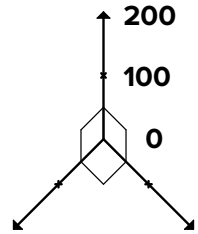




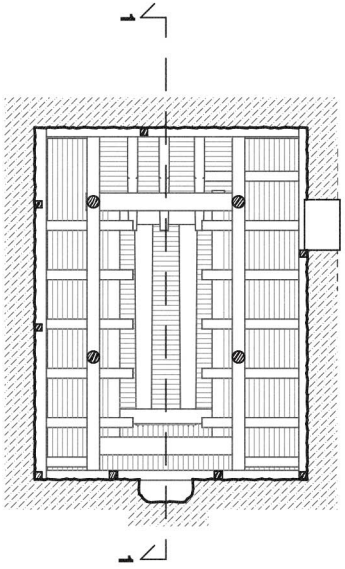


Case study N13
Section 1-1; Reflected ceiling plan



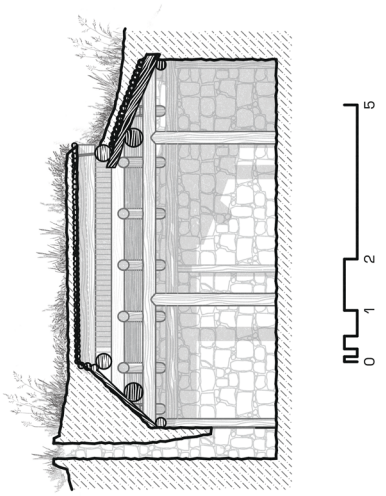


Case study N13
Axonometric scheme



0 1 2 5

Case study N14
Reflected ceiling plan



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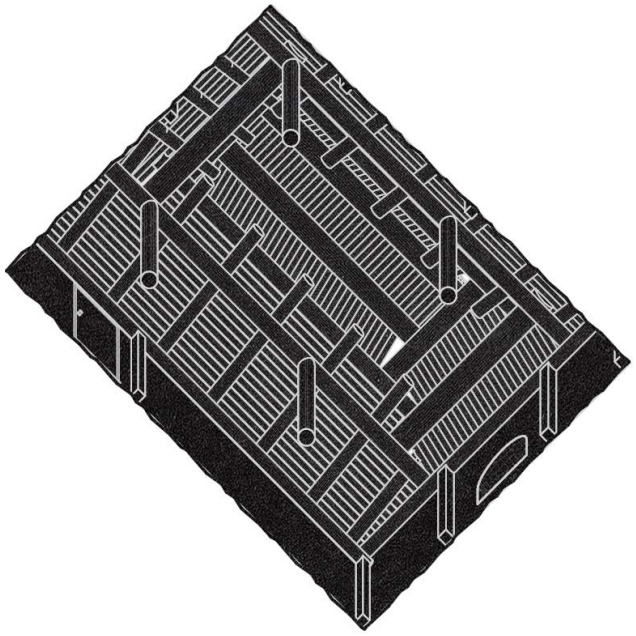
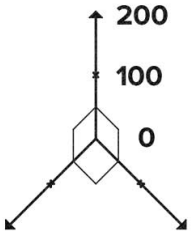
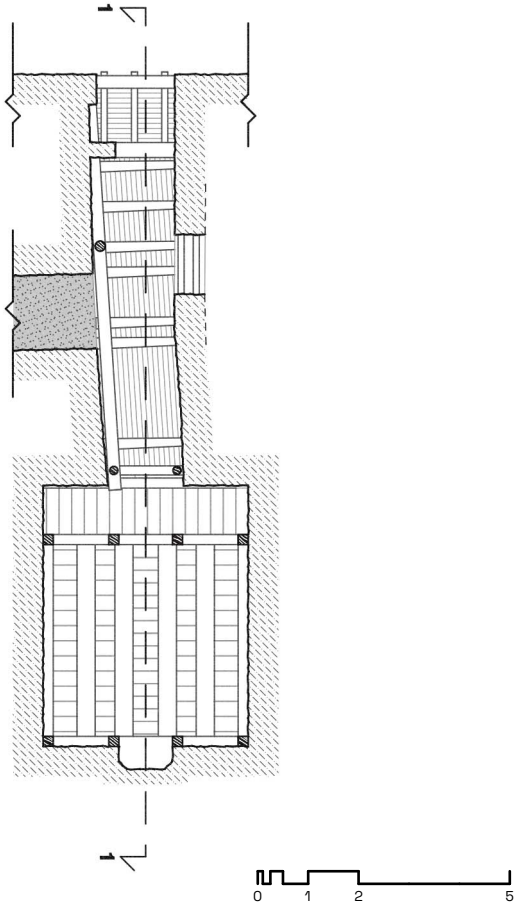
0 1 2 5

Case study N14
Section 1-1

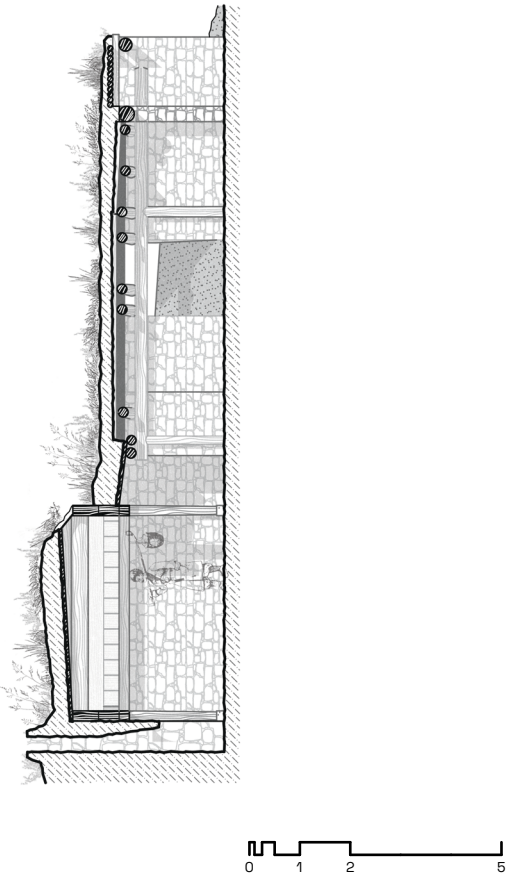




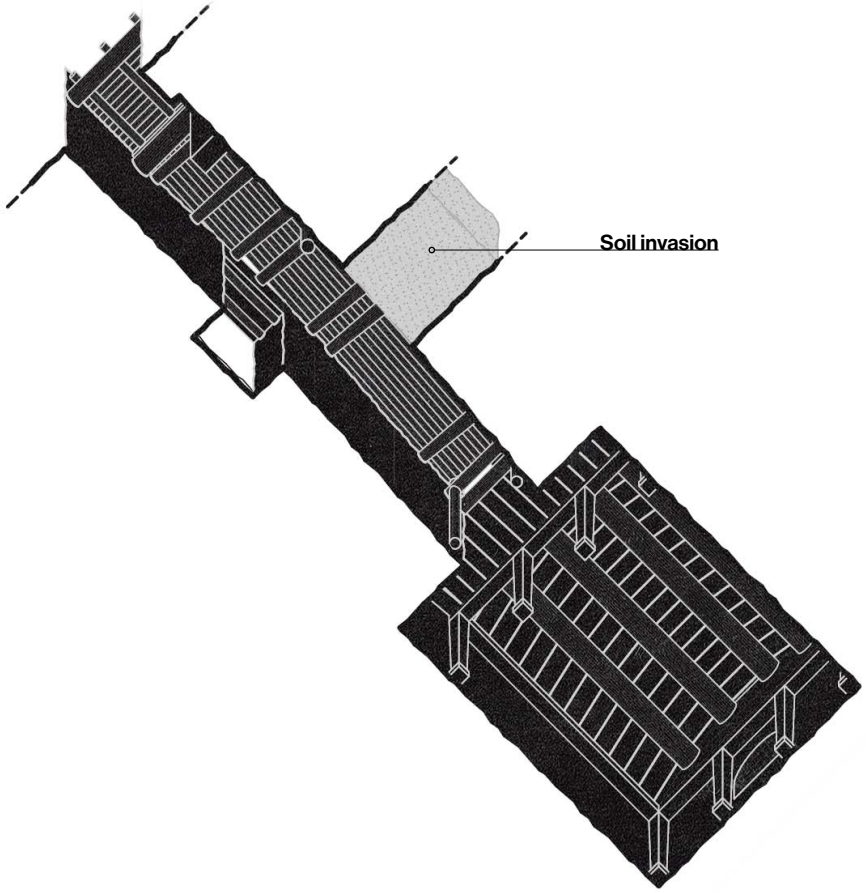
Case study N14
Axonometric scheme

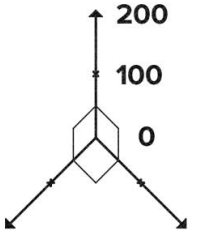


Case study N15
Reflected ceiling plan

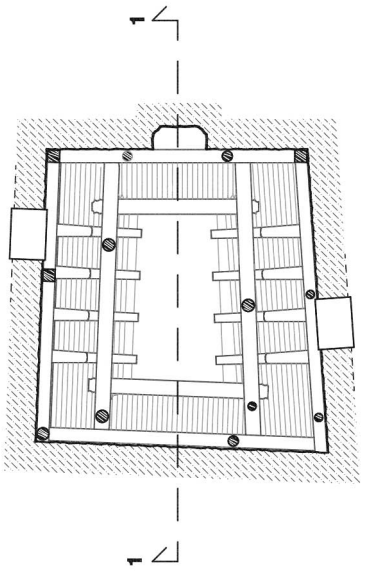


Case study N15
Section 1-1



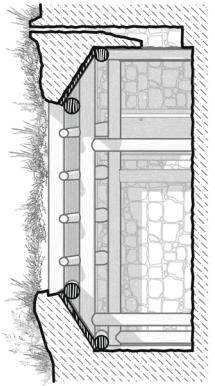


Case study N15
Axonometric scheme



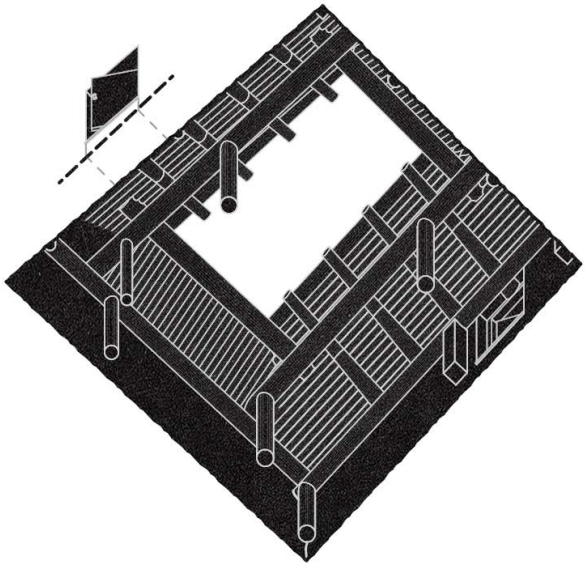
0 1 2 5

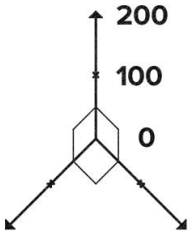
Case study N1 5
Reflected ceiling plan



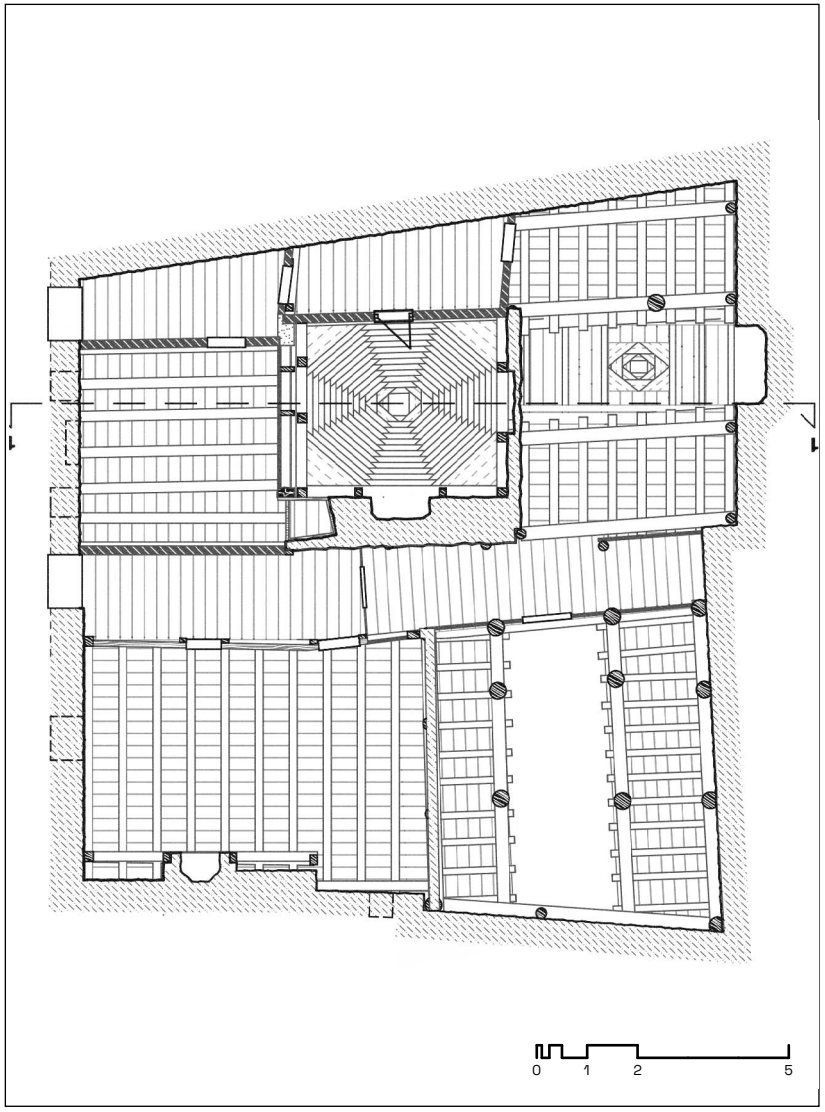
0 1 2 5

Case study N15
Section 1-1

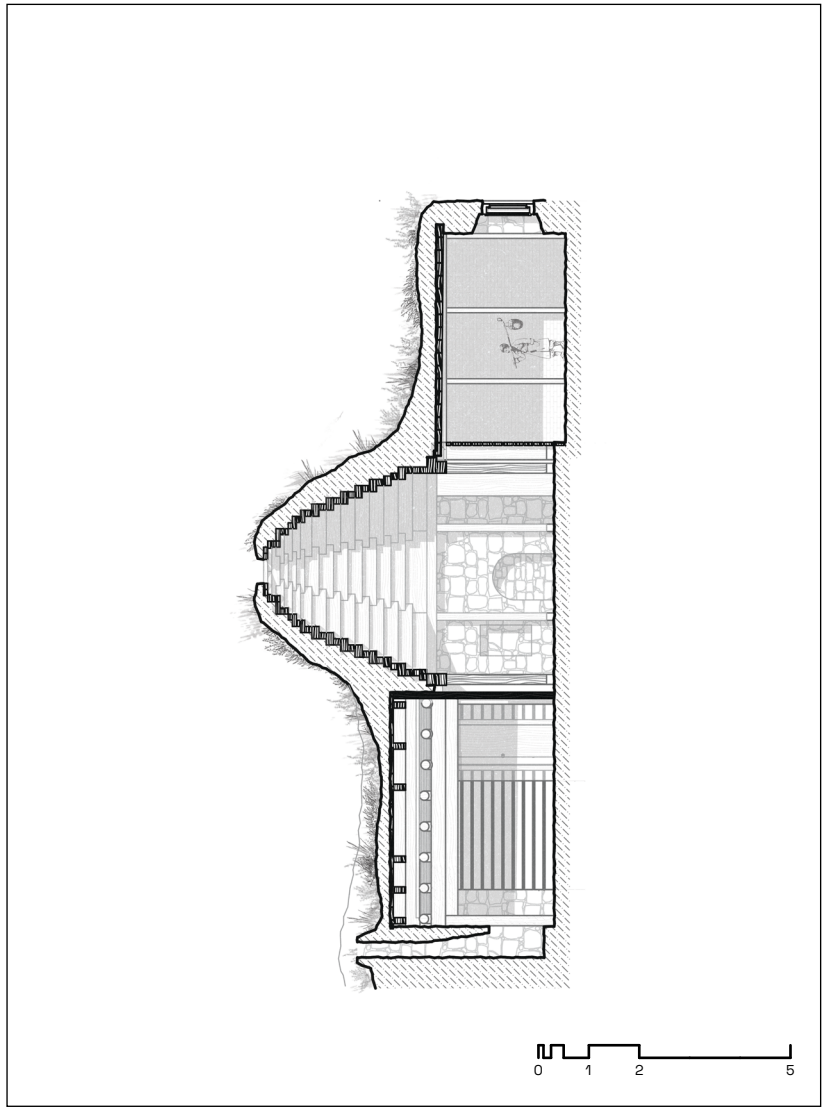




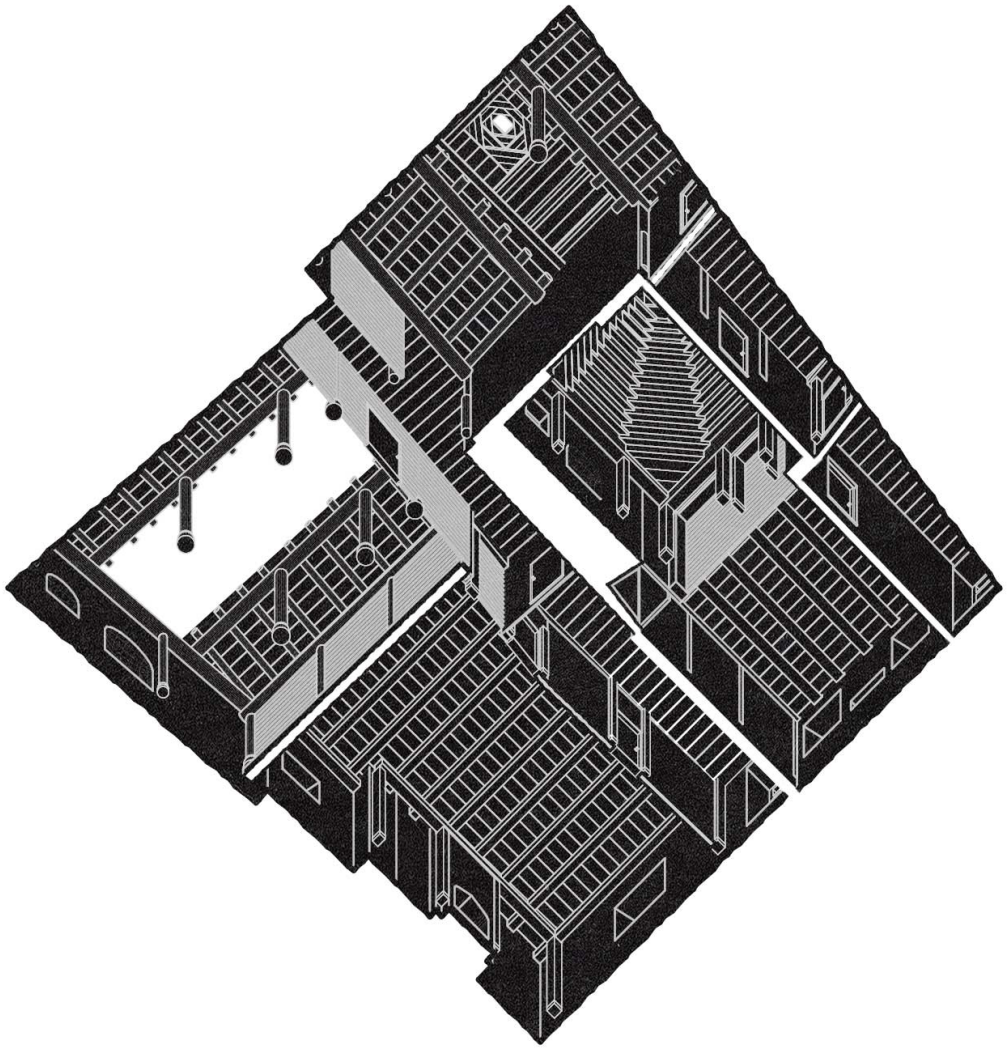
Case study N15
Axonometric scheme

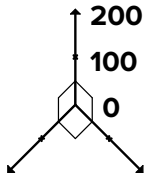


Case study N1 6
Reflected ceiling plan



Case study N16
Section 1-1





Case study N16
Axonometric scheme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