PHYSICAL AND THERMAL PROPERTIES OF PINE-NEEDLE LIGHTWEIGHT LOAM

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ABSTRACT

PHYSICAL AND THERMAL PROPERTIES OF PINE-NEEDLE LIGHTWEIGHT LOAM

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Lightweight loam (LWL) is an ancient earth-based insulation material. Different types of LWL have been developed according to the usage and the availability of materials. However, the most used is straw and LWL is better known as straw-clay or slip-straw.

In Turkey, straw is a valuable material used as an animal fodder. On the other hand, pine-needles are available in large quantities in Turkey. Production of mud-bricks and traditional mud roof insulation with pine-needles has proven its compatibility with earth construction. Therefore, using pine-needles as filler in an earth-based insulation material is proposed.

Two types of pine-needles and two types of soil have been used to determine the suitability of the material. Relations between soil type and viscosity of the loam, type and amount of pine-needles have been investigated for the determination of physical properties of the material. Vapor resistivity and hygro-thermal properties of 4 different pine-needle LWL and straw LWL samples have been monitored during long periods under different weather conditions. The results of the tests have been compared to establish the efficiency of the material as a humidity regulating insulation material.

Pine-needle LWL shows an appropriate performance compared to other materials. Shrinkage, density and water absorption can be controlled by modifying the type of pine-needle and soil together with their proportions. More importantly, vapor and heat resistivity of pine-needle LWL compare well with straw LWL which benefits are already recognized in several countries.

This research makes clear that the material could be employed for the construction of energy efficient and nature friendly buildings and help to develop an alternative to petroleum based insulation materials. However, since this thesis is only an exploratory work on some parameters of pine-needles LWL, more work is needed on its general behavior and production method.

Keywords: lightweight loam, natural building materials, sustainable building materials, pine needles, earth construction.

ÖZ

ÇAM İĞNELİ HAFİF KERPİÇİN FİZİKSEL VE ISIL ÖZELLİKLERİ

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Tez Yöneticisi: Prof. Dr. Soofia Tahira Elias Ozkan

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Hafif kerpiç, toprak bazlı kadim bir ısı yalıtımı malzemesidir. Malzeme yeterliliği ve kullanım amacı bakımından farklı hafif kerpiç türleri geliştirilmiştir. Farklı dolgu malzemeleri içerisinde en çok kullanılanı samandır ve buna bağlı olarak, hafif kerpiç yabancı kaynaklarda saman-kil veya kaygan-saman olarak da bilinmektedir. Türkiye'de saman hayvan yemi olarak da kullanılmaktadır. Öte yandan; çam iğnesi Türkiye'de büyük oranda mevcuttur. Çam iğnesinin kerpiçte ve geleneksel toprak çatıda kullanılması, toprak yapılarla uyumluluğunu kanıtlamaktadır. Bu nedenlerden dolayı, çam iğnelerinin hafif kerpiç içerisinde kullanımı önerilmektedir.

Yapı malzemesi uygunluğunun belirlenmesi için iki tür çam iğnesi ve iki tür toprak kullanılmıştır. Fiziksel özellikler belirlenirken toprak türü, kullanılan çamurun akışkanlığı ve çam iğnelerinin türü ve miktarı arasındaki ilişki araştırılmıştır. Çeşitli hava koşullarında uzun süre boyunca 4 farklı çam iğneli hafif kerpiç ile samanlı hafif kerpicin ısı ve nem özellikleri izlenmiştir. Çam iğneli hafif kerpicin nem düzenleyici ısı yalıtım malzemesi olarak ne kadar etkin olduğunu tespit etmek için test sonuçları karşılaştırılmıştır.

Çam iğneli hafif kerpiç, diğer malzemelerle karşılaştırıldığında uygun bir performans göstermektedir. Büzüşme, yoğunluk ve su emme değerleri; kullanılan çam iğnesi ve toprak türleri ile miktarları değiştirilerek kontrol edilebilmektedir. Çam iğneli hafif kerpicin buhar ve ısı özdirenci değerlerinin, birçok ülkede faydaları kabul gören samanlı hafif kerpiç ile kıyaslanabilir olduğu görülmüştür.

Bu çalışma, çam iğneli hafif kerpicin doğa dostu ve enerji tasarruflu yapıların inşasında kullanılabileceğini ve petrol bazlı ısı yalıtım malzemelerine alternatif oluşturabileceğini göstermektedir. Bununla birlikte, bu tez sadece çam iğneli hafif kerpicin bazı değişkenleri üzerinde yapılan keşif amaçlı bir çalışmadır ve malzemenin genel davranışı ve üretim teknikleri üzerinde daha fazla çalışma yapılmalıdır.

Anahtar Kelimeler: hafif kerpiç, doğal yapı malzemeleri, sürdürülebilir yapı malzemeleri, çam iğnesi, toprak yapım teknikleri.

To My Little Big Family

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Lastly I would like to thank my mother, my father and my sister for their endless love and belief on me. I would not be able to follow the path that I believe in without their trust and to have a deep love and respect on nature without their education.

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CHAPTER 1

INTRODUCTION

In this chapter; the argument for the study, its objectives, the procedure of the study and the disposition of the chapters within the thesis, are presented.

1.1. Argument

The energy crisis and the degradation of nature had reached its peak in the 20th Century. Even though the usage of non-renewable natural resources continues to increase, also awareness has been raised among several sectors by creating more ecologically friendly opportunities and solutions.

Much research has been done on buildings for the same purpose since studies show that construction sector has a huge part on the amount of energy consumption: from the production and the transformation of the building materials to the construction, usage and disposal of the buildings. Therefore, it is important to make more research to be able to find alternative solutions such as improvement of natural building materials or ecological design principles.

Earth-based natural building materials have been the major building material in most countries for centuries, and they offer appropriate solutions for creating affordable dwellings in poor countries. Alongside of how natural earthen materials are affordable; they are also eco-friendly since they do not require an industrial production phase and they can be found almost everywhere in the world therefore they are suitable for self-built construction.

Other significant feature on development of energy efficient building is the usage of insulation materials. There are many industrially produced insulation materials but because of their production methods and raw materials, they don’t offer an ecological solution as much as natural ones. In brief, improvement of both natural and insulation materials will help to decrease energy consumption and also support to create a more ecological world.

Usage of fibers in lightweight loam construction varies from one country to another one, since it depends on the availability of the material or the desired properties of the material. One of the most common filler in lightweight loam is straw but its availability may be depending on the fluctuating production of cereals and the usage of organic by-products for energy production. These features may also result as increasing prices of straw that will lower the accessibility of the material. Correspondingly, such potential problems should cause investigations on new types of aggregates for self-built construction of lightweight loam.

A possibility of research is the development of pine-needles LWL. Pine- needle is a fibrous material that is easily available in Turkey, since conifers forests represent more than the half of the forest areas in Turkey. It has also been used as ingredient of construction material traditionally in Turkey (Çelebi 2012), but no research has been found on the properties of pine-needles as construction material. Therefore, it was decided to test pine-needles to be used in lightweight loam construction.

1.2. Objectives

The aim of the research is to study earthen material used as insulation material. Earthen materials have been used during centuries as load-bearing or finishes material, but usage as earth only as a binder for fibers is a new possibility that was developed with the invention of modern construction and the absence of need for structural usage of infill systems.

In this study, a new material is proposed, combining earth and pine-needles together to produce an infill material that could be used as thermal insulation in framed walls. This material will be studied for its hygro-thermal properties and the aim is to demonstrate its capacity to be used in modern and traditional construction.

To achieve this aim, three main objectives have been defined as follow:

The first objective is to understand the workability of pine-needles lightweight-loam (LWL) by preparation of the mix, molding and the drying process of the material. This step is necessary as the material is new and has never been made with pine-needles before.

The second objective is to define physical properties of pine-needles LWL such as shrinkage, density and water absorption which are important to understand the possibility of the material to be used as a building material.

Since LWL is not considered as a load-bearing material and used only as infill material, main focus of the research is to identify the properties of pine-needles LWL as an insulation material. Therefore, third objective is to understand the hygric and thermal behaviors and to compare them with straw LWL and different natural and commercial insulation materials such as mud brick, fired brick and autoclaved aerated concrete.

1.3. Procedure

Extensive survey of the literature has been done to be able to compile the information about the history and the characteristics of lightweight–loam (LWL) as a construction material. The survey has been done not only on scientific journals, but also on available forums and Do-It-Yourself (DIY) websites and handbooks where techniques, mixes and demonstrations of material properties are available.

The experiments that were done are aimed to be on-field tests since the usage of LWL by self-builders is being researched (LWL is mostly being produced by self-builders directly on field). Also the samples used on experiments were prepared by two different species of pine-needles and two types of soil with different compositions and regions for a more extensive comparison and to determine the suitability of easily accessible pine species.

The methodology that is based on experiments was designed to be in three steps:

To be able to define the workability and appropriate proportions of the material, preliminary tests were done based on Turkish Standard on Adobe Blocks and Its Construction Rules (Turkish Standards Institute 1977) since it is the only standard that explains a protocol on the definition of natural building material.

As the second step, the samples chosen as an outcome of preliminary tests were prepared in appropriate molds. Physical characteristics were defined with the data from the drying process and the tests done after proper drying. For the definition of hygric behavior, the capillarity water absorption test was made on all the samples following an adaptation of a non-destructive protocol of the Building Research Laboratory elaborated for loam experiments (Minke 2006) . Also vapor resistivity test was done as an on-field test to compare the behavior of different samples of

LWL. Additionally, straw LWL, adobe brick, fired brick and autoclaved aerated concrete as commercial insulation materials were tested for comparison.

As the third step, thermal behavior of pine LWL was investigated. Three mixes of pine-needle LWL and two mixes of straw LWL were used to produce external wall for thermal boxes, and data-loggers with sensors were used to record the internal ambient temperature of each box as well as the south wall inside surface temperature. Weather data were recorded by a weather station situated close to the experiment site. The data were monitored during three weeks of warm weather in Ankara in an exposed location without any obstacle to the sun radiations. The relative humidity was also monitored during this period and this allowed comparison of the behavior of the material under real weather conditions.

1.4. Disposition

All the information of this study is clarified in six chapters.

Chapter 1 is composed of argument, objectives, procedure and disposition in which the aim and the process of the research are explained as a summary.

Chapter 2 that is literature review covers general information about sustainable building materials and detail information on lightweight loam as a construction material by giving it definition and history together with the explanation of its composition, production, and possible building elements to be built. Also structural, thermal and sustainable characteristics of lightweight loam are compiled from literature. Experimental procedure that has been used through the research is clarified.

Chapter 3 represents research materials that were used. The compositions of raw materials and mixes that were used to prepare samples for experiments are explained.

Also the equipment that was used for sample production, experiments and general equipment as secondary tool are clarified.

Chapter 4 represents research methodology of the study. Firstly the collection of the materials and soil identification is described. Than the procedures for preliminary tests and experiments are explained.

Chapter 5 covers the results and discussion of the research. Firstly the results of properties of soil are given and convenience of production techniques and suitability of soil samples are discussed. Than both preliminary tests and physical property results are given and the discussions are done for each test.

Chapter 6 represents the conclusion of the research is explained by giving a summary of research findings and recommendations for further studies.

CHAPTER 2

LITERATURE REVIEW

In this chapter, the definitions of sustainable building materials and lightweight-loam (LWL) are given briefly. Descriptions of sustainable building materials are compiled. Several names of LWL with definitions are also specified. Since traditional LWL has improved on different types with different additives, the evolution of the material is explained as a brief history. All the information explained are compiled from 50 sources relating with natural, ecological and traditional building materials.

2.1 Sustainable Building Materials

To be able to understand what a sustainable building material is, firstly "sustainability" should be defined clearly, and then the reasons for using sustainable materials should be explained. According to Keefe (2005), sustainability does not have any clear meaning even if it is being used very often. Sustainability is depending on all actions of human-being and their effect on environment. Keefe (2005) also defines the concept of sustainability as having the liability of protecting the earth's eco-system and sources by the current population for continuity of life also in the future.

This concept is being undermined by over consuming limited sources of the planet and discarding any local action or tradition. For instance in the report of The Oil Depletion Analysis Centre and Post Carbon Institute (2008), it is indicated that the production of oil – which is a limited source – will soon reach a peak and start to decline permanently (Figure 1), that will cause big energy crisis such as transportation problems. In the same report, it is also advised to local authorities to control energy consumption in the buildings.

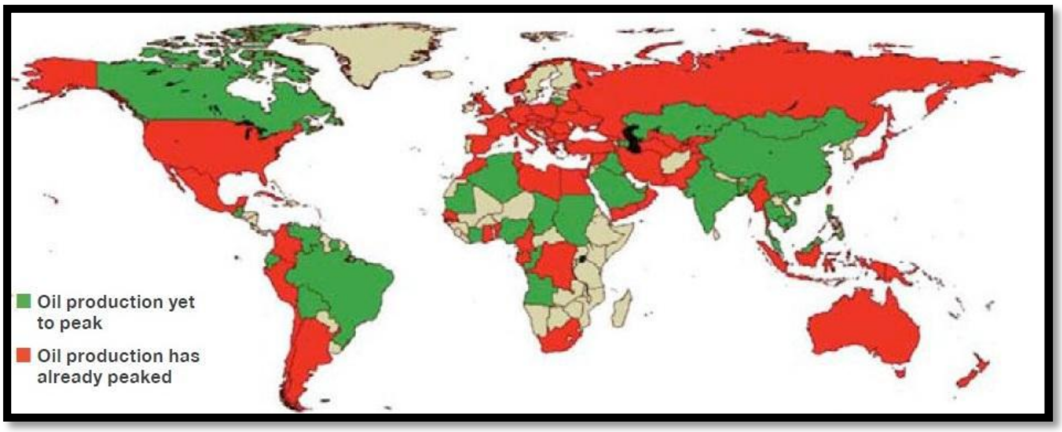

Figure 1: Reaching peak at oil producing countries. Source: The Oil Depletion Analysis Centre (ODAC), 2008

Furthermore, in the report of Itard *et al*. (2008), the graphs of final energy consumption per sector (residential, non-residential, construction industry and others) of each European country from 2004 are given. When the average of the countries' energy consumption are taken, the residential sector (households) uses 30% of the total energy, non-residential uses 12% and the construction industry uses 2% (Itard et al., 2008). Additionally, on the website of United Nations Environment Programme (About UNEP-SBCI-Why Buildings 2015) it is stated that buildings are responsible for 40% of global energy consumption, 25% of global water, 40% of global resources, and they emit approximately 1/3 of GHG emissions.

From these data's, it can be understood that buildings have a big impact on energy consumption. As Vardy and MacDougall (2007) state, citing Magwood and Mack, there is a need to find both economic and environmental friendly building materials because of the raising awareness about negative environmental impacts. On the website of European Commission (Energy Efficiency/Buildings 2015), it is claimed that through enhancement of buildings' energy efficiency in the European Union (EU), total energy consumption can be reduced between 5% and 6% and CO_2 emissions can be lowered about 5%. Therefore, it can be deduced that a building material should have low energy consumption and less impact on environment, to be able to be sustainable.

According to Kim and Rigdon (1998), when choosing a building material, major factor is about cost which just represents manufacturing and transportation instead of including social and environmental costs. For that reason, they suggest to search "cradle-to-grave" analysis of building materials which is containing pre-building, building and post-building phases of the materials, to be able to state their sustainability. Additionally, in the report of "Sustainable Building: A Materials Perspective", Trusty (n.d) points to the importance of life cycle assessment when defining sustainable building materials.

By thinking in the context of life cycle assessment, natural building materials which were used also in the traditional buildings can be counted more sustainable than synthetic ones. Some criteria of sustainability of natural and traditional building materials which are defined by Ryan (2011) as: non-pollutant; energy efficient and using low energy in production, transport and use; locally produced; durable and easy to maintain and repair; produced by socially fair means; low waste and capable of being re-used and recycled.

Sustainable building materials also need self-built approaches in developing countries because of using locally available, natural materials that are evolved from traditional building techniques. According to Houben and Guillaud (2008), building with earth is an important solution for production of houses in a short time in developing countries, at the same time it allows using local materials and creating job opportunities while people are building for themselves.

2.2 Definition of Lightweight-Loam

In literature, LWL is defined with several other names such as: slip-straw, straw-clay, and light-clay. It is a building technique consisting of slip-clay and several aggregates; and mostly used as infill material for walls. Since the additives to clay can show varieties, it is chosen to name the building technique as lightweight-loam (LWL).

Komurcuoglu (1962) names lightweight-loam in Turkish as "hafif kerpiç"; which means "light adobe". On the contrary to load-bearing construction system, this construction technique is applied on wooden structure and the material consists of grass or straw as lightweight materials inside the adhesive slip loam. Komurcuoglu (1962) also explains the main advantages of light adobe as possibility to use non-shaped wooden pieces in every size as bearing element and not to require expensive interlacing construction.

According to Minke (2006), to be able to call the mixture of loam and lightweight aggregates as "LWL", its density should be less than 1,200 kg/m^3. He is also making a classification according to the additive to loam: lightweight straw loam with straw additive, lightweight wood loam with sawdust or wood additives, lightweight mineral loam with mineral aggregate additives.

Kruithof (2009) states that the difference between LWL and other earth walls is that earth walls consist of mostly earth and with a little bit of straw (or any other kind of additive), however, LWL includes mostly straw, with small amount of slip clay to hold the straw together. Therefore, when most of the earth walls are considered as thermal-mass, LWL has high insulation property.

Houben and Guillaud (2008) explain a technique of LWL with straw additive which is named as straw-clay. It is explained as the mixture of straw and clayey earth which is soaked in water to get a fluid form. The function of earth is defined as providing cohesiveness of straw.

In the report of Gaia Architects (2003) and (Goodhew, Griffiths ve Morgan, Investigation into the Variations of Moisture Content of Two Buildings Constructed with Light Earth Walls 2005), the description of LWL is given the name of “light earth”, which comprises not only straw as aggregate, also woodchip, hemp and other appropriate fill materials to mix with slip clay.

2.3 Brief History of Lightweight-Loam

Lightweight-Loam is an earth-based material; therefore its history is connected to earth construction history. Although earth construction history is not well documented (Houben and Guillaud, 2008), this material has been used for more than 9000 years (Minke, 2006, Figure 2).

Figure 2: Fortified City, Draa Valley, Morocco Source: Minke, 2006

As Minke (2006) remarks, in dry regions where there is not enough wood for building, using earth as a major construction element was developed (Figure 2), such as mud brick or rammed earth. On the other hand, in Europe that has a colder climate, mud brick and rammed earth were also used but mostly, earth was used as an infill material in the wooden-framed buildings. For instance, wattle and daub that is one of the oldest construction methods was widely used. This method can also be counted as ancestor of lightweight loam. According to Houben and Guillaud (2008), in this construction method, wooden structure that is serving as load bearing element are filled with daub and straw supported by wattles (Figure 3). Komurcuoglu (1962) states that the construction technique of LWL is more simplified than wattle and daub in terms of craftsmanship.

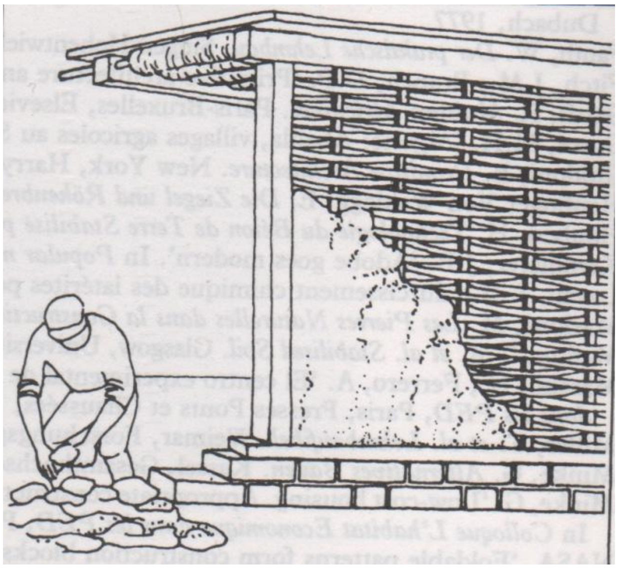

Figure 3: Wattle and Daub Construction Source: Houben and Guillard , 2008

As Gaia Architects (2003) acknowledge, there is no clear documentation that differentiates several traditional infill techniques such as wattle and daub or LWL, but the acceptance of LWL as a construction material itself started in the 20th Century in Germany. However, Kruithof (2009) claims that LWL construction was started in 16th Century or earlier, buildings that are more than 400 years old are still in use. In any case, improvement of this technique shows the need of enhancing the insulation capacities of the buildings because of the weather conditions.

As similar with other European countries, in Germany vernacular earth construction was continuing to be built until First World War, but it was started to be seen as an old-fashioned technique. At the same time, some people were documenting these traditional examples that are almost lost. For instance, Wilhelm Faulth firstly defined the technique “Strohlehmstanderbau” – Standard for Straw Loam Construction – in a publication of Berlin in 1933, which is a straw-clay mixture packed in formwork such as LWL. Faulth also published a book called “Der Praktische Lehmbau”- Loam Construction Handbook - which he explained light earth construction comprehensively (Gaia Architects, 2003). After that, more researches and publications were followed.

During the eighties, LWL was started to be practiced widely and in 1998, Franz Volhard conducted researches about LWL and published his results in his book “Leichtlehmbau” - Light Earth Building (Goodhew, Griffiths ve Morgan, Investigation into the Variations of Moisture Content of Two Buildings Constructed with Light Earth Walls 2005). When it comes to 1990s, with the help of growing ecological movement, LWL was spread to other European countries and US.

At the same time, studies about earth construction regulation were started. In Germany, different building standards exist for non-stabilized earth construction: DIN 18945 for earth blocks, DIN 18946 for earth mortar and DIN 18947 for earth plaster ((DIN Normen für Lehmbaustoffe 2015) and only construction and production of LWL blocks is included inside DIN 18945 (Lehmsteine – Begriffe, Anforderungen, Prüfverfahren). Other types of LWL construction (exterior wall, interior walls, internal insulation in renovation projects, roofs or floors etc.) are included inside the “Lehmbau Regeln” which is a set of professional rules framing the usage of non-stabilized earth construction in Germany. (Lehm in

Holzbalkendecken 2015). Also in State of New Mexico; standards of LWL construction published the “Clay Straw Guidelines” (Gaia Architects, 2003).

2.4 Composition and Production of Lightweight Loam

In this section, different varieties of LWL with differentiation of additives to loam and the properties of soil are explained. After clarifying the components, technique of producing LWL mix is explained.

2.4.1. Soil

LWL is a material constituted of binder – clayey soil – water and fillers. In any version of this material, clayey soil and water are stable ingredients. For that reason, before describing the different fillers, characteristics of soil should be defined.

Berge (2009) defines soil as common name of fine-particle materials that can be divided as mineral, organic or dissolved result from animals and plants. It includes clay, silt, sand and gravel and all of them have different grain sizes (Table 1) which are defining type of the soil by dominant ingredient. For instance, clayey earth should contain at least 60% of clay. Soil that is taken over a depth of between 5 and 35 cm also includes some organic matters (Houben ve Guillaud 2008).

The inorganic, mineral-based materials that are regarding natural building which are clay, sand, lime, stone and mica have all derived from the same rock that composes mountains and bedrock (Racusin ve McArleton 2012). Each material that constitutes loam has different chemical properties; therefore they have different functions in construction.

Table 1: Soil by their grain sizes Source: Bjørn Berge, The Ecology of Building Materials, 2009

Material	*Grain size (mm)*
Clay	Less than 0.002
Silt	0.002–0.06
Sand	0.06–2.00
Gravel	2.00–64.00

Clay, silt and sand are used together for earth construction; plastering, brick and ceramic production, and manufacturing expanded minerals (Houben ve Guillaud 2008).

i. Organic Matter

The top soil which is called "humus" consists of decomposed plants and has a black appearance. Soil may also include recently decomposed organic matter which has different properties than humus (Houben ve Guillaud 2008).

In general, organic matter has a low mechanical strength caused by the high moisture content (from 100% to 500%) and its structure is spongy. The acidity of organic matters in the soil may stimulate acid reactions with water and it may cause corrosion on the materials which it comes into contact (Houben ve Guillaud 2008). Therefore, soil that consists of inorganic matters is used to produce natural building materials. Additionally, Keefe (2005) remarks that topsoil which is until 45 cm from the surface should not be used for construction because of its content in organic component.

ii. Clay

Clay is made mostly of feldspar and some other minerals. According to its crystalline structure which is depending on its geological source; there are three main types of clay: kaolinites, smectites and illites (Racusin ve McArleton 2012). The different minerals are giving clay a characteristic yellow or red color (Minke, 2006).

The binding force between the clay particles is made through ionic bridges linking the particles together. The strength of those bridges – and then the mechanical strength of the material – is determined by the quantity of cations which composes the clay element and that can attract free anion from water (Keefe 2005). Racusin and McArleton (2012) also indicate that the size of clay is very small that its surface is large enough to hold water in and among its molecules by attracting water molecules with ionic charges on its surfaces. Figure 4 shows the bonding between clay particles and their appearance while the clay is liquid, plastic and solid.

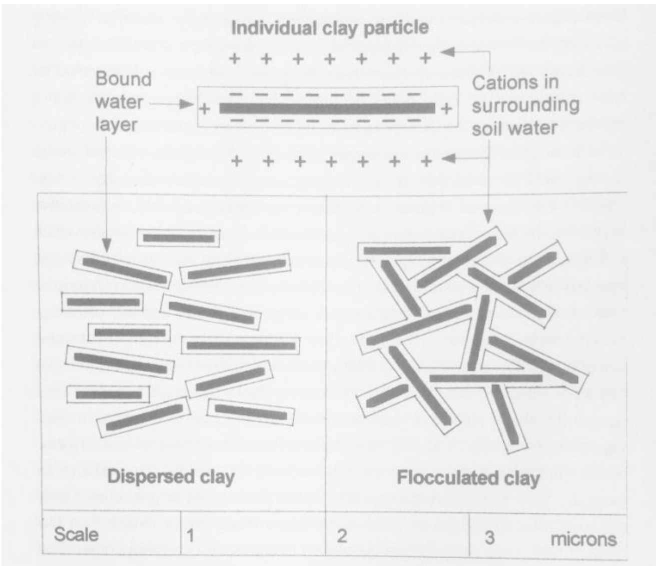

Figure 4: Electro-static bonding between clay particles in the absence of water (Keefe 2005).

Water-holding capacity and hydrophilic features of clay makes this material very essential for natural building. Also plastic and flexible qualities of clay make the material easily workable and useful for plastering, painting and decorating (Racusin ve McArleton 2012).

Kaolinites are the most preferable type of clays for natural building purposes in terms of plastering, painting and as binding material for cob or LWL since they do not expand too much when water is added and they will tend to crack less when the water leaves compared to other clay types (Racusin ve McArleton 2012).

iii. Silt

Fine quartz minerals constitute silts which have not the same cohesion properties with clay (Keefe, 2005). Silt is a soil stabilizer and gives permeability to it (Houben and Guillaud, 2008).

iv. Sand

Sand consist of non-porous and non-cohesive particles either round-shape or angular-shape depending on the transportation or weather conditions (Keefe, 2005). It is usually originated of silica, quartz or calcium carbonate (shell fragments) for beach sand (Houben ve Guillaud 2008).

Sand surfaces have very low adsorption and it avoids shrinkage and swell of sand in the presence of water. This permeable quality of sand makes it filter water instead of keeping it as clay does (Houben ve Guillaud 2008). Sand is used for acoustic insulation, aggregates for concrete materials, plasters and mortars. Gravel can be used also as aggregates in concretes such as sand (Berge, 2009).

2.4.2. Organic Fibrous Materials

The birth of architecture and agriculture happened correspondingly about 10,000 years ago, when products of plants and animals became a part of human-made shelters (King 2010). The author also states that during development of civilizations for many centuries, different properties of agricultural fibers were discovered that have benefits for buildings, so they were used widely either as structural and infill materials.

They can also be used for decorative purposes such as application of bamboo or straw as wallpapers. On the other hand, functional uses of organic fiber materials are in two ways: insulation and tensile reinforcing. When the fibers are kept together in a form, they create air voids in between that provide high insulation (King, 2010). They are also being used as binders in concrete materials that are procuring the durability of the building by avoiding cracks.

In LWL construction, mostly straw is used as organic fiber material. Straw is the general name of agricultural by-products that are dry stalks of crops such as wheat, rye, barley, and oat. It includes cellulose, lignin and high amount of silica that avoids fast rotting, and has a watertight surface. Because it is an easy-obtainable material and does not require any special skill for preparation, many building methods were developed that use straw as a major material: straw bale construction, compressed straw panels-blocks and LWL. In straw LWL construction; walls, floors and paving can be built with any kind of cereal straw (Houben and Guillaud, 2008). Besides using straw as a building material, it is used for de-compacting of soil, as covering of stables' ground and rarely as fuel (Minke and Mahlke, 2005).

Except of straw that are made of crops, different organic fibrous materials were also used in LWL construction. For instance, usage of lavender straw, crushed sun flower and corn stalks, hemp and linen in LWL has been reported by Floissac (2012).

Even though usage of pine-needles in LWL construction could not be found in references, its usage is recorded for construction. For instance, pine-needles were being used traditionally as fibrous material for cob and mud brick construction in Turkey (Çelebi 2012) and as insulation material in Nepal (Sawyer ve Fuller 2012).

2.4.3. Wooden Residue Materials

Wood chips, wood shavings and saw dust are wooden residue aggregates for wood lightweight loam. Usage of these wooden residues with concrete material makes the final material lighter because of density decrease. It also increases thermal insulation capacity (Joseph and Tretsiakova-McNally, 2010).

Usage of wood chips (Figure 5) developed mostly in Germany because of the possibility of using mechanical production and the shortening of construction time. It is also preferred to use in places that is not possible to find straw easily and cheaply. Preferably hardwoods and strong softwoods are used but in general any kind of wood can be used. Usage of bark should be avoided because it makes material non-resistant to rotting but since the small pieces of wood are chipped, it is not easy to prevent its usage in a large scale production of wooden chips (Minke 2006, Gaia Architects 2003).

Figure 5: On the left woodchips and on the right sawdust pictures are displayed (http://www.rrlandscapesupply.com/mulch.php, http://www.usedtractors.co.za/pine-shavings-and-pine-sawdust/).

Although wood shavings have similarity with wood chips, they are used rarely. Since it is easy to compress wood shavings, it is not easy to get lightweight mixes. Therefore, it is advised to use wood shavings with other aggregates to balance different properties. Both wood chips and shavings are used in monolithic wall construction (Minke 2006, Gaia Architects 2003).

Sawdust (Figure 5) consist of small particles that absorbs water more than other aggregates which causes more water need for the mixture. Also because of particle size, small gaps are filled easily so it improves strength of mass with clay but also increases density. Therefore, sawdust is used in block production where density and drying can be under control during production (Minke 2006, Gaia Architects 2003).

2.4.4. Mineral

Porous mineral aggregates such as expanded clay, foamed glass, expanded lava, expanded perlite and pumice can be used as additives for LWL (Minke 2006). According to Gaia Architects (2003), mineral aggregates are rot proof and fire proof which is giving a flexibility to apply it anywhere on the building. It is also stated that there is no shrinkage during drying. Minke (2006) remarks that although it is easier to find these aggregates with low-cost in some developed countries, it is more advisable to use them in big construction projects because of high-cost machine requirement.

Figure 6: Expanded clay pellets (https://en.wikipedia.org/wiki/Hydroponics).

One of the most preferable mineral additives is light expanded clay. Berge (2009) states that all types of clay can be expanded as soon as it consists of fine particles with low amount of lime and high amount of iron and expanded clay pellets should be aired around one year before using (Figure 6).

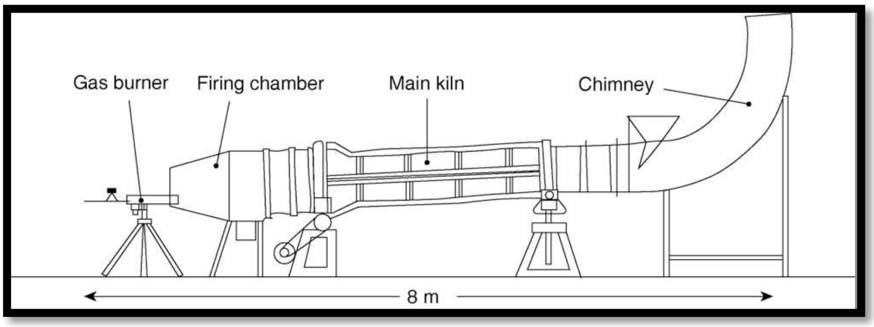

Figure 7: Section through a Pakistani mobile rotating kiln for the production of expanded clay pellets (Berge 2009).

Expanded clay is produced in a rotating kiln by mixing sawdust, oil or coal with clay then fired at temperature of 1150 °C. It takes around seven minutes for clay pellets to transform into expanded clay pellets. Usually the metal cylindrical kiln is 12-60 meter long but smaller mobile models Figure 7 can be used. Berge (2009) cites from Brien et al. that “For the manufacture of a light clay block Zytan moulds are filled with light expanded clay, then heated at temperatures of about 1000 C.”

Foamed glass can be produced from recycling glass with foaming additives and shows similar properties with expanded clay. Expanded perlite is made of volcanic rock that can be found in the Greek island of Milos, in Hungary (Minke 2006) and in Turkey (Öncül 1975). Expanded lava has similar properties with expanded perlite except of its higher density. Pumice is an already expanded porous volcanic stone that has density between 500 to 750 kg/m^3 (Minke 2006).

2.4.5. Technique of Production

On the contrary to other earthen materials, LWL is used as an insulation material. Therefore the quantities of ingredients and the production method of mix are very different.

Preparation of LWL mix process consists of three parts: ingredient supply, mixing and tamping. It is more rational to apply LWL where there is lightweight materials and clayey soil. Kömürcüoğlu (1962) states that plenty of organic lightweight materials (fillers) such as straw should be mixed with liquid clayey loam to obtain LWL mix. Racusin and McArleton (2012) give different proportions for different fillers to be mixed with slip loam.

i. Preparation of Slip Loam

Before using soil to prepare LWL mix, slip loam that is homogenous and in optimum liquidity should be prepared. Clods of soil with high amount of clay needs preparation before being use: they must be crushed, dissolved in water or thinned with sand (Minke, Building with Earth: Design and Technology of a Sustainable Architecture 2006). Usually it is necessary to crush the soil and then sieve it before mixing with water since it may include undesirable large particles. Minke (2006) advices to use a cylindrical sieve that is inclined and turned manually (Figure 8). According to Marcom (2011), clods of soil should be mixed with water in a concrete mixer, and then it should be sieved (Figure 9).

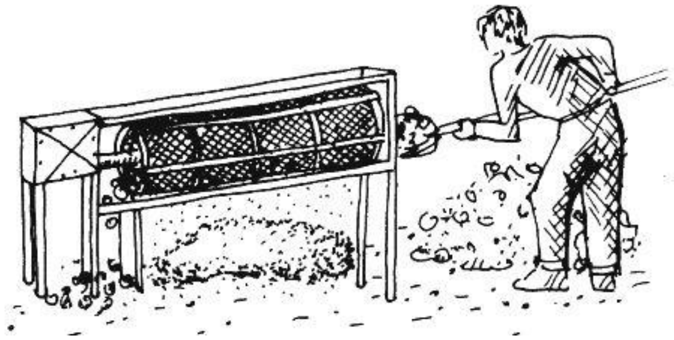

Figure 8: Cylindrical sieve (Minke, 2006)

Different procedures are explained to be able to obtain a homogenous slip loam. According to Minke (2006), clods of soil that are crushed and sieved should be let in water during 12 to 48 hours since water curing improves the binding force of the loam due to electrochemical attraction between different clay minerals. Marcom (2011) adds that slip loam that is on the surface of the basin is used to be mixed with fillers since sand and clay lumps settle. Another method to obtain a homogenous slip loam is to use an electrical hand mixer (Figure 9) which is usually used to produce small amounts of mixes (Minke 2006).

Another important feature of slip loam is its viscosity. Marcom (2011) defines the viscosity according to the thickness of slip loam that sticks on the hand. Viscosity test by Gaia Architects (2003) that is explained in “Experimental Procedures” section gives a more replicable definition of viscosity.

Figure 9: On the left, preparation of slip loam with mixing in concrete mixer and sieving after into the basin (Marcom 2011). On the right, usage of electrical hand mixer for small quantity of slip loam is seen (Minke 2006).

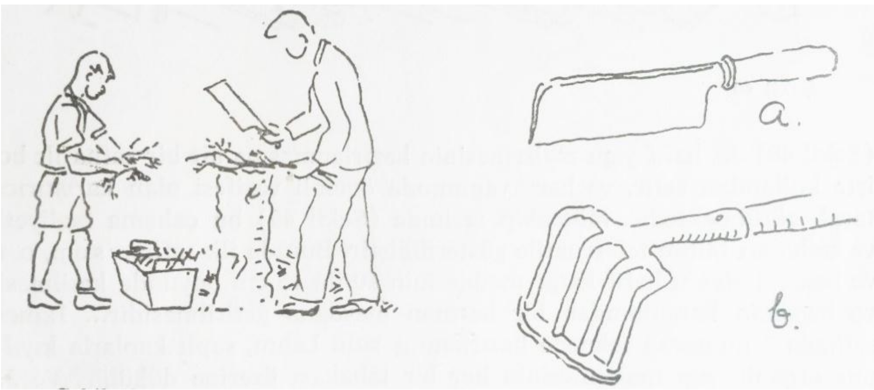

Figure 10: On the left, chopping process of fillers is seen. On the right, tools for chopping and mixing fillers are seen (Kömürcüoğlu 1962).

ii. Mixing Slip Loam and Fillers

According to Kömürcüoğlu (1962), chopper that is being used to cut the filler in appropriate size and fork that is being used to mix slip loam are essential tools while preparing LWL mix (Figure 10).

All the preparation process is explained on Figure 11. First step of preparation is to cut the filler on 10 to 15 cm sizes. When preparing the mixture of straw and clay, the length of straw stalks should not be longer than the thickness of the wall (Minke 2006). Houben and Guiilaud (2008) specify the optimum length of straw as 15 to 40 cm.

Than slip loam that is prepared in advance should be poured on the filler patch and mixed with the help of fork to obtain a homogenous mix. Finally, LWL mix should be poured into the formwork (or mold) and tamped (Kömürcüoğlu 1962).

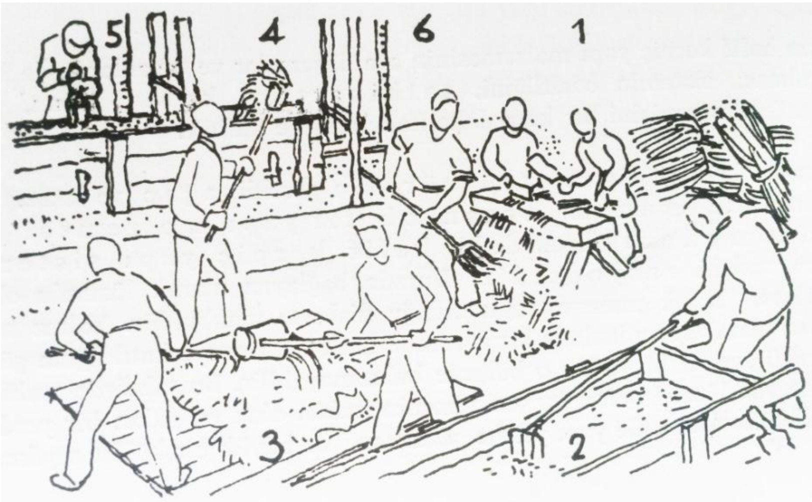

Figure 11: Phases of preparation and mixing of slip loam and filler (Kömürcüoğlu 1962).

Figure 12: Dipping the filler inside the slip loam basin (Marcom 2011).

Marcom (2011) explains a different procedure of mixing slip loam and fillers. Fillers that were cut in appropriate size should be dipped in the basin of slip loam (Figure 12). After the slip loam and filler mix is taken out, it should let to dry one night to get rid of too much liquid in the mix so that LWL mix can be ready to be used.

2.5. Building Elements Made with Lightweight Loam

Several building elements can be built by using lightweight-loam (LWL) with different aggregates. In this section, such building elements and their production methods will be explained for each variety of LWL.

Before explaining different building elements, it should be mentioned that LWL mix cannot be formed by hand; it should be molded to be able to have a form. Houben and Guillaud (2008) mention that this technique can be used to produce several building elements such as walls and floors, in monolithic or block forms by formwork. Ability to build either as blocks or infill panels and non-load bearing properties are also indicated by Gaia Architects (2003). Therefore, in the classification diagram of Earth Construction Methods by Houben and Guillaud (2008), straw-clay (LWL) is put on form section (Figure 13).

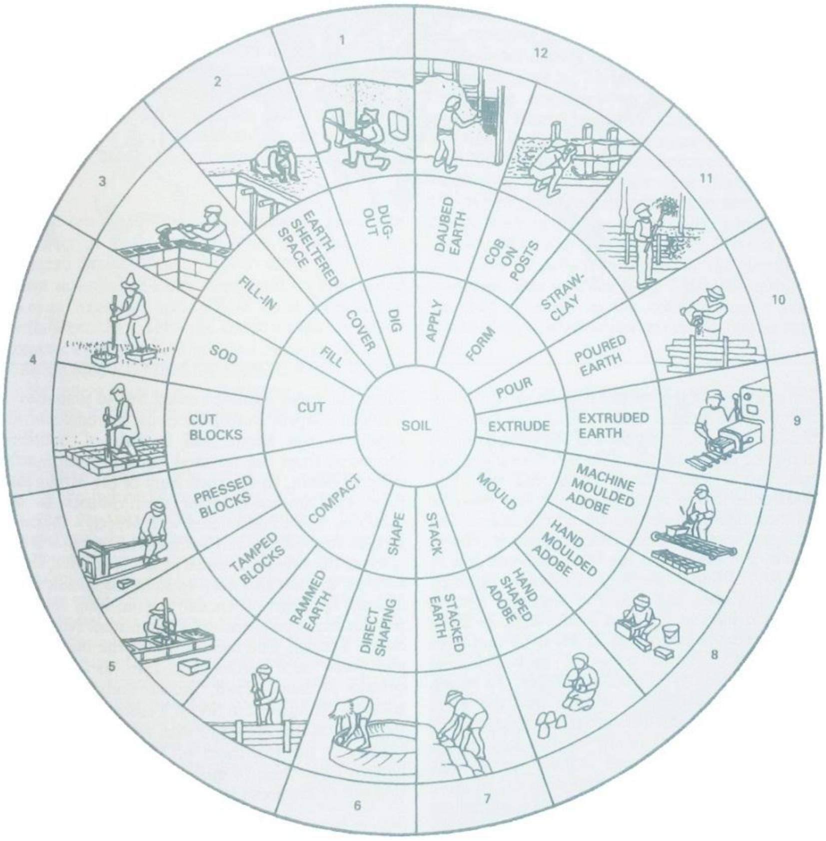

Figure 13: Classification of Earth Construction Methods (Houben and Guillaud, 2008).

2.5.1. Monolithic Infill Materials

LWL is always used as an infill material within the structural frame of timber that is taking all the loads. Before the application of LWL material, timber frame is built with a roof cover, which provides comfortable working conditions during harsh weather. More importantly, un-plastered walls are protected. Frame is also useful for fixing items on the walls even if fixing into LWL is possible.

Various timber frames can be used for LWL construction (Figure 14). LWL mix has a certain density; therefore the structural frame should be calculated by an engineer. But in any type of frame, the distance between two main posts cannot be longer than 1.5 meter to avoid slumping (Marcom 2011). Minke (2006) adds to it that the width of the exterior wall should not be more than 30 cm because of risk of rotting in the center.

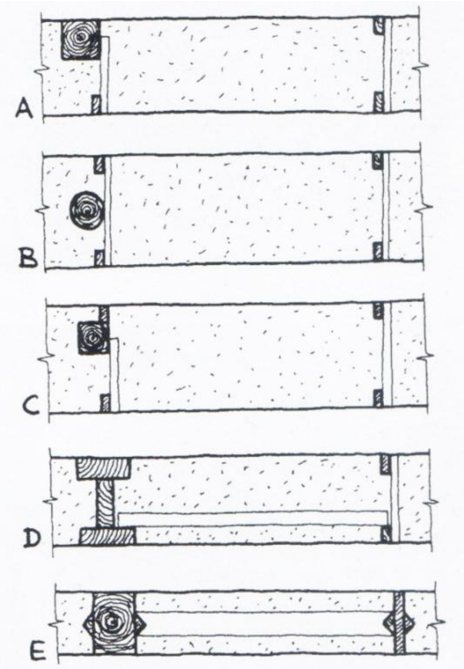

Figure 14: Horizontal sections with various timber frames for LWL construction (Gaia Architects, 2003).

Houben and Guillaud (2008) note that with lightweight straw loam construction, the thickness of exterior walls should be between 20 to 30 cm in order to procure required insulation and the thickness of interior walls can be about 12 cm.

Kömürcüoğlu (1962) explains the structural frame of LWL in Figure 15. It can be seen that the round-shape timber posts are being covered with LWL mix and horizontal wooden supports of LWL walls are put frequently during the process of building. It also shows that wooden frame supplies the surface to attach the formwork.

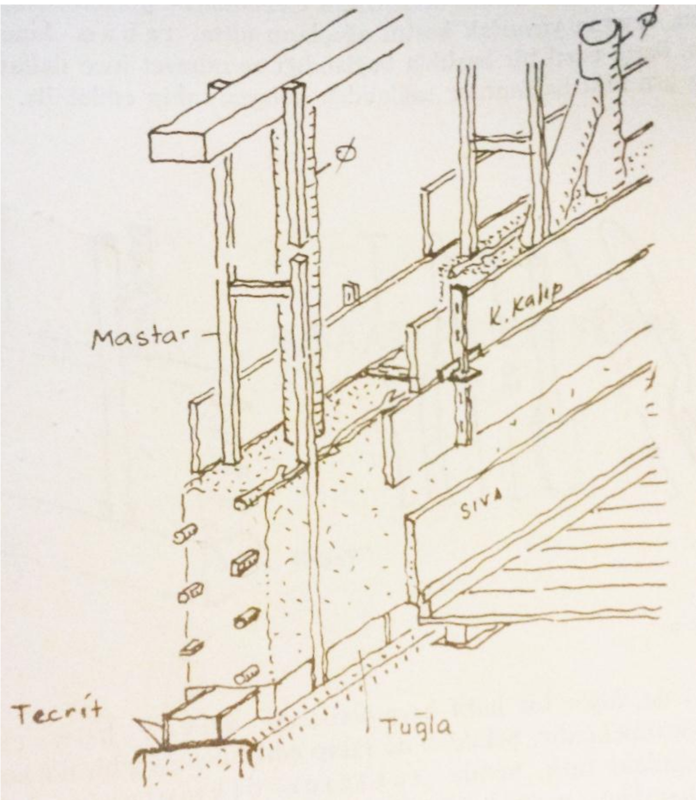

Figure 15: Construction of LWL on timber frame structure (Kömürcüoğlu 1962).

Building infill walls with LWL material is made by pouring and tamping the material into the formwork that is built on timber frame. It requires thinner formworks than what is used with rammed earth because less impact is involved. Climbing formworks (Figure 16) that procures application of material step by step are used (Minke, 2006).

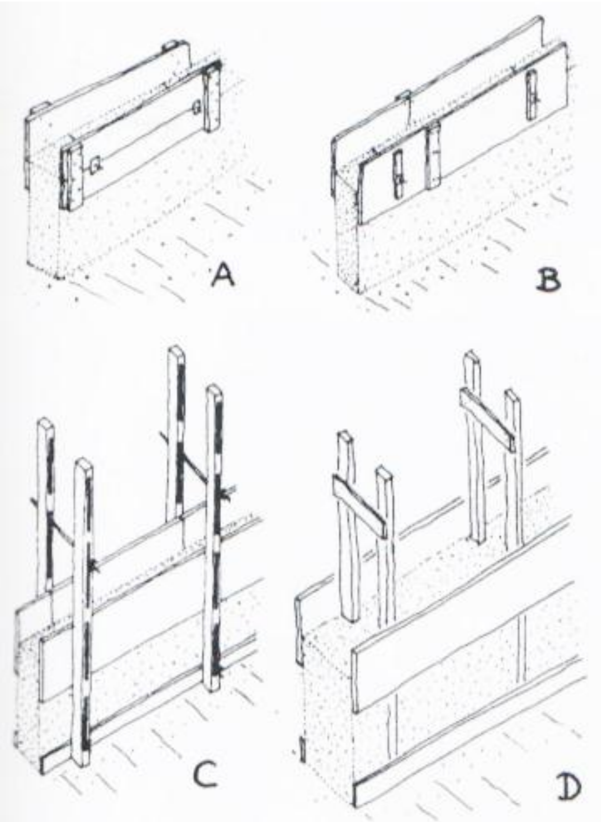

Figure 16: Illustration of construction process with 4 different climbing formwork (A, B, C, D) used in LWL walls. Source: Kruithof, 2009

After pouring and tamping the mixed material, the walls must be left to dry for several months before starting with plastering. Because of the high amount of straw in the material, the walls have a straw-like appearance and this texture also eases plastering work (Houben ve Guillaud 2008). With the straw-loam mixture, tamping should be done softly by help of sharp stick (Figure 17), to avoid making the mixture denser (Gaia Architects, 2003).

Figure 17: On the left, tamping process of straw LWL is seen (Gaia Architects 2003). On the right, climbing formwork and texture of straw LWL wall surface is shown.

Even though it is easier to mix wooden residue aggregates with loam, final material has a lower thermal insulation compared to straw-loam mixture and also drying time is very long. Lightweight mineral loam material can be tamped, poured or pumped into the formwork. Because mineral-loam mixture soaks up less water, drying time is shorter. Therefore, it avoids rotting and has higher vapor diffusion and surface hardness compare to straw loam and wood loam (Minke 2006).

2.5.2. Blocks

LWL with fillers such as straw, saw dust, wood-chips, cellulose fibers, cork, perlite, pumice and expanded clay can be produced as blocks as well and they are used mostly for exterior walls because of their high thermal insulation values (Minke 2006). According to Gaia Architects (2003), classification of lightweight blocks should be done as manual production that requires usage of molds and commercial production that requires either molds or extrusion.

Marcom (2011) claims that main reason of producing blocks manually is that it costs less than commercial production because it gives the opportunity to use the earth from the site which is free and cancels transportation cost. This type of production also creates more ecological way of construction. Kruithof (2009) finds the manual production of lightweight blocks similar to mud brick production because it also needs to be prepared with mound and let dry until it gets hard.

According to Gaia Arhitects (2003), firstly the size of the blocks should be defined in order to prepare the metallic or wooden molds. Kruithof (2009) states that the block sizes should be determined according to the wall sizes to avoid cutting blocks unnecessarily (Figure 18). After shaping the blocks with molds, they are moved in a covered place where there is enough ventilation for drying (Gaia Architects 2003). The sizes of the blocks show different characteristics. Houben and Guillaud (2008) remark that drying takes less time with small bricks. On the other hand, Gaia Architects (2003) state that production of larger blocks reduces the production and building time even if takes longer time to dry. Minke (2006) mentions a project done by German architect Sylvester Dufter, where 50 x 60 x 30 cm sized lightweight straw blocks are used. He refers the properties of this block with these words:

> *"Though each block weighs 26 kg, they are produced under cover and close to the wall, and can then be almost flipped over into their final positions. Using such blocks, a 50-cm-thick wall gives a U-value of 0.3 W/m^{2}K. Dufter guided several do-it-yourself projects using these blocks. In one case, the owner-builder family produced 1500 blocks in five weeks, sufficient for their entire house."*
>
> (Minke 2006, 69)

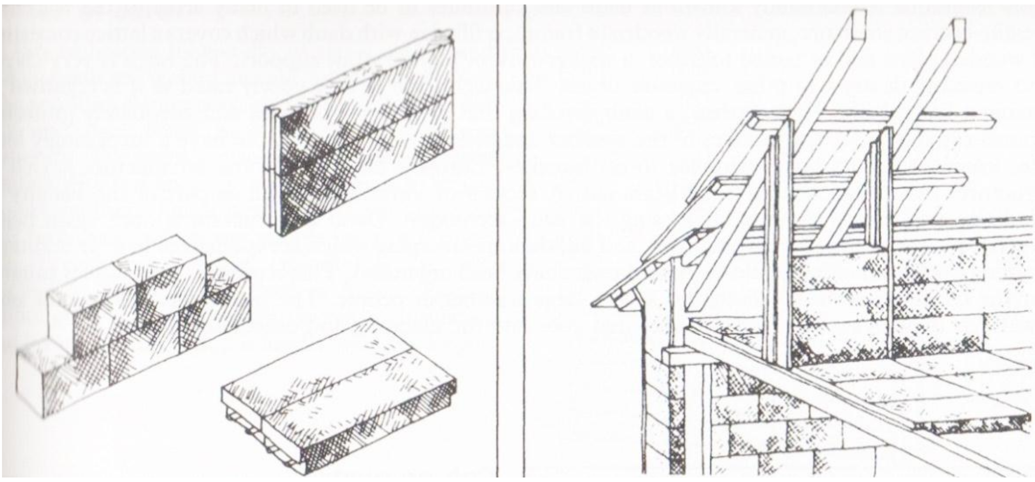

Figure 18: Lightweight blocks with different sizes and their applications on wall (Houben ve Guillaud 2008).

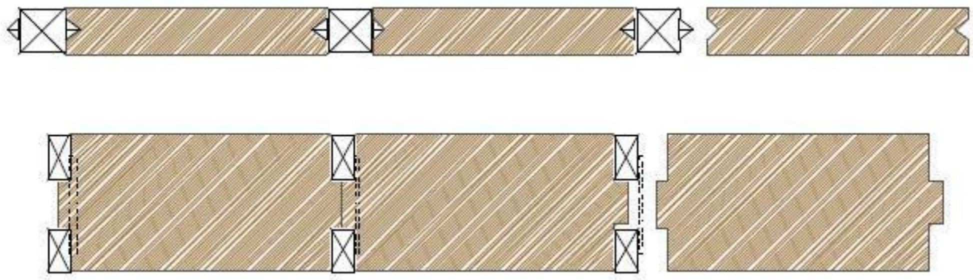

Figure 19: Interlocking possibilities of lightweight blocks to 10 and 30 cm width frames (Gaia Architects 2003).

Whatever the size is, it is also important how the blocks are connected within the frame to have a stable construction. Two interlocking types of blocks (Figure 19) are explained by Gaia Architects (2003) as a drawing of 10 cm and 30 cm thick walls. On each example, blocks are fitting to the structure either with protrusion or recession.

It is easy to supply commercial lightweight blocks across Europe but they just have a regular market in Germany (Gaia Architects, 2003). As Minke (2006) notifies, lightweight prefabricated wall panels can be also produced commercially with the density of 800 to 1000 kg/m3. The thickness of the panels should be 6-12 cm and sizes are determined as 30 x 60 cm and 62.5 x 100 cm.

2.5.3. Floors

Minke (2006) defines lightweight floor slabs as infill material between joints that also procures thermal and sound insulation.

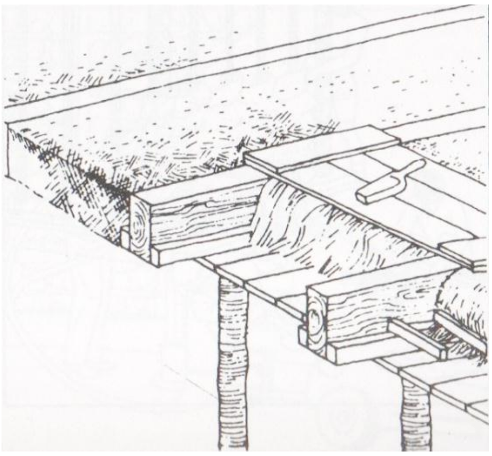

Figure 20: Lightweight straw floor application. Source: Houben and Guillaud, 2008

Houben and Guillard (2008) indicate that floor construction with lightweight straw loam is the horizontal version of wall construction (Figure 20). Mixture of straw and loam is filled in between the wooden baulks. The bottom can either be closed by wooden planks or left open because straw LWL floor has the capacity to support more than 500 kg/m2. It can be just covered with earth or lime plaster. Floors can be also built by blocks. Houben and Guillard (2008) state that the results of experiment of concrete reinforced floor blocks with the sizes of 70 x 30 x 10 cm show that it is possible to carry 200 kg with a deflection of 0.5 mm.

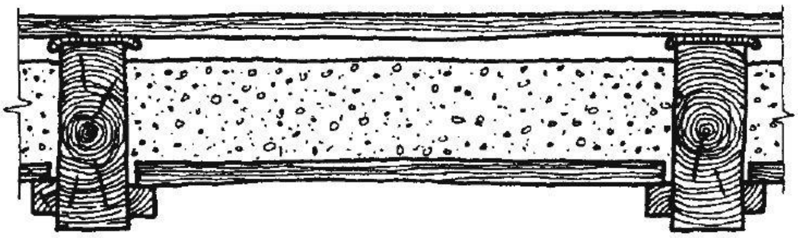

Figure 21: Mineral LWL is used between floor joists (Minke 2006).

Minke (2006) states that mineral LWL pumped in the pipes is very suitable for ground floors. Figure 21 shows the usage of mineral LWL as infill between the floor joists. If the density of mineral LWL used in the floor is higher than 1000 kg/m3, it provides a good sound barrier and gives a good thermal storage (2006).

2.5.4. Complementary Insulation Materials

During the renovation of the old houses, LWL materials are used for providing insulation. Gaia Architects (2003) explain the reason why LWL is used as insulation material with these words:

> *"In Germany, light earth is often chosen because of its unique mix of insulative capacity combined with its thermal capacity, vapor diffusivity and physical movement characteristics which are consistent with the materials generally used in older buildings."*
>
> (Gaia Architects 2003, 115)

There are two types of insulation for the walls: external and internal. According to Gaia Architects (2003), even if the external insulation is the best way of insulating a building because it stabilizes interior temperature, because of its high-cost internal insulation may be preferred. Gaia Architects (2003) continue, stating that external insulation is expensive because of required scaffolding for the top parts of the exterior walls, and need of waterproofing. The problem with internal insulation is it may create cold thermal bridges on the intersection of exterior walls and partition walls and also because the exterior walls will not be able to store heat when interior is warm; it may cause condensation that causes moisture balancing difficulties.

Gaia Architects (2003) refer to Volhard that before starting with insulation, the wall should be covered with wet loam to increase cohesion and application of LWL as insulation on exterior wall can be maximum 150 mm thick. If it is thicker, it will not dry sufficiently since it is only from one side.

They can be either built with formwork or blocks. Minke (2006) gives the example of lightweight mineral blocks that includes expanded clay as aggregate with sizes of 15 x 15 x 30 cm are produced and used on a rammed earth houses' exterior walls for improving thermal insulation in Tata, Hungary. Also wall panels from lightweight minerals that are developed by Minke can be used as insulation material on the exterior walls.

LWL material can be also used on roof as insulation. The organization called Building without Borders (2010) built a straw-bale house in Haiti with straw LWL insulation on the roof. This insulation above the ceiling provides cooling in summer because of the protection from the heat of the sun.

2.6. Characteristics of Lightweight Loam

In this section, structural, thermal and moisture regulation characteristics are explained as well as the total energy consumption of the material. The values of LWL varieties with different fillers are given.

2.6.1. Structural Characteristics

Either in monolithic or block form, lightweight loam (LWL) is never used as a load-bearing material. Even if it has structural value, LWL is not counted on structural properties of the building. The compression extent under load-consolidation- from external or self-weight (compressive strength) and shrinkage rate against water evaporation are the structural concerns of LWL (Gaia Architects, 2003).

i. Importance of Density under Vertical Loads

Density of materials directly affects the compressive strength value. Minke (2006) remarks that soil grain size, water proportion, applied dynamic or static compression and clay mineral type are affecting the compressive strength of the loam. When the grain sizes get smaller, the gaps in between are being filled so it increases the density of the material.

Minke (2006) also gives an example of a compressive strength test by using compacting apparatus on cylindrical samples with equal densities. The sample of freshly dug earth was compressed by the machine 10 times with 4.5 kg weight and it was compacted about 30-40 %. The other sample from silty soil mixed with water in a mechanical mixer during 15 minutes then left dry. When the compressive strengths of samples measured, it was understood that the sample that is not compacted has higher compressive strength. This result indicates that the preparation can be much more effective on strength than compaction.

Berge (2009) explains another test that is measuring binding strength of material is called “figure-of-eight” (Figure 22). The material is shaped in eight (8) form and hanged with additional weight. More weight is added until the material breaks. The result of a figure-of-eight (Figure 23) test shows the direct relation between compressive strength and binding strength.

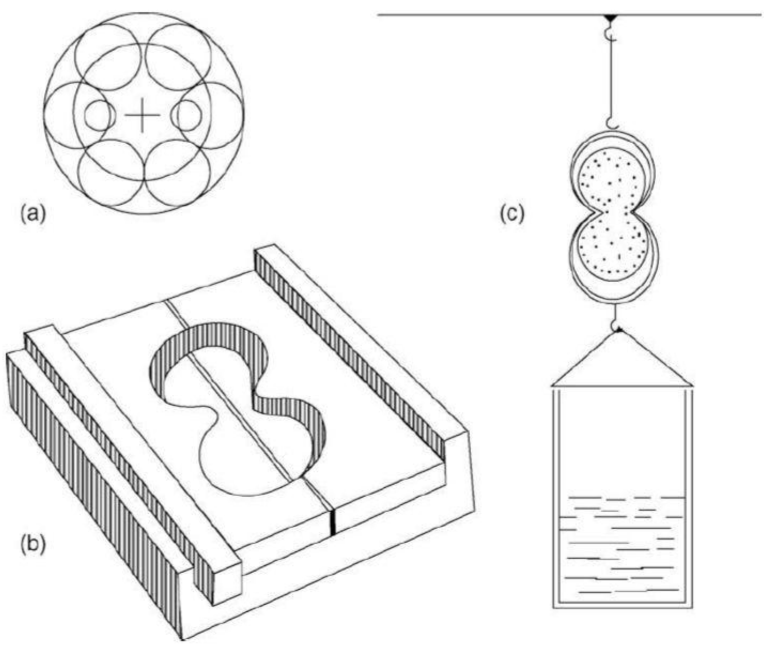

Figure 22: Figure-of-eight binding strength test equipment (Berge 2009).

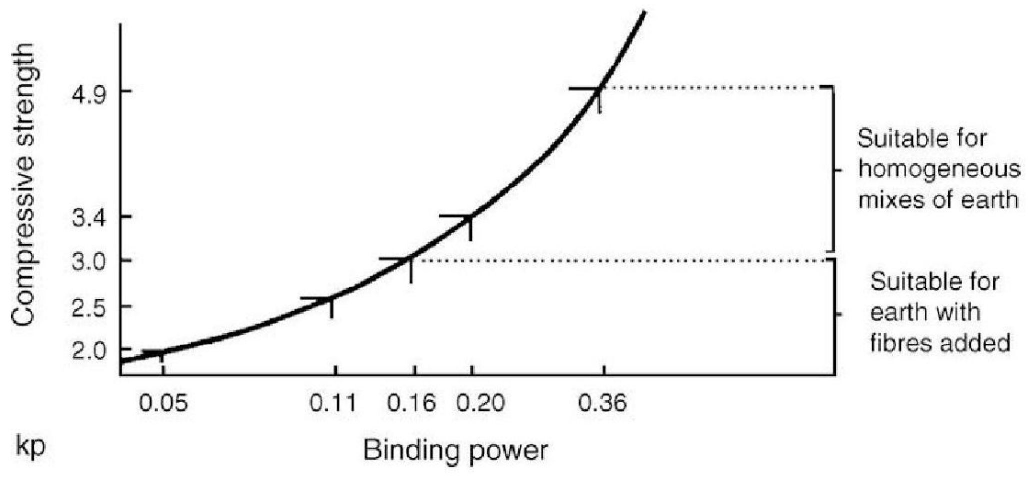

Figure 23: Determining compressive strength based on the results in the 'figure-of-eight' test (Berge 2009).

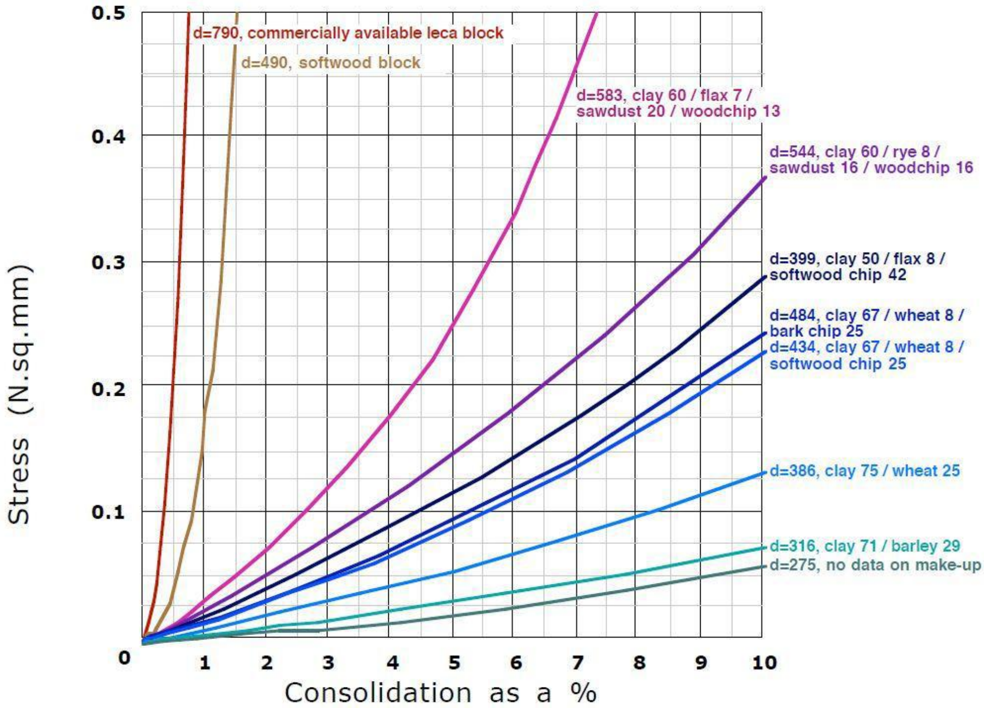

Figure 24: Consolidation values of various LWL samples under vertical compressive load. Source: Gaia Architects, 2003

Even though the addition of small amount of fibers has effect on compressive strength increasing, addition of straw has the decreasing effect (Minke, 2006). On the other hand, Gaia Architects (2003) report a consolidation test by University of Helsinki, which was related with vertical compression and the consolidation of various LWL samples under load. The result (Figure 24) shows that LWL varieties cannot be compared with, for instance commercially produced expanded glass block. It is also the indication of direct link between consolidation and density.

ii. Shrinkage

Shrinkage occurs on monolithic LWL construction while it is not seen on dry, commercially produced blocks or panels (Gaia Architects, 2003). On the other hand, it is possible to totally avoid shrinkage during drying process by regulating the percentage of aggregates in the mixture of mineral LWL (Minke, 2007).

Gaia Architects (2003) state that LWL may shrink about 15 to 40 mm in one storey height after tamping properly. The shrinkage ratio is also depending on water content, type and amount of clay and grain size distribution of the aggregates (Minke, 2006). Addition of fibers such as animal or human hair, fibers from coconuts, sisal, bamboo, needles from needle trees and cut straw also reduce the shrinkage ratio because of the decreased clay content and absorption of water by fibers (Minke, 2006). The effect of additives on water absorption of loams (Figure 25) is seen on the result diagram of Minke (2007).

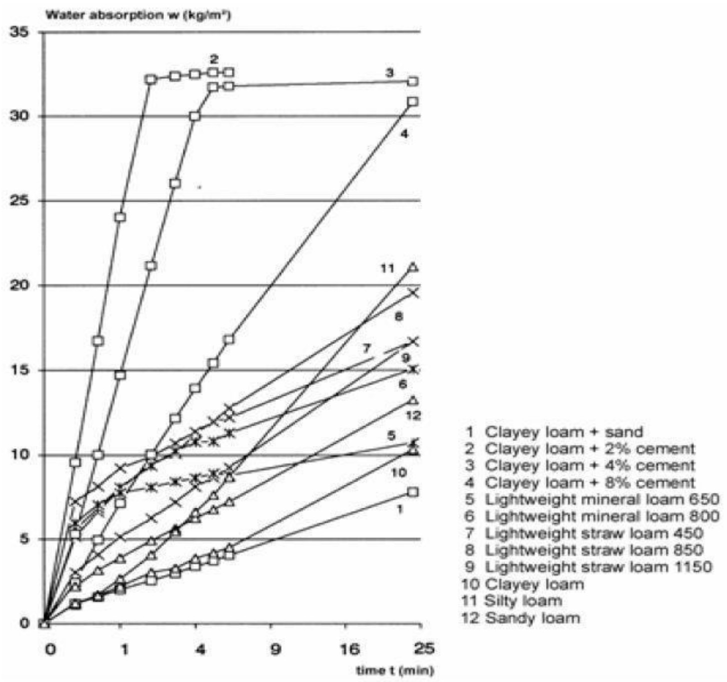

Figure 25: Water absorption of loams according to their additives (Minke 2007)

2.6.2. Thermal Characteristics

According to Kocaman, Sisman and Gezer (2011), high consumption of energy in the buildings is also because of low quality insulation applications. They claim that rural buildings in Turkey are not built in terms of heat saving and around 50% of energy consumption in Turkey is caused by heating of buildings. Besides energy saving, *"…thermal insulation on rural buildings also improves human health, quantity of animal production and quality of stored agricultural products."* (Kocaman, Sisman ve Gezer 2011)

Thermal insulation is depending on air gaps in the material and humidity level. When the gaps inside the material increase, it gets lighter and thermal insulation gets higher. In opposite, when the humidity level increase, insulating affect decreases. For that reason, LWL materials have high thermal insulation properties because of low air transmission. Resistivity to heat flow through a building element is expressed by R-Value that is overall heat transfer (Minke, 2006).

i. Thermal Conductivity

Minke (2006) defines thermal conductivity k (W/mK) as "the heat transfer of a material", and it indicates "the quantity of heat, measured in watts/m², that penetrates a 1 meter thick wall at a temperature difference of 1˚C." According to Gaia Architects (2003), thermal conductivity of materials is depending on three features of the material: the amount of air gaps within the element that is related to material compression, cellular structure of the material and the quantity of water or vapor trapped.

The density of the material affects the thermal insulation. Minke (2006) states that with straw LWL, the density cannot be lower than 500 kg/m³. Normally with 700 kg/m³ of density with 30 cm thick wall building, the k-value is 0.21 W/mK. Mineral LWL with density below 600 kg/m³ has better thermal insulation properties than lightweight straw loam because of the higher moisture content of straw (Minke, 2006).

Many experiments are done to be able to measure thermal conductivity. (Forest Products Lab (2004) made a test of four formulations of straw LWL with different densities to extend existing values of thermal conductivity that are given by Minke on “Earth Construction Handbook” and Volhard. The test is done by mixing straw, clay and water respectively with proportion ratio of 1:1:7 and stuffed in five sided OSB frame. The samples were let dry in conditions protected from any change of weather condition. Four lightweight straw loam samples were cut to 4 or 6 inch uniform thickness and left in a room with constant conditions. The results of samples (Figure 26) show that thermal conductivity measurements fit to Volhard’s k-value versus density curve.

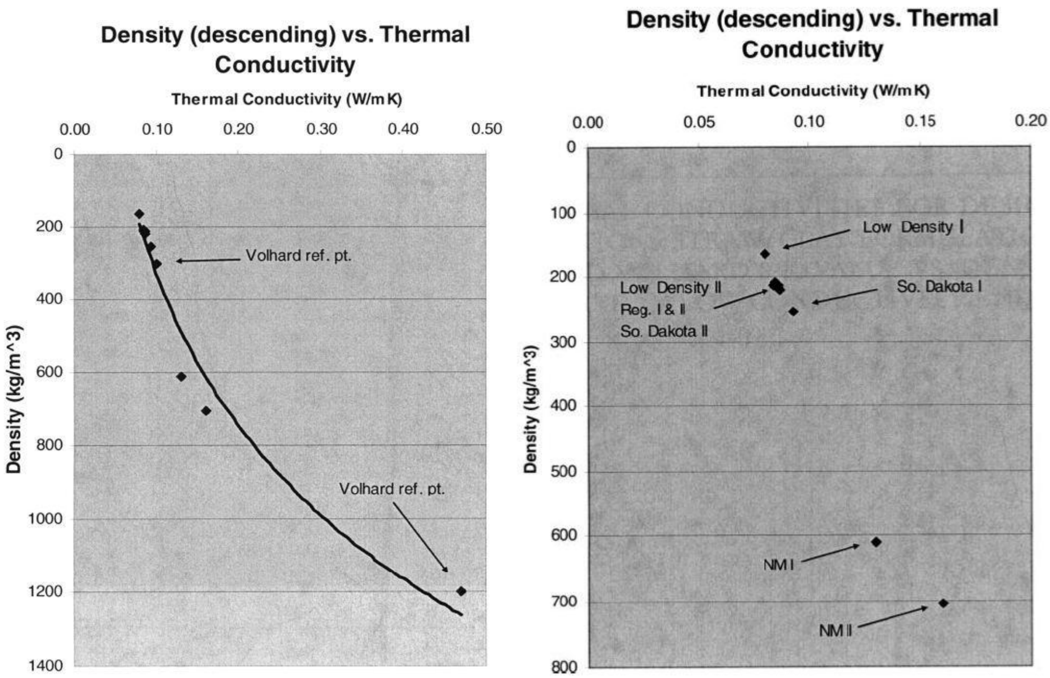

Figure 26: Comparison with Volhard’s Density vs. Thermal Conductivity (Forest Products Lab 2004).

Table 2: Thermal probe measurements of lightweight straw loam and lightweight woodchip loam Source: Gaia Architects, 2003

Material		No. of Samples	Average Thermal Conductivity W/mK	Average Thermal Capacity J/kgK
Clay-Straw		4 x 150mm cubes	0.07	Inconclusive at Present
Clay-Woodchip		4 x 150mm cubes	0.15	1500

Gaia Architects (2003) report another experiment by Plymouth University, Department of Civil and Structural Engineering, on thermal conductivity measurements of straw LWL and woodchip LWL with sizes of 150mm cubes. The thermal conductivity values (Table 2) were measured with the transient probe test that measures with a needle-like probe that a heater and heat sensor running down the center of the inside of the probe, by rising of temperature. The results show that straw LWL (Clay-Straw) provides a better heat insulation than woodchip LWL (Clay-Woodchip).

Miljan, Miljan, and Miljan (2013) conducted a research on thermal conductivity of walls insulated with natural materials. In the research, blocks made of hemp LWL with the thickness of 13 cm were also tested by closing a window frame. Other materials that were tested are straw and reed bales, horizontal reed. After all the walls were dry, heat flux transmitted through the wall was measured by heat flow plates that were attached on each wall. Finally, thermal transmittance of each wall was measured according to this formula:

$$U = \frac{q}{T_i - T_e} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(1)}$$

Where:

q: heat flow through the wall (W/m^2)

T_i: room temperature (^oC)

T_e: outdoor temperature (^oC)

Results show that hemp LWL test wall does not suit to the government regulations of the Republic of Estonia Minimum energy performance requirements since U-value of hemp LWL wall (0,259 W/m^2K) is not inside the allowed limit. Miljan, Miljan, and Miljan (2013) add that this was an expected result because of the thickness of the wall.

ii. Thermal Capacity

According to Gaia Architects (2003), thermal capacity of a material is the product of specific heat (kJ/kgK) that is indicating the amount of required heat to warm 1kg of a material through 1 K and density (kg/m^3). It is also known as thermal mass and it basically means the capacity of a material to store heat or cold.

Heavyweight materials such as earth, stone, brick and concrete have high thermal capacities because they keep the heat energy and emit it back when ambient temperature is lower than their own temperature. Lightweight materials such as LWL have low thermal capacities that heat up and cool down quickly (Gaia Architects 2003).

On the experiment of lightweight straw loam and lightweight woodchip loam done by Plymouth University, Department of Civil and Structural Engineering, thermal capacity of the materials were also measured. For this experiment, samples with 50 mm cube are prepared and heated to a high temperature during more than 24 hours and immediately moved into an insulated container that has a certain temperature. The results (Table 3) show the average thermal capacities (J/kgK) of lightweight materials (Gaia Architects 2003).

Table 3: Thermal capacity measurements of lightweight straw loam and lightweight woodchip loam Source: Gaia Architects, 2003

Material		No. of Samples	Average Thermal Capacity J/kgK
Clay-Straw		4 x 50mm cubes	1000
Clay-Woodchip		4 x 50mm cubes	1500

Goodhew and Griffiths (2005) conducted a research on sustainable earth walls to meet the building regulations by comparing thermal conductivity and thermal capacity straw-bale, straw LWL, un-fired clay bricks. The results (Table 4) show that straw-bale has better thermal insulation but lower thermal capacity compared to straw LWL. With a lower density, straw-LWL has a higher specific heat capacity than bricks.

Table 4: Measured thermal properties of straw-bale, straw LWL and bricks (Goodhew & Griffiths, 2005).

The measured thermal properties of the materials

	Density, ρ (kg/m^3)	Thermal conductivity, λ ($W\,m^{-1}\,K^{-1}$)	Diffusivity, α ($\times 10^7\,m^2\,s^{-1}$)	Volumetric heat capacity, λ/α ($\times 10^{-3}\,J\,m^{-3}\,K^{-1}$)	Specific heat capacity, $\lambda/\alpha\rho$ (J/kg K)
Straw bale	60	0.067 (0.002)	18.2 (0.5)	36.8 (0.7)	600 (10)
Clay–straw mixture	440	0.18 (0.01)	4.6 (0.4)	400 (50)	900 (100)
Bricks, claytec	800	0.24 (0.02)	3.8 (0.3)	650 (20)	750 (30)

The values inside the parentheses are standard deviation.

2.6.3. Moisture Regulation

Traditional buildings are built by natural materials which are porous and permitting the moisture to pass through the walls also balancing the humidity of the air inside (Gaia Architects 2003). In spite of that, in modern buildings, synthetic materials such as plastic sheets or metal foil are being used to prevent moist air to enter inside through walls (Ryan 2011). On the other hand, lack of thermal insulation in old buildings cause high heating expenses. For that reason, when improving the energy efficiency of the buildings in the last 30 years, it is considered to improve both thermal and humidity comfort which means regarding the health and humidity benefits of traditional and building with natural materials without ruling out thermal benefits of modern buildings (Gaia Architects 2003).

The moisture sources (Figure 27) are explained by (Straube 2006) as:

1. Rain and snow, splash water
2. Vapor absorption or capillarity
3. Stored moisture
4. Water or vapor from the ground

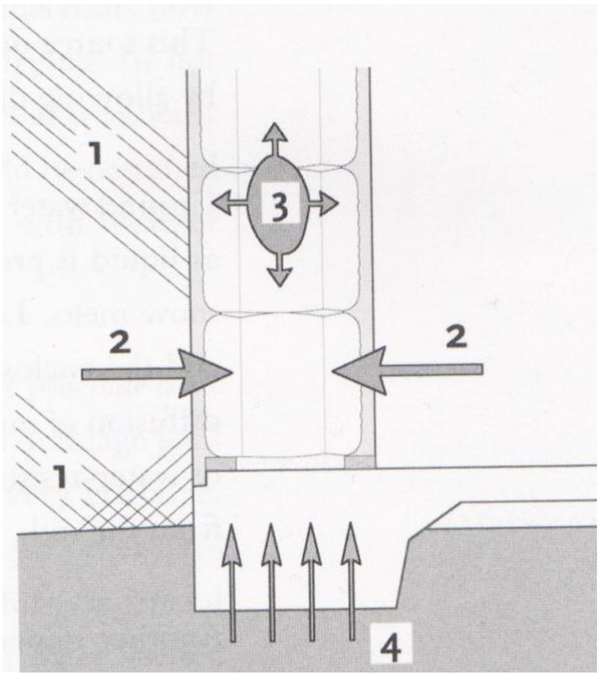

Figure 27: Moisture sources and wetting mechanisms (Straube 2006).

According to these factors, in the following parts, capillary action, vapor diffusion and condensation are explained in relation with LWL. It should be noted that usually the wall is covered therefore precipitation does not affect directly the material. The reason is that direct contact of water to LWL destroys the material (Minke 2006).

i. Capillary Action

The materials with open porous structures transform and store the water that always moves from ambiance with high humidity to ambiance with low humidity. The transportation of water is called "capillary action". The quantity of absorbed water by the material is depending on water absorption coefficient of the material and time. Studies show that fired bricks absorb more water than any kind of LWL (Minke, 2006). The results of a test that is measuring quantity of water absorbed by different materials by time (Figure 28) show that samples of straw LWL absorbs more water than mineral LWL.

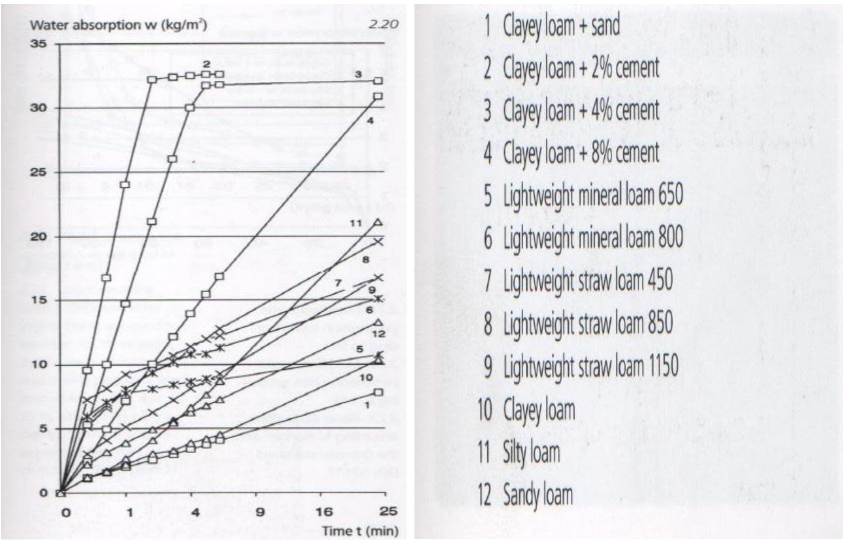

Figure 28: Water absorption graph of lightweight loam with different fillers and other loam types (Minke 2006)

ii. Effect of Vapor

While the direct contact with water has negative impact on LWL, the material can absorb and transfer vapor without damage (Minke 2006). The ability of a material to transfer vapor is called vapor diffusion. It is important to know the resistance of the material to the vapor diffusion to avoid condensation into the wall. Condensation may happen when the difference between hot humid interior air and cold dry exterior air is too important so the vapor may condensate into the wall (Minke 2006, Gaia Architects 2003). The figure below shows the condensation process of LWL wall in case of cold weather that may cause condensation inside the wall where the cold air from outside and hot air inside meet (Figure 29).

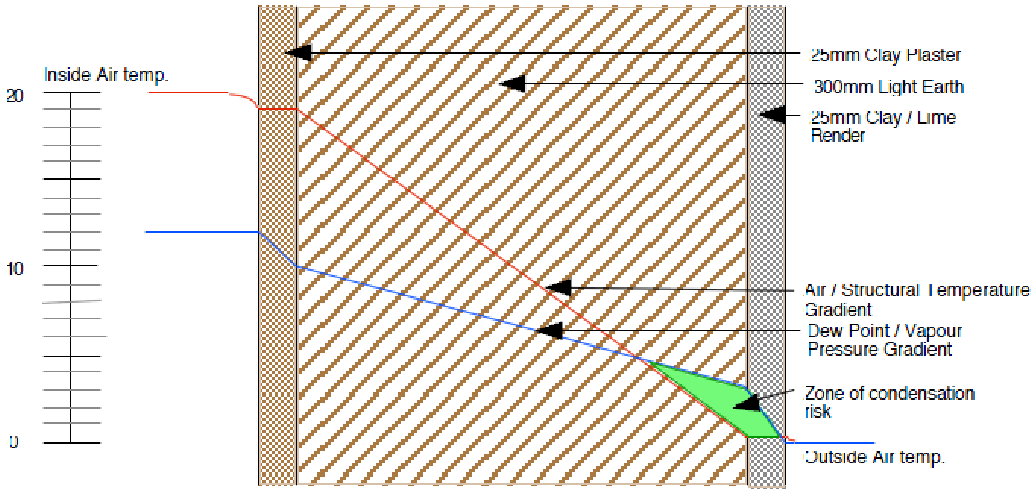

Figure 29: Condensation process of LWL wall (Gaia Architects 2003).

Another feature that should be mentioned is if the amount of moisture trapped inside the wall is too high, it may have difficulty to regulate the humidity inside the building and also it may condensate (Minke, 2006).

One of the effects of condensation is the consisted dampness that lowers the thermal insulation capacity of the material and causes fungus growth in the material. Humidity is transferred through the material by capillary action. For that reason, the materials with high capillarity like LWL are preferable for moisture regulation. A possibility to avoid condensation is to build the wall with an inside layer of material with higher resistance to vapor diffusion than the outside layer (Minke 2006, Gaia Architects 2003).

2.6.4. Total Energy Consumption

Global warming, fossil fuel consumption, water use, acidification and toxic release to air are the impacts of building materials on earth. These impacts occur in all the stages of material's life time. For instance, more than three billion tons of raw materials are used for the production of building materials or other products every year. Additionally, the loss of raw materials on the site cause by natural events such as soil erosion is bigger than the used raw materials for production (Calkins 2009).

The selection of building materials is as important as the effort on reduction of operational energy use in buildings (Berge 2009). Saghafi and Teshnizi (2011) state that determining the materials to be used on the building in order to lower the energy consumption and the impacts on the environment are a difficult issue for the project team because the criteria for this new class of materials are not defined clearly. Therefore, the terms embodied energy and life cycle assessment used for environmental assessment of building materials and construction methods (Keefe 2005) are defined for LWL.

i. Embodied Energy

According to Keefe's (2005) definition, *"Embodied energy is a measure of all the energy consumed in the extraction, processing, manufacture and transportation of a building component or material up to and including the actual construction process."* Additionally, Berge (2009) gives subjects of the energy costs of restoring mined areas, marketing and packaging, combustion value of material itself (also known as feedstock) as inputs of embodied energy.

Berge (2009) explains the factors of total energy consumption in production process which the embodied energy of materials comprise 85-95% of it:

- The energy consumed from extracting and manufacturing of raw materials is depending on the varieties of machines used.

- During the manufacturing process, used energy from heating, lighting of manufactory and maintenance of the working environment are counted as *"secondary energy consumption"*.

- Energy used in transportation of raw materials is related to distance, type of fuel and type of transport (Table 5).

Table 5: Energy consumption values on various transportation types (Berge, 2009).

Type of transport	*MJ/ton km*
By air	33–36
By road, diesel	0,8–2,2
By rail, diesel	0,6–0,9
By rail, electric	0,2–0,4
By sea	0,3–0,9

Saghafi and Teshnizi (2011) contend that determining embodied energy of a building is very difficult because of the deficiency of universally accepted method for calculation of embodied energy and the substantial methods are doubtable. Huberman and Pearlmutter (2007) also give the reasons of why embodied energy has few attention as "the lack of a clear assessment methodology and the data required to implement it", and the usual assumption that energy used on production of a building is too few than its energy used during whole operation time. Studies show that 80% of energy consumption is from operational phase while 20% is embodied energy

(RAIA 2004). In spite of that, the percentage of embodied energy increases while the energy consumption of the buildings during their life time becomes lower (Mumma 1995).Gaia Architects (2003) remark that in general materials that are used in LWL construction require little or zero energy for extracting, harvesting and producing and little energy for transportation. They also indicate that one of the advantages of manually produced lightweight blocks have little or no embodied energy compared to commercially produced ones that require cost for importing and manufacturing. Also lightweight mineral loam has higher embodied energy than other varieties of LWL because of the required energy for production of mineral aggregates but even their embodied energy is not as high as timber and bricks need (Minke, 2006).

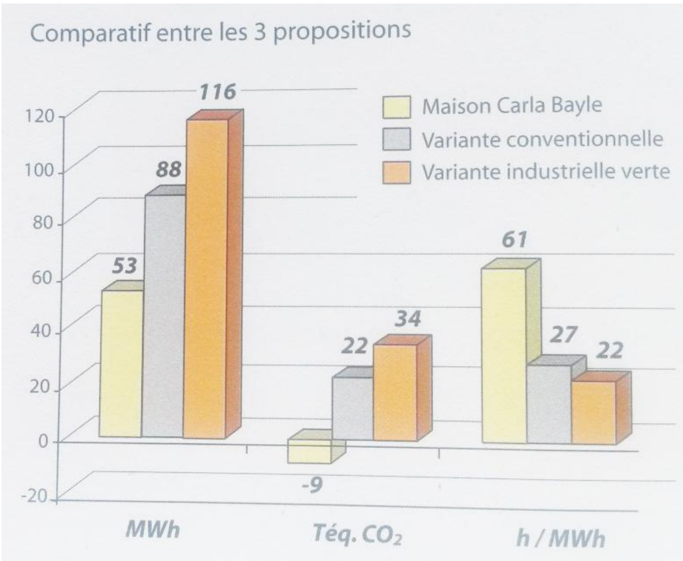

Figure 30: Comparison of three houses with same design but three different materials. First bar-chart gives embodied energy, second bar-chart gives CO2 consumption and third one gives amount of labour needed. "Maison Carla Bayle" represents LWL, "Variante conventionnelle" represents conventional materials and "Variante industrielle verte" represents industrial green building materials (Marcom 2011).

Marcom (2011) compares a specific type of house made of lightweight loam, conventional materials in France and industrial green building materials in terms of their embodied energy, CO_2 consumption and amount of labor per embodied energy unite (Figure 30). The results show that LWL has the lowest embodied energy and CO_2 consumption but the need of labor per embodied energy unite is highest.

ii. Life Cycle Assesment

Huberman and Pearlmutter (2007) state that life cycle of a building consists of three phases: *pre-use phase (embodied energy), use phase (operational energy) and post use phase (demolition or possible recycling and reuse)*. With the industrialization, energy consumption highly raised especially for the pre-use phase.

To be able to achieve to whole environmental costs of buildings during their life time, several guidelines and draft standards have been developed in recent years and of them is life cycle assessment (Huberman ve Pearlmutter 2007). Life cycle assessment aims to define and quantify all environmental impacts of materials to be able to make an extensive and multidimensional comparison. The analysis of a material's life cycle involves costs of planning, design, extraction and installation from pre-use phase, costs of fuel, operation, maintenance and repair from use phase and lastly costs of replacement, recycle or ultimate disposal from post-use phase. (Kubba 2010).

Besides integrating the factors such as solar control, ventilation and other bioclimatic features to reduce energy consumption during the usage of the building (RAIA 2004), Huberman and Pearlmutter (2007) emphasize that choosing appropriate building materials during the design stage procures lower energy consumption during the use phase of the building. They also determine the stages of life cycle assessment as: *"goal and scope definition, life-cycle inventory, impact assessment and interpretation."*

Any study about life cycle assessment of LWL was not found. On the other hand, since LWL comprises earth material, it can be compared with life cycle of earthen materials in general. Schreckenbach 2004 states that earth is a recyclable and reusable material on construction and therefore it has a self-sustaining life cycle (Figure 31).

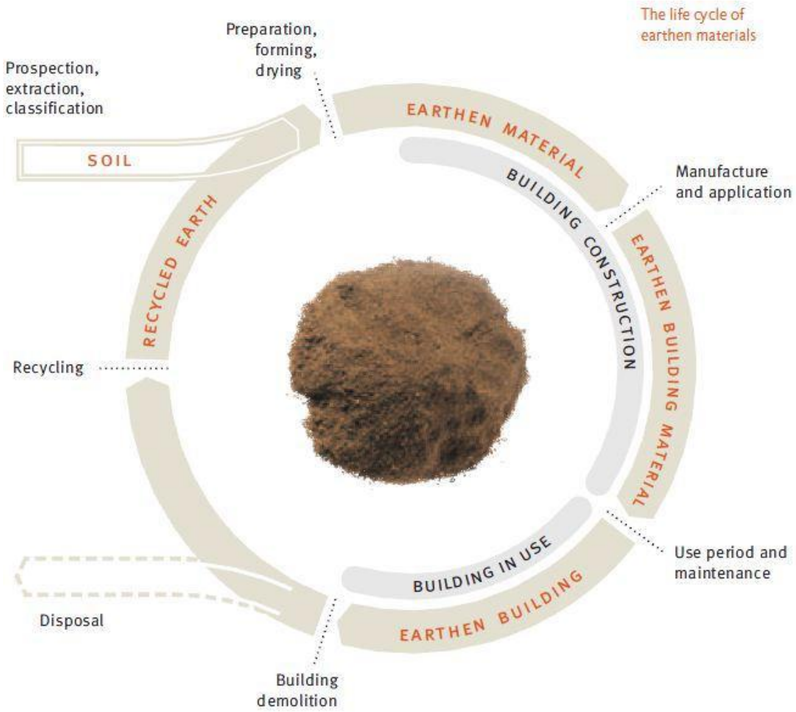

Figure 31: Life cycle of earthen materials (Schreckenbach 2004).

2.7. Experimental Procedures

In this section, all the experiments that were conducted during the research is explained. Experiments were done to identify properties of soil used and physical characteristics, thermal and hygric behavior of pine needle LWL.

2.7.1. Soil Identification

According to the diversity of the earth, it is very important to identify the components of the soil before using. There are many tests existing for soil identification. In a scientific sense, it is interesting to make all the possible analyses and tests of a soil but the main purpose that is researching for construction material should not be forgotten (Houben ve Guillaud 2008). Three soil tests from Houben and Guillaud (2008) are explained below.

i. The Touch Test

According to this test, if the sensation of the soil is hard, it is sandy and if the sensation is slightly hard, the soil is silty. Clayey soil is defined if the sample becomes cohesive when it is dry and it becomes plastic and sticky when it is wet.

ii. The Shine Test

If the cut surface appearance is dull, it is most probably the result of a silty soil. If the cut surface gives a shiny appearance, it indicates that the soil consists of high amount of clay.

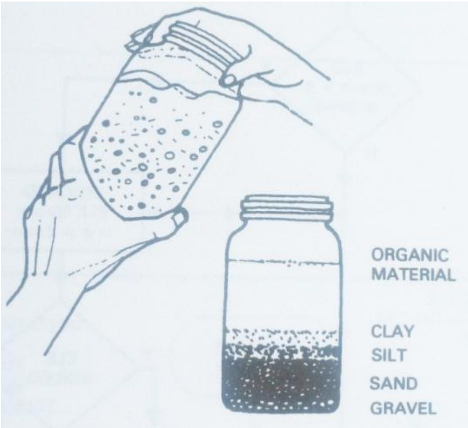

Figure 32: The bottle test (Houben ve Guillaud 2008).

iii. The Bottle Test

While previous tests give a rough idea about the texture of the soil and the amounts of different grains, the bottle test gives proportions of the content of the soil. For this test, only a transparent cylindrical bottle is required.

The quarter of the bottle should be filled with soil and the remaining part with water. After letting the soil to be settled, the bottle should be shaken strongly and let again on a leveled surface. After around 45 minutes, the sedimentation of the soil can be observed (Figure 32).

2.7.2. Linear Shrinkage Test

Alcock's Test -also known as the linear shrinkage test- was taken from the publication of Houben and Guillaud (2008). To perform this test, there is a need of a defined wooden box (Figure 33). Before putting the mix inside the box, the corners should be oiled with a wooden spatula. The filled box should be either exposed to the sun during three days or left in the shade during one week. After that, the dried sample should be moved to one end and the total shrinkage can be measured.

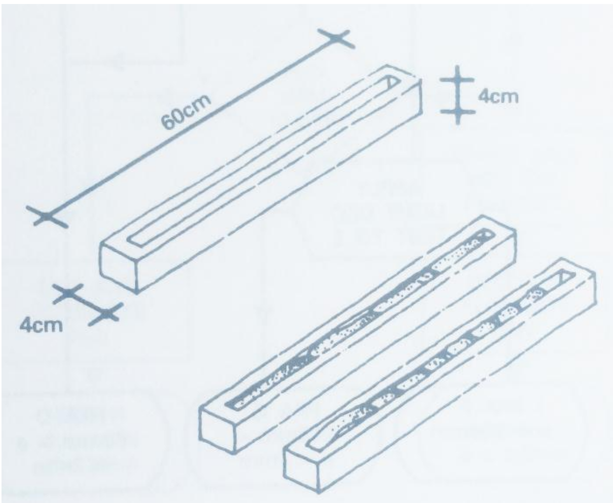

Figure 33: The box that should be built to perform linear shrinkage test (Houben ve Guillaud 2008).

2.7.3. Density

According to (Minke 2006), when the mixture is taken out of the mould after drying, then weighed and divided by the volume of the mould, 40% of the resulted density can be false. Therefore, trimming the corners of the sample to have a cuboid is explained as the only accurate method of determining density, since this method avoids excess fibers and air spaces left around the edges of the mould.

Minke (2006) also explains that to determine the amount of water in a loam mixture, the weight of the sample should be measured than the sample should be heated in an oven to 105°C until the weight stays constant, the mix is dry: the difference of two weights gives the amount of not chemically bound water; also the density of the mix.

2.7.4. Vapor Resistivity

According to Lertwattanaruk and Choksiriwanna (2011), a box made of 10 cm thick polystyrene foam with one opening should be prepared in the sizes of the sample. The sample should close the box by fitting on the open side and coated with a cement base coat. Inside the box, a relative humidity meter should be placed near the wall compared with lightweight concrete. Finally the data should be collected during 24 hours under actual weather conditions to observe the change of humidity level in the box.

2.7.5. Water Capillary Absorption

German Standard DIN 52617 explains the method for determination of the water capillarity absorption coefficient in the following way: the sample is soaked in 3 mm height water on a plane surface and periodically its weight increase measured. After that, the coefficient (w) is calculated:

$$w = \frac{W}{\sqrt{t}} [kg/m^2 h^{0.5}] \qquad (2)$$

Where:

W is the increase in weight per unit surface area

t is the time in hours elapsed

Building Research Laboratory has improved DIN 52617 to use it with earthen materials since earthen samples erode and dissolve underwater over time. The improved method is explained by (Minke 2006) as:

> *"To prevent the penetration of water from the sides as well as the swelling and deformation of the cube, samples are covered on all four sides by a glass-fibre reinforced polyester resin. To avoid the erosion of particles from the submerged surface, a filter paper is attached beneath and glued to the polyester resin sides. To preempt deformation of the weakened loam at the bottom during weighing, a 4-mm-thick sponge over an acrylic glass plate is placed underneath."*

(Minke 2006, 27)

CHAPTER 3

RESEARCH MATERIALS

In this chapter, the research materials as well as the equipment used during the survey are explained. Since an experimental research was conducted, firstly the properties of raw materials used for making the samples were described. Then the quantities of raw materials that were used to produce samples were explained for both preliminary tests samples and main experiment samples. Also the names of the samples together with the ingredients were shown on the tables prepared.

After explaining the research materials, different equipment that were used to perform all the experimental work were told. Firstly the equipment that were produced and used for sample production explained. Then the testing equipment that was used to conduct the experiments was clarified. Finally, general equipment used for the continuity of the experiments was stated.

3.1. Materials

To be able to analyze and understand the results of the experiments, it is important to state the materials used to produce samples. Therefore, raw materials and produced mixes with their amounts of components are explained.

3.1.1. Raw Materials

As it can be understood from its name, pine needles lightweight loam (pine needles LWL) is made of three main raw materials: water, earth and pine needles. Before identifying the process of preparing pine needles LWL, it is important to elaborate the properties of raw materials used.

i. Water

As liquidizer, water that was used to prepare the mixtures of different patches was standard tap water and it was taken from both Kerkenes Eco Center and Middle East Technical University.

ii. Soil

The initial factor while choosing the soil was the locality. Therefore, the soil used was taken either from Şahmuratlı village quarry near Kerkenes Eco Center where the villagers used to take for preparing adobe – noted as KERK loam – or from the forest in METU – noted as METU loam - where the experiments were conducted.

iii. Pine Needle

Two different species of conifers were chosen for their two different types of needles to be able to make a comparison and determine the suitability of easily accessible pine species. Also pine species were selected according to their prevalence in Turkey (General Directorate of Forestry n.d.). The first one is the Black Pine (*Pinus Nigra*) which have long needles varying between 10 and 15 cm and represent 20% of the forest in Turkey (General Directorate of Forestry tarih yok) (Figure 34). The second one is the Scots Pine (*Pinus Sylvestris*) which is less wide spread but have smaller needles with sizes ranging from 4 to 8 cm (Figure 35).

Figure 34: Black Pine (Pinus Nigra) in METU Forest.

Figure 35: Scots Pine (Pinus Sylvestris) in METU Forest.

These differences of lengths are helping to make a more extensive research on the material. To provide convenience for the experiments, pine needles were named as “LPN *(Long Pine Needles)*” for Black Pine and “SPN *(Short Pine Needles)*” for Scot Pine.

3.1.2. Mixes

Many samples were produced specifically for different experiments on varying sizes and mixtures. Therefore, it is decided to explain each of them separately. While the proportions of mixtures were decided by the researcher, in most of the experiments the sizes were chosen according to the test protocol.

i. Preliminary Tests – TS 2514 Samples

8 samples with different proportions of LPN, SPN, earth and water were prepared. From each sample, 3 or 4 specimens were made for control test. Also one test sample named as S-0 was prepared for comparison. Amounts of LPN, SPN and soil in the samples were put by volume while the amount of water was put in liter. On each sample, the volumes of LPN and SPN were decided to be fixed while the volume of soil was varied. The amount of water was decided to put by experiencing the texture of mixtures: whether they are too liquid or too dry.

The samples were named according to experiment applied and type of pine needles used. For the shrinkage samples, abridgments of PR from "*Preliminary*", LPN from "*Long Pine Needles*" and SPN from "*Short Pine Needles*" are used (Table 6).

Table 6: Composition of preliminary test mixes.

Name	LPN	SPN	SOIL	WATER
Unit of Measure	volume	volume	volume	Liter (lt)
S-0 (Test Sample)			1	1
PR-LPN (A_1, A_2, A_3, A_4)	2		1	2
PR-LPN (B_1, B_2, B_3, B_4)	3		1	2.25
PR-LPN (C_1, C_2, C_3)	4		1	3
PR-LPN (D_1, D_2, D_3)	6		1	4.5
PR-LPN (E_1, E_2, E_3, E_4)	8		1	4
PR-SPN (A_1, A_2, A_3, A_4)		6	1	1.8
PR-SPN (B_1, B_2, B_3, B_4)		8	1	6

ii. Preliminary Tests - Pressed Block Samples

The preparation of lightweight pine blocks as a second phase of preliminary test was done in Kerkenes Eco-Center. 10 types of samples were prepared with different proportions of soil, LPN, straw and water. Similar with the shrinkage samples, amounts of LPN, straw and soil in the samples were put by volume while the amount of water was put on liter. On each sample, the volumes of LPN, straw and soil were varied and the amount of water was decided according to previous mixture's workability and state of the pressed block.

Naming of pressed blocks was done by using abridgments of PR from "*Preliminary*", LPN from "*Long Pine Needles*" and B from "*Block*" and S from "*Straw*". Sample called S-0 was prepared by the mixed material with left overs of other samples (Table 7).

Table 7: Composition of pressed block mixes.

Name	Straw	LPN (v.)	Soil (v.)	Water	Quantity
Unit of Measure	Volume	Volume	Volume	Liter	
PR-B-S-1	1		1	4	2
PR-B-S-2	1		1	3	3
PR-B-S-3	2		1	4.5	2
PR-B-S-4	2		1	4.5	2
PR-B-S-5	1		0.75	3	2
PR-B-S-6	1		0.5	1.5	1
PR-B-LPN-1		1	0.5	2	1
PR-B-LPN-2		1	0.75		1
PR-B-LPN-3		1	0.5		1
S-0	Mixed material with left overs was used.				

iii. Experiments

Different mixes were prepared to be used for brick samples and thermal boxes that were built to perform different experiments. 13 mixes of pine-needle LWL, 2 mixes of straw LWL and 1 mix of woodchips LWL were prepared with different ratio of pine to slip-loam, by changing the viscosity of loam as well as the type of needles and the type of clay. Since the production was done in three times, the results of the previous production of samples helped to determine the proportion of the following batch.

The preparation of the mixes with KERK loam was done in Kerkenes Eco-Center (Şahmuratlı Village) and mixes with METU loam was done in Ankara. According to the results of the preliminary tests, instead of mixing soil and water separately with pine needles, slip-loam mixtures with different viscosities from water and soil were prepared.

The amount of pine needles and slip was decided on unit. It was decided to prepare mixes in 1 unit of slip with 4, 8, 12, 16, 24 and 32 unite of pine needles. Finally, three samples were produced from each different mix.

While brick samples were produced with all the mixes prepared, six mixes were used to produce external wall for thermal boxes which are:

- 8, 12 and 24 units of pine needles for 1 unit of METU slip loam (LPN-METU-1, LPN-METU-2 and LPN-METU-4)
- 8 units of LPN for 1 unit of KERK slip loam (LPN-KERK-3)
- 6 and 8 units of straw for 1 unit of KERK slip loam (STRAW-KERK-1 and STRAW-KERK-2)
- Mix of woodchips and KERK slip loam was prepared only to be used as a thermal box. 6 units of woodchips for 1 unit of KERK slip loam is used.

Since 15 different types of mixes for experiments were prepared, their composition was summarized on Table 8 with essential information for easy understanding. Woodchips LWL mix is not mentioned on Table 8 since no measurements were taken and it was only used for thermal behavior test.

Table 8: Composition of experiment mixes.

Name	Type of Loam	Viscosity (diameter in cm)	Type of Pine Needles	Volume of Pine Needles for 1 volume of Slip-Loam	Brick Samples	Thermal Boxes
LPN-KERK-1	Kerk	15	LPN	4	x	
LPN-KERK-2	Kerk	15	LPN	6	x	
LPN-KERK-3	Kerk	15	LPN	8	x	
LPN-KERK-4	Kerk	5	LPN	8	x	
LPN-KERK-5	Kerk	8,5	LPN	8	x	
LPN-KERK-6	Kerk	10	LPN	8	x	
SPN-KERK-1	Kerk	10	SPN	6	x	
SPN-KERK-2	Kerk	10	SPN	8	x	
LPN-METU-1	Metu	10	LPN	8	x	x
LPN-METU-2	Metu	10	LPN	12	x	x
LPN-METU-3	Metu	10	LPN	16	x	
LPN-METU-4	Metu	10	LPN	24	x	x
LPN-METU-5	Metu	10	LPN	32	x	
STRAW-KERK-1	Kerk	15		6	x	x
STRAW-KERK-2	Kerk	15		8	x	x

3.2. Equipment

Sample production equipment, testing equipment and general equipment had different roles in producing mixes, samples and while performing the experiments. Therefore, each group of equipment is explained separately.

3.2.1. Sample production equipment

Equipment explained in this section was built to produce different samples for different experiments.

i. Shrinkage Boxes

Two types of shrinkage boxes were built with pine wood in order to perform two different shrinkage tests.

The first test was taken from the Turkish standard for the production and usage of adobe: “TS-2514” (Turkish Standards Institute 1977). Therefore, the sizes of the shrinkage box were also adapted and a wooden mold with the sizes of 20 cm long, 4 cm wide, 2.5 cm deep was built (Figure 36). While building the box, it was also considered that it should be possible to dismantle the mould to be able to take out the produced sample easier.

Figure 36: Shrinkage box according to TS-2514.

A wooden box consist of four separations (each of them 60 cm long, 4 cm wide and 4 cm deep) was built to perform Linear Shrinkage Test (Figure 37). Since the samples were meant to stay inside for a period of time, the box was not built as demountable.

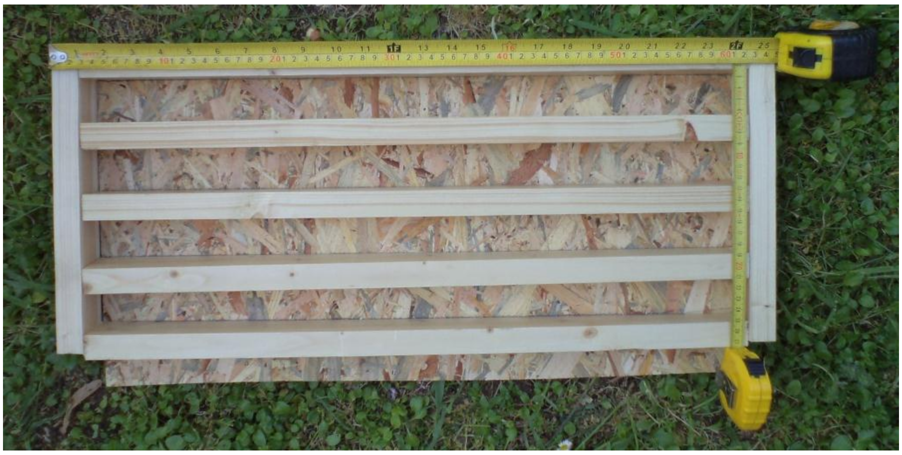

Figure 37: Shrinkage box that is used for Linear Shrinkage Test.

ii. Pressed Block Machine

The machine that was used to produce pressed blocks was similar to The Cinva Ram type machine and it was designed by Ecological Designs of Masvingo in Zimbabwe (Davis 1994) and it was located in Kerkenes Eco Center (Figure 38).

Figure 38: Pressed block machine in Kerkenes Eco Center.

iii. Brick Mold

A wooden mold of appropriate dimensions defined by Gaia Architects (2003) was built in order to produce the brick samples. The interior dimensions were taken as 30x15x10 cm.

iv. Thermal Box

Thermal box that was built consisted of two layers of chipboard. It had interior volume of 60x30x25 cm and the interior space where it creates a wall while filled up had a thickness of 10 cm. The walls were straightened up with the help of stick pieces which are made of pinewood (Figure 39).

Figure 39: Thermal Box.

3.2.2. Testing equipment

Equipment used to perform different experiments is explained one by one.

i. Water Absorption Apparatus

The water absorption apparatus was built according to instructions that were written at TS 2514 (Turkish Standards Institute 1977). Therefore, a leveled wooden stick was put on some height and the ropes that were holding the samples were attached on it. A basin that was filled with water was put just under the samples so that the samples could dip 5 cm in water.

ii. Polystyrene Boxes

Polystyrene boxes (Figure 40) were built to perform vapor resistivity test as it was explained by Lertwattanaruk and Choksiriwanna (2011). A box made of 5 cm thick polystyrene foam with one opening was prepared. Inside dimensions of the box was 20x13x10 cm so that the trimmed sample (20x8x10 cm) was closing the box by fitting on the open side and there was a 20x10x10 cm space left inside the box to be able to put a data logger. The opening of the box was sealed with silicon.

Figure 40: Vapor resistivity test boxes made of 5 cm thick polystyrene foam.

iii. Data Loggers

Two types of data loggers were used to measure relative humidity and temperature levels of the samples (Figure 41).

- Tinytag Plus 2 (TGP-4500) was designed to monitor the internal temperatures from -25˚C to +85˚C and relative humidity from 0 to 100 % by using built-in sensors. The data logger is suitable for outdoor usage. To be able to transfer the data to the computer, Tinytag Explorer software and a USB cable were required (TinyTag Plus 2/TGP-4500 2015).
- Onset HOBO data logger (U12-012) was also used to measure temperature, relative humidity and it was only suitable for indoor environments. It was designed to monitor temperatures from -20˚C to +70˚C and relative humidity from 5 to 95 %. Direct USB interface and HOBOware software was used to transfer the data (HOBO Data Logger-U12-012 2015).

Figure 41: On the left, TinyTag Plus 2 (TGP-4500) is seen (TinyTag Plus 2/TGP-4500 2015). On the right, Onset HOBO data logger (U12-012) is seen (HOBO Data Logger-U12-012 2015).

iv. Weather Station

HOBO U30-NRC Weather Station Starter Kit (Figure 42) was used to measure outside temperature and relative humidity for the time of the experiment. It is possible to measure temperature, relative humidity, barometric pressure, leaf wetness, light intensity, rainfall, soil moisture and wind with this kit and it is suitable for outdoor usage (HOBO U30-NRC Weather Station Starter Kit - U30-NRC-SYS-B 2015).

Figure 42: HOBO U30-NRC Weather Station Starter Kit (HOBO U30-NRC Weather Station Starter Kit - U30-NRC-SYS-B 2015)

3.2.3. General equipment

Some equipment was used as a secondary tool while performing the experiments:

- Weighing scale that has 0.01 gr precision was used to measure the weights of the samples.
- Regular cooking type of gas oven was used to dry the samples.
- Metallic tape measure was used to take measurements of samples and boxes during production or any experiment.
- Shovel and spade were used to collect required soil.
- Sieve with 3 mm holes was used on collected soil.

CHAPTER 4

RESEARCH METHODOLOGY

In this chapter, the methodology of the research is presented comprehensively. The study is based on experimental research and the experiments are grouped in three parts: soil identification tests, preliminary tests on the workability of the LWL and main experiments to be able to define the physical characteristics, hygric and thermal behaviors of lightweight loam (LWL).

In this study, lightweight pine-needles loam is aimed to be used by self-builders instead of to be produced as an industrial building material; the methodology of this study is based on on-field experiments. Also because of the same reason, it is decided to use easily accessible, low-cost tools and locally available materials and the experiments are conducted where the raw materials are acquired.

The methodology of this study is also focused on the comparison of lightweight pine-needles loam with some other natural materials such as adobe brick and pressed block and standardized materials such as fire brick, autoclaved aerated concrete and expanded polystyrene on different experiments.

Research methodology does not only involve the process of experimenting, it also involves the preparation and the production before actually testing. For this reason, this chapter explains collection of materials, soil identification, together with procedures for preliminary test and main experiments chronologically by giving details required.

4.1. Collection of materials

The range of pine needles and soil which are two important components of lightweight pine needles loam affects the behavior and the characteristic of the material. Thus, different types of soil and pine needles were researched near experiment areas and collected.

4.1.1. Soil

Soil was taken from two different areas which are Kerkenes Eco Center (Yozgat Region) and Middle East Technical University Forest (Ankara Region). Both soil samples were dug from at least 50 cm below the ground level and were sieved with a 3 mm sieve to be able to eliminate any organic elements and stones.

4.1.2. Pine needles

Similar with soil, pine needles used for experiment were taken from both Kerkenes Eco Center and Middle East Technical University Forest.

For the accuracy of the experiment, dry pine needles that were on the ground were chosen. Organic matters, pine cones and branches in the collected patches were separated by hand. Only the pine needles were used for the experiments. Before making the experiments, pine needle patches were laid in a room with sun exposure and protected from weather conditions to dry better.

4.2. Soil identification

Since soil has the role of binding agent in LWL, it was very important to identify the soil that is used in the experiment.

The soil identification tests are aiming to determine the suitability of the soil and the approximate proportions of the samples for the following experiments. To be able to test suitability of the soil, some test examples were chosen and done from the publications of Houben and Guillaud (2008) and Davis (1994). These tests are explained below briefly.

4.2.1. The touch test

After taking out the big pieces from the soil, small amount of samples were taken by hand and were rubbed with two fingers to be able to identify the soil's content by its texture.

4.2.2. The shine test

Slightly moist soil was taken and formed into a ball. The ball was cut with the help of a clean knife to observe the cut surfaces.

4.2.3. The bottle test

While previous tests give a rough idea about the texture of the soil and the amounts of different grains, the bottle test gives proportions of the content of the soil.

A clean glass bottle was filled with soil until the quarter of the bottle and three remaining quarters were filled with clean water. After leaving the bottles standing so the soil was soaked, it was shaken to mix the soil and the water, than it let to rest. The shaking and resting procedure was done after an hour. When it was rested long enough (approximately 1 hour) the sedimentation of the sand, silt, clay and organic content was observed. The percentages of the layers were calculated by measuring first the whole length of the bottle, than the lengths of the sand, silt and clay layers.

4.3. Procedure for Preliminary Tests

Preliminary tests were done to understand the possibility of producing lightweight pine needle loam and its suitability as a construction material before identifying accurate properties. Thus, many trials have been done during preparation of the mixes, also shrinkage and water absorption tests taken from Turkish Standards

Institute (1977) have been done to be able to classify lightweight pine needles loam as a construction material according to Turkish Standards for mud bricks.

Correspondingly, the results of the preliminary tests lead to improve the samples and production method for the following experiments.

4.3.1. Preparation of the Mixture

The first trial of mixing pine needles, mud and earth was done. Since it was the stage of understanding the workability of earthen material with pine needles, the proportions of the mixes were directly decided on the field and the mixes were prepared according to the feeling of the researcher that has an experience on preparing earth-based materials.

The amounts of LPN (Long Pine-needles), SPN (Short Pine-needles) and earth were measured by volume; the amount of water was measured by liter. All the mixes were prepared by hand. Mixes of LPN and SPN were prepared separately. At first water and earth were mixed and then pine needles were added. According to the thickness of the mixture, the amount of the water was decided (Figure 43). Mixing water and earth by hand then adding pine needles resulted in a non-homogeneous mixture that had lumps of earth inside. But this mixture was cohesive enough to produce blocks.

Figure 43: Preparation process of the mix for preliminary tests.

4.3.2. Production of the Samples

Two types of samples were produced. Firstly, samples were prepared for shrinkage and water absorption tests explained in Turkish Standards Institute (1977) and pressed blocks were produced to see appropriateness of LWL for this type of production.

i. Samples according to TS 2514

Since the experiment was taken from Turkish Standard-2514 by Turkish Standards Institute (1977), wooden moulds were built as explained. Mixtures from each sample were put in the wooden moulds and pressed. Then the samples were taken out of the mould and put on an oiled plain glass piece. The measurements from each sample were taken and each of them was marked on their place with a glass marker and let to dry at a temperate room (20-24˚C and 40% of humidity). The differences of length were measured during 2 weeks, until the shrinkages were finished (Figure 44).

Figure 44: Some of the samples are shown on the oiled glass. The samples were aligned by meter.

ii. Pressed Blocks

Experiment has been done with the Cinva-Ram press as a possibility to have a reproducible set-up and to exert a constant and equal pressure on the mix.

Since approximate proportions were determined, each sample of lightweight blocks was built by depending on the one before. For samples PR-B-S-1, PR-B-S-2 and PR-B-S-3, the slip was prepared by only mixing soil and water with a hand tool. This kind of preparation created difficulty to mix slip and straw, also it is resulted a non-homogeneous mixture, since the slip was containing lots of lump inside. Therefore, slips for the following mixtures were prepared by mixing soil and water with an electric mixture. Appearance and the stability of the blocks after taken out of press were observed.

4.3.3. Density

After the shrinkage had stopped on each sample, their density values were calculated. The sizes of the samples were measured in the middle of each face and the average sizes of opposite faces were used on calculation. Measurements from the middle sizes of samples were taken. The final weights of each sample were measured.

The density was calculated according to the equation below.

$$\rho = \frac{m}{V} [kg/m^3] \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(3)}$$

Where:

m is the weight in *kg*.

v is volume in m^3.

The comparison between set of samples was done by comparing the average density of each set.

4.3.4. Shrinkage Test

It is important to define amount of shrinkage on a construction material to be able to avoid undesirable settlements of the walls and cracks that may weaken the structural system of the building. Therefore, different shrinkage tests were applied.

Two types of shrinkage tests were conducted to be able to give a more comprehensive definition. The shrinkage test explained in Turkish Standard-2514 by Turkish Standards Institute (1977) and the linear shrinkage test were applied simultaneously.

i. Shrinkage Test in TS 2514

According to TS 2514 (1977), formula of shrinkage value is:

$$R = L1 - L2 \qquad (4)$$

Where:

L1: Length of the sample just after preparation

L2: Last length of the sample after the shrinkages stopped.

The accepted shrinkage value is the mean value of mixtures from each sample. According to TS 2514, if the final difference is bigger than 2 mm, the test should be done again.

Two types of shrinkage were calculated: shrinkage depending on first measured length and shrinkage depending on mold size (20 cm). This is because after the samples were taken out of the molds, immediately expansions on each sample were observed, therefore the first lengths became longer than mold. In this manner, the shrinkage values are bigger than the calculated shrinkage according to 20 cm long mold size. As mentioned before, the authorized shrinkage value for a suitable mud brick was given as 2 mm in TS 2514 (Turkish Standards Institute 1977).

ii. Linear Shrinkage Test

Before putting the moist mixtures into the molds, the inside surfaces of the box were greased with used engine oil. When putting the mixtures, the corners of each mold were pressed with a wooden spatula. The filled box was left in a temperate room in the shade for seven days. After the dried samples were pushed to one corner to measure the total shrinkage value from the sample to the other end of the mold.

4.3.5. Water Absorption Test

After all the samples were dried and shrinkage stopped, water absorption test was applied on each sample. The test was done according to instructions of TS 2514 (Turkish Standards Institute 1977). Mixes from each sample were attached to a stick with rope. Then each of them was dripped 5 cm in water. Every ten minute, measurements were taken separately from parts of the sample that is above the water, and below the water. This was done to specify water absorption by humidity level above and separation below. The measurements were taken until 90th minute. According to Turkish Standards Institute (1977), there are three indications. If the sample separates itself in 1 hour, it is counted as “easy hydrolyte material”. If the sample separates itself in more than 1 hour, it means the sample is resistant to resolution. Finally, if the sample separates itself less in than 45 minutes, it should not be used for brick construction.

4.4. Procedure for Experiments

The preliminary tests help to understand the general quality of pine needle lightweight loam (LWL). To be more accurate, the following experiments were done to define the appropriate proportions and physical characteristics of pine needle LWL as a construction material and specify the validity of pine needle LWL as insulation material. The experiments that were explained in Literature Review chapter were adapted from several scientific publications for the study of pine needle LWL. Some of the experiments were also applied on different standardized and natural materials for comparison.

Primary purpose was to define the physical characteristics of pine needle LWL to be able to produce appropriate samples for the following experiments. Capillary water absorption, vapor resistivity and thermal behavior experiments were done to understand the behavior of pine needle LWL as an insulation material and how it regulates the heat and the humidity compared to the straw LWL, mud brick, fired brick and autoclaved aerated concrete.

4.4.1. Preparation of the Mixes

The preparation of the mixes for the main experiments was done according to the procedure explained by (Gaia Architects 2003).

Since the first trials gave a result of non-homogeneous mixture, it was decided to prepare the slip loam before mixing with pine needles. Earth was sieved into a plastic sheet and then mixed with water in a deep plastic bucket. To avoid lumps, an electrical mixing tool was used (Figure 45).

Figure 45: On the left, sieved soil is seen. On the right, preparation of slip loam via electrical mixing tool is seen.

The amount of water was decided on the liquidity of the slip. The suitability of the slip was determined by two on-field tests from the publication of Gaia Architects (2003).

Figure 46: Process of viscosity test (Gaia Architects 2003).

Figure 47: On the left: slip loam puddle has around 14 cm diameter viscosity. On the right: Viscosity test according to the trace of slip loam on the skin.

First test is to dip a finger into the mixed slip and to identify the mix: the thickness should be that of a thin cream and the finger print should be covered.

The second and more accurate test is viscosity test. A graduated bowl was used to take 100 ml of slip to be poured onto a clean and plain glass from a height of 100 mm. The diameter of the slip puddle was checked (Figure 46). According to Gaia Architects (2003), the ideal size of the diameter should be between 125mm and 175mm. Addition of water or earth on the slip mixture was continued until the diameter measured was around 150 mm for each sample. At the same time, slip loam specimens with viscosity values of 50, 85, 100 and 150 mm diameter were used to make mixes to identify the effect of viscosity (Figure 47).

The final mixtures for each sample were prepared by pouring the ready slip onto the pine needles and mixed by hand. Because of the difficulty of mixing, gloves were used. The materials were mixed manually until visible homogeneity was reached (Figure 48).

Figure 48: Process of mixing slip loam with pine needles.

4.4.2. Production of the Samples

Brick samples and thermal boxes were produced to perform experiments and the same procedure of production was followed up for both.

i. Brick Samples

Two molds were put on the top of each other and they were fulfilled with mixture. Then the mixture was tamped until the half way. So like this, in one sample, the amount of mixture was provided 2 times the volume of mold for a more compressed sample (Figure 49). To avoid the phenomenon of expansion, the mold was possible to be closed and the sample were kept to dry in it for at least 12h. After being taken out of the mold, the samples were let to cure and dry in hot and dry environment (Figure 50). Finally, three brick samples were produced from each different mixture (Figure 51).

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Figure 49: Two volume of mix is tamped into one volume of mold to be able to obtain a condensed brick sample.

Figure 50: Brick samples are taken out of molds after 12 hours to avoid expansion.

Figure 51: Brick samples made of both pine needles and straw.

ii. Thermal Box

The thermal box was fulfilled with the mixture and tamped until the half of its length. Than another box produced at half length of the thermal box was put on it and again fulfilled and tamped until the half-length. So like this, the thermal box was fulfilled with the mixture that was 2 times the volume of the thermal box (Figure 52).

Figure 52: Process of making LWL boxes.

Similar with the production of bricks, the box was closed and kept dry during at least 12 hours to avoid the phenomenon of expansion. After being taken out of the mold, the samples were let to cure and dry in hot and dry environment (Figure 53).

Figure 53: Pine-needle LWL box directly after being taken out of the mold.

4.4.3. Physical Characteristics

Shrinkage and density as physical characteristics of lightweight pine needle samples with different compositions were measured. The procedures for each experiment were taken from Minke (2002) and the information was applied for lightweight pine needle loam samples.

As Norton (1997) explains for adobe bricks, the test samples were let to dry in exterior condition –protected from rain and direct sun- during one week to avoid cracks and large shrinkage and then cured during one month in a warm and dry environment.

i. Shrinkage

For the reasons that are explained on section 4.3.4, shrinkage values of the final samples were also calculated. Once lightweight pine needle loam samples were cured, each face of each sample was measured and the average dimensions of each set of sample were calculated. The dimensions were measured with the help of tape measure in the middle of each face. Their final dimensions were compared to the dimensions of the molds in order to calculate the shrinkage value (S) in percentage:

$$S = \frac{L_m - L_{AS}}{L_m} \times 100 \quad \text{.................................... (5)}$$

Where:

L_m is the size of the mold (length, width or height).

L_{AS} is the average of the sample faces as defined above .

The shrinkage values on length, width and the height of each sample were calculated. Since the dimensions are different on length (30 cm), width (15 cm) and height (10 cm), the comparison of the shrinkage on metric unit could not be reliable. Therefore, shrinkage values were calculated on percentages for each dimension to be able to make a reasonable comparison after all.

ii. Density

Bulk density is usually determined on fully dry samples. To eliminate water in the samples, they were put in an oven at 105°C until reaching constant weight: which means that all the water has evaporated. In the case of this research, since all the samples have been let to cure in a green house, constant weight has been determined to be reached after 6 hours on the 3 heavier samples and it has been assumed that it was the same for all the samples.

After fully drying, weight of the samples and sizes of all faces have been measured same as explained in the previous section. Volumes of samples were calculated from their dimensions and density was obtained according to the equation (3).

A second calculation of density have been done after trimming samples – as suggested by Minke (2006) - to a smaller size appropriate to further tests. Each face of the samples was trimmed to an approximate dimension of 20x10x8cm to avoid corner and top effect where the fibers are not evenly distributed and their average dimensions and weights were calculated (Figure 54).

Figure 54: The difference of trimmed and non-trimmed side of brick sample is seen.

The densities (ρ) of untrimmed and trimmed samples were calculated.

$$\rho = \frac{m}{v}\,[kg/m^3]\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ (6)$$

Where:

m is the weight in *kg*.

v is volume in m^3.

iii. Capillary Water Absorption

The capillarity water absorption test was made on all the samples following an adaptation of a non-destructive protocol of the Building Research Laboratory elaborated for loam experiments. The aim of the adaptation is to keep the integrity of the material even after the sample is laid on a water layer by using different materials then explained in protocol to avoid water penetration.

The experiment was conducted in Kerkenes Eco-Center (Şahmuratlı Village). Bottoms of each sample were covered with a 1 mm thin cleaning cloth made of 65% viscose and 35% polyester. Then each side of the covered surface is sealed with silicon (Figure 55). 5 mm thick tray was used to be filled with water: this was made to be sure that the water will not go higher than 5 mm. As it is recommended by the British standard (Wilson, Carter and Hoff 1999), the weights of samples were taken and laid in water after (Figure 56). Then, weights of samples were taken after 1, 5, 14, 30 and 55 minutes (Figure 57). Finally the water capillarity absorption coefficients were calculated for each sample by using the equation 6 and the curve of absorption was drawn.

$$w = \frac{W}{\sqrt{t}}\,[kg/m^2h^{0.5}]\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ (7)$$

Where:

w is the increase in weight per unit surface area

t is the time in hours elapsed.

Figure 55: Samples covered with cloth and sealed with silicon.

Figure 56: Samples are shown being laid on water.

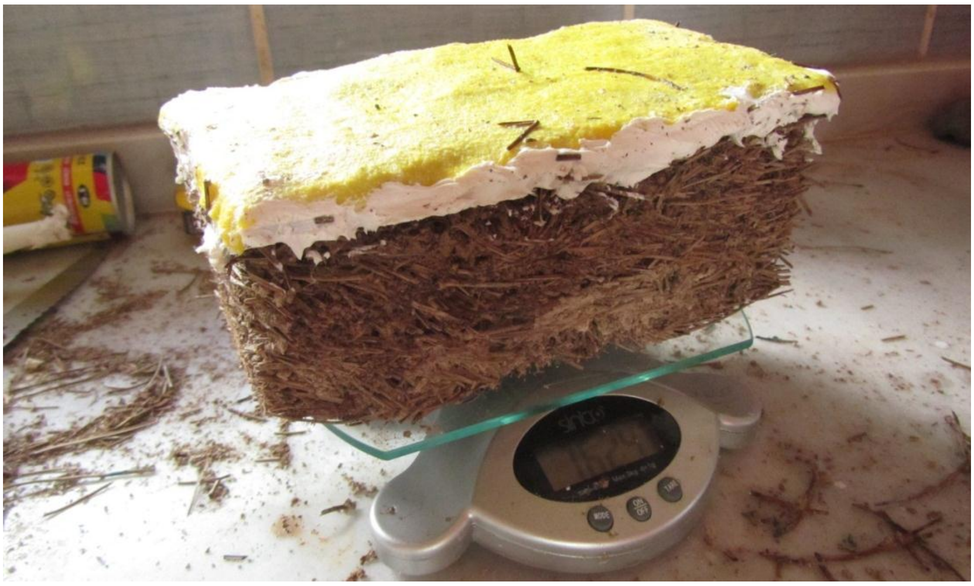

Figure 57: Sample is weighted after 1, 5, 14, 30 and 55 minutes.

4.4.4. Material Performance Tests

In this section, experiments conducted on the Hygric properties and Thermal performances of the light weight loam (LWL) mixes are explained. Together with pine-needle LWL; straw LWL, mud brick, AAC block and polystyrene (XPS) block are tested for performance comparison.

i. Vapor Resistivity

This on-field test was used to compare the behavior of the different samples of pine needle LWL and straw LWL on vapor resistivity. The experiment that Lertwattanaruk and Choksiriwanna (2011) used was taken as a model for calculation of moisture absorption and was adapted to the weather conditions of the test environment and the samples produced.

The experiment was conducted in Kerkenes Eco-Center (Şahmuratlı Village). The boxes for each sample were made of 5 cm thick polystyrene foam (Figure 58). The trimmed samples (20x10x8 cm) were fit at the open side of the box and sealed with silicon around to avoid air circulation. When the samples were put, the size of the gap left inside the box was 20x10x10 cm where a data-logger – Tiny Tag data logger - measuring the temperature and relative humidity was placed in each of them.

Figure 58: Vapor resistivity test box made of 5 cm thick polystyrene is seen with one of the pine-needle LWL sample. The box is not closed and sealed yet.

Since the weather conditions were stable, artificial humid and dry conditions were created for the experimental boxes. Therefore, the boxes were let in a basement room during 36 hours where before water was poured on the ground to create a very humid condition (between 50% to 70% RH) and then the boxes were let in the solar house under very dry condition (between 5% to 55% RH) during 36 hours. Samples LPN-KERK-2-C, LPN-KERK-3-A, LPN-KERK-6-A, SPN-KERK-2-B, LPN-METU-1-A, LPN-METU-2-A, LPN-METU-4-A and STRAW-KERK-2 were used in this experiment.

ii. Thermal Behavior

Four different mixes of pine needle LWL and two different mixes of straw LWL were used to produce external wall for thermal boxes. Also boxes were built by using mud-bricks, autoclaved aerated concrete (AAC) and polystyrene for comparison.

As it is explained in building materials chapter, these boxes had in interior volume of 60x30x25 cm and the wall had a thickness of 10 cm. Although the interior volume of the box is not big enough to give actual ambient temperature and relative humidity data, it is possible to understand the thermal behavior of the materials by making a comparison in between themselves.

The boxes were put on 10 cm thick expanded polystyrene and closed with the same material as well. Gaps in between expanded polystyrene and the walls were sealed with silicon to avoid air penetration.

Tiny-Tag and Hobo data-loggers were used to record the internal ambient temperature of each box. Interior and exterior surface temperatures of the south wall were recorded in summer and winter times with Hobo U12 data loggers and surface sensors.

The long faces of the boxes were facing south and north, and boxes were placed on the roof to avoid any obstacle to sun radiations. Weather data were recorded by a weather station situated close to both experiment sites. The recorded weather data includes air temperature and relative humidity, solar radiation together with wind direction and speed. The data were monitored 18 months in Ankara and in Şahmuratlı village. The relative humidity was also monitored during this period and it allowed another comparison of the behavior of the material under real weather conditions.

On the other hand, during winter and spring season -when the exterior temperature is between 0ºC and 10ºC- candles were lighted inside each box and closed to see the insulation behavior of the materials in heated ambience.

The boxes that were made of LPN-KERK-3, STRAW-KERK-1, STRAW-KERK-2, woodchips LWL and mud-brick in Kerkenes Eco-Center (Şahmuratlı Village) were placed on the flat roof of one of the buildings (Figure 59 and Figure 60).

The boxes that were made of LPN-METU-1, LPN-METU-2, LPN-METU-4, AAC and polystyrene (XPS) in METU Campus were placed on the roof of Architecture Faculty (Figure 61 and Figure 62).

Figure 59: Thermal boxes on the flat roof of mud brick house in Kerkenes Eco-Center during winter time.

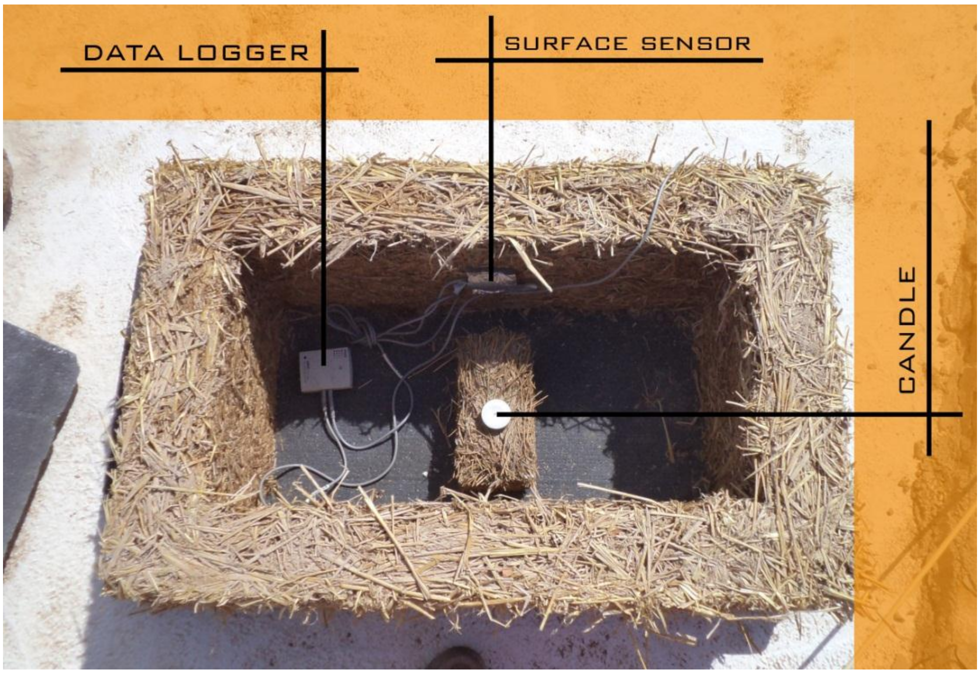

Figure 60: One of the pine-needle LWL box is seen with HOBO data logger, surface sensor on south wall and candle placed on pine-needle LWL block.

Figure 61: Thermal boxes on the flat roof of Architecture Faculty Building in METU Campus during spring time.

Figure 62: One of the closed pine-needle LWL box is seen with surface sensor on south wall.

CHAPTER 5

RESULTS AND DISCUSSION

In this chapter, physical properties of the soil samples and pine needle lightweight loam (LWL), workability of mixes and the results of the experiments that are explained in research methodology are explained in detail. Also the discussions are given at the end of each section.

5.1. Properties of Soil

The result of touch test showed that KERK soil has a harder texture than METU soil. The ball cuts prepared according to shine test showed that ball cut from KERK soil has a dull appearance while ball cut from METU soil has a shiny surface. This early soil identification tests resulted that METU soil should have a higher amount of clay than KERK soil.

The result of bottle test displayed that KERK soil contains between 25-30 % of clay, 10 to 15% of silt and 60 to 65% of sand (Figure 63) while METU soil contains between 60-65% of clay, 10-15 % of silt and 25-30% of sand (Figure 64).

The results of the bottle test are in accordance with the results of the touch test showing that METU soil is a clayey soil and KERK soil is a sandy soil.

Figure 63: Result of bottle test for KERK Soil.

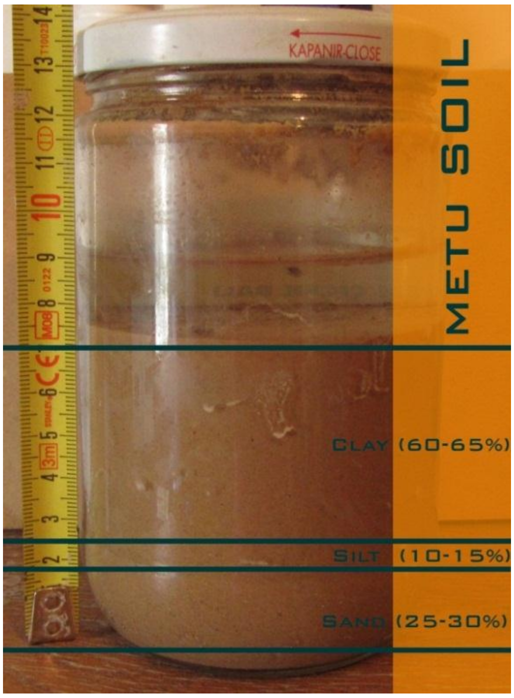

Figure 64: Result of bottle test for METU Soil.

5.2. Production Techniques

Pine needle LWL is a newly tested construction material. Therefore, how the samples that were prepared with different methods work should be explained. Different techniques of production were tested and different building elements were tried.

5.2.1. TS 2514 Samples

The samples prepared with LPN and SPN mixes were expanded directly after they were taken out of the mould. Samples with SPN were giving a more compact result compared to samples with LPN. It can be concluded that the sizes of the moulds are too small for testing pine needle LWL construction and it is difficult to get relevant results.

5.2.2. Pressed Blocks

During the compaction process, some problems occurred, making it impossible to use the press.

1- Most of the slip flew away from the gap of the machine due to the over pressure exerted on the material.
2- The samples had to be done with a high amount of slip compare to LWL construction requirement, since the stability of the blocks could not be sustained with press machine.
3- The block samples that were built with LPN (PR-B-LPN-1, PR-B-LPN-2, and PR-B-LPN-3) were showing similar behaviors. After being taken out of press, the pine blocks managed to keep their form but after a short time they showed deteriorations –starting from the corners- because of the expansion of the pine needles. The integrity of straw blocks was better compared to pine blocks (Figure 65).

Figure 65: Pressed Blocks prepared with respectively LPN (left) and straw (right).

These results show that instead of using press machine, usage of mold for LWL construction is found more appropriate since it is giving a chance to use high amount of fibers.

5.2.3. Bricks

During the preparation of the mixes, it was easier to work with straw than pine needles: it requires usage of gloves since it may cause scratches on the hands.

More cracks were observed on the samples with higher amount of slip loam. Among the samples prepared with high amount of pine needles, the integrity of the ones with METU loam was better than the ones with KERK loam. This result showed that the amount of clay has a positive effect on the durableness of the sample. Amount of expansion did not show a big difference between the samples with LPN and SPN.

Brick production method allows a fast drying process and avoids rottenness since all the bricks were turned during drying.

Samples that were prepared with the same mixes gave a close result of density values so it allows reproducing same samples successively. This can be the result of stable viscosity of slip loam.

5.3. Preliminary Tests

The results of preliminary tests that were done to give a clue on the physical properties of pine needle LWL are given. Also the discussions on the relation between shrinkage, density and water absorption and comparison of pine needles (LPN and SPN) are done.

5.3.1. Density

After the samples dried, the mean density values were calculated for each mix. The maximum density was determined for the soil without fibers (S-0) at 1352.5 kg/m3 while the minimum density was calculated for the mix PR-SPN-B as 645 kg/m3. For long pine-needles, the mean density ranges from 696.67kg/m^3 to 1100kg/m^3 whereas for short pine-needles, the mean density varies from 645kg/m^{3}to 937.5kg/m^3.

PR-LPN-A contains highest amount of soil, thus its density (1100 kg/m3) is very close to the density limit for LWL construction (1200 kg/m3) given by Gaia Architects (2003) and it is much higher than the densities of other LPN mixes.

Since the amount of pine needle was measured by unit and not by weight, some inconsistencies in the density can be seen on Table 9 and Figure 66. The mean density of the mix PR-PLN-D is lower and PR-PLN-E is higher than it was expected. However, this represents the possibilities that could appear on a building site and is in accordance with the difficulty – underlined by Gaia Architects (2003) – to achieve constant quality of mixes on a same wall. On the other hand, nonrealistic density value can be seen on comparison of PR-LPN-D (1/6 unit of soil, density: 696.67 kg/m3) and PR-LPN-E (1/8 v. of soil, density: 730.00 kg/m3).

Table 9: Density values of preliminary test samples.

MİX NAME	WET WEIGHT	DRY WEIGHT	DENSITY
Unit	kg	kg	kg/m³
S-0 (Test Sample)	353.5	270.5	1352.5
PR-LPN (A_1, A_2, A_3, A_4)	301.5	220.0	1100.0
PR-LPN (B_1, B_2, B_3, B_4)	276.0	196.5	982.5
PR-LPN (C_1, C_2, C_3)	193.0	187.3	936.7
PR-LPN (D_1, D_2, D_3)	276.3	139.3	696.7
PR-LPN (E_1, E_2, E_3, E_4)	217.8	146.3	730.0
PR-SPN (A_1, A_2, A_3, A_4)	257.8	187.5	937.5
PR-SPN (B_1, B_2, B_3, B_4)	200.8	129.0	645.0
MAX	353.5	270.5	1352.5
MİN	193.0	129.0	645.0

The comparison of densities of mixes with short and long pine needles underlines the same results. For a same unit of pine needles i.e. PR-LPN-D and PR-SPN-A or PR-LPN-E and PR-SPN-B, density values are totally different which mean that the amount of pine-needle by unit was not constant (Table 9).

The comparison of the trend lines of mixes with short pine-needles and long pine-needles shows an almost parallel slope but a higher position for short pine-needles, i.e. a higher density for the same unit of pine-needle. (Figure 66) This due to the fact that the short pine-needles are easier to compact and stack in the formwork so a higher density can be achieved despite a same unit.

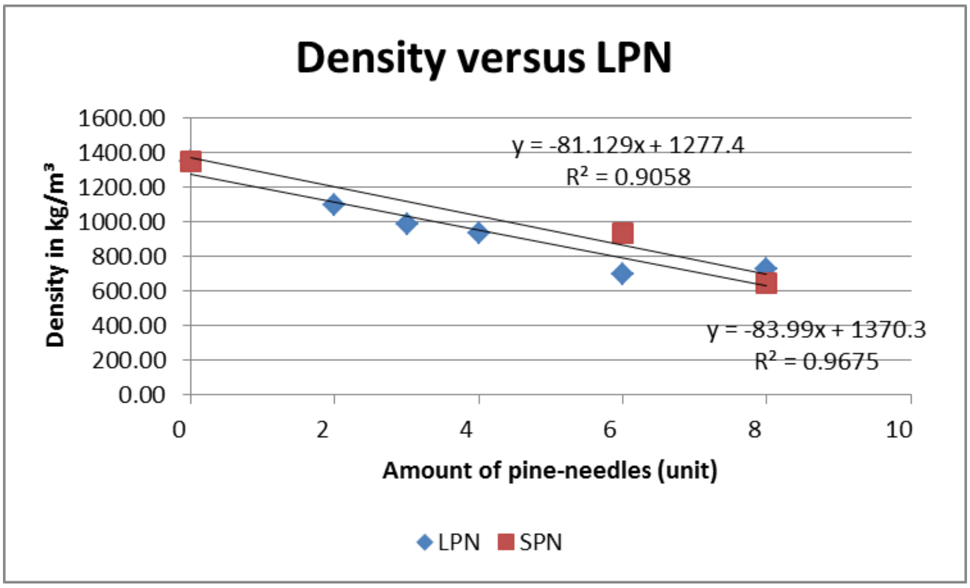

Figure 66: Correlation between density of mix and ratio of LPN.

5.3.2. Shrinkage

As it is underlined in Research Methodology Chapter, since the samples expanded directly when they were taken out of the molds their expanded length was also measured one by one.

The range of fresh expanded length was between 20.5 cm and 20 cm, i.e. 2.5% and 0%, the average expanded lengths were also calculated Table 10.

After the samples dried, shrinkage depending on the mold size was calculated. The maximum average shrinkage was calculated for mix S-0 as 2.3 cm (11.4%) while the minimum average shrinkage was calculated for mixes PR-LPN-B and PR-SPN-B as 0.1 cm (0.3% and 0.7%) and mixes PR-LPN-C, PR-LPN-D and PR-LPN-E were still in expansion compare to the mold size. Individual and average shrinkage values are given in Table 11 and Table 12 for LPN and SPN mixes, respectively.

Table 10: Shrinkage values of preliminary test samples.

MİX NAME	FRESH LENGTH	DRY LENGTH	SHRINKAGE (Depending on 1st measurement)	PERCENTAGE OF SHRINKAGE (Depending on 1st measurement)	SHRINKAGE (Depending on mould size: 20 cm)	PERCENTAGE OF SHRINKAGE (Depending on mould size: 20 cm)
Unit	cm			%	cm	%
S-0 (Test Sample)	20.3	17.7	2.5	12.1	2.3	11.4
PR-LPN (A_1, A_2, A_3, A_4)	20.2	19.7	0.5	2.5	0.3	1.5
PR-LPN (B_1, B_2, B_3, B_4)	20.4	20.0	0.4	2.1	0.1	0.3
PR-LPN (C_1, C_2, C_3)	20.5	20.2	0.3	1.3	-0.2	-0.9
PR-LPN (D_1, D_2, D_3)	20.4	20.1	0.3	1.6	-0.1	-0.4
PR-LPN (E_1, E_2, E_3, E_4)	20.2	20.1	0.1	0.5	-0.1	-0.5
PR-SPN (A_1, A_2, A_3, A_4)	20.5	19.8	0.6	3.0	0.2	1.2
PR-SPN (B_1, B_2, B_3, B_4)	20.4	19.9	0.6	2.7	0.1	0.5
MAX	20.5	20.2	2.5	12.1	2.3	11.4
MİN	20.2	17.7	0.1	0.5	0.1	-0.9

Table 11: Individual and average shrinkage values of SPN mixes.

Name	Shrinkage (1st measurement)	Percentage	Shrinkage (mold)	Percentage
Unit	cm	%	cm	%
PR-SPN-B1	0.2	1.0	0.6	2.9
PR-SPN-B2	0.1	0.5	0.6	2.9
PR-SPN-B3	0.2	1.0	0.6	2.9
PR-SPN-B4	0.1	0.5	0.4	2.0
Mean value	0.1	0.7	0.5	2.7
PR-SPN-A1	-0.1	-0.7	0.4	1.7
PR-SPN-A2	0.3	1.5	0.8	3.9
PR-SPN-A3	0.2	1.0	0.6	2.9
PR-SPN-A4	0.2	1.0	0.7	3.4
Mean value	0.2	1.2	0.6	3.0

Table 12: Individual and average shrinkage values of LPN mixes and S-0.

Name	Shrinkage (1st measurement)	Percentage	Shrinkage (mold)	Percentage
Unit	cm	%	cm	%
PR-LPN-A1	0.2	1.0	0.4	2.0
PR-LPN-A2	0.2	1.0	0.5	2.5
PR-LPN-A3	0.3	1.5	0.5	2.5
PR-LPN-A4	0.4	2.3	0.6	3.2
Mean value	0.3	1.4	0.5	2.5
PR-LPN-B1	0.2	1.0	0.4	2.0
PR-LPN-B2	0.1	0.3	0.4	2.2
PR-LPN-B3	0.1	0.5	0.5	2.5
PR-LPN-B4	-0.1	-0.7	0.4	1.7
Mean value	0.1	0.3	0.4	2.1
PR-LPN-C1	-0.1	-0.5	0.3	1.5
PR-LPN-C2	-0.1	-0.7	0.3	1.5
PR-LPN-C3	-0.3	-1.5	0.2	1.0
Mean value	-0.2	-0.9	0.3	1.3
PR-LPN-D1	-0.1	-0.3	0.3	1.7
PR-LPN-D2	-0.1	-0.5	0.4	2.0
PR-LPN-D3	-0.1	-0.5	0.2	1.0
Mean value	-0.1	-0.4	0.3	1.6
PR-LPN-E1	0.2	1.0	0.3	1.5
PR-LPN-E2	-0.2	-1.0	-0.2	-1.0
PR-LPN-E3	-0.1	-0.3	0.1	0.7
PR-LPN-E4	-0.3	-1.5	0.2	1.0
Mean value	-0.1	-0.4	0.1	0.6
S-0-A	2.5	12.5	2.6	12.9
S-0-B	2.3	11.5	2.5	12.4
S-0-C	2.3	11.5	2.4	11.9
S-0-D	2.0	10.0	2.3	11.3
Mean value	2.3	11.4	2.5	12.1

According to TS 2514, the authorized shrinkage limit is 0.2 cm. According to this limit, only; PR-LPN-B, PR-LPN-C, PR-LPN-D, PR-LPN-E and PR-SPN-B can be used as building material (Figure 67).

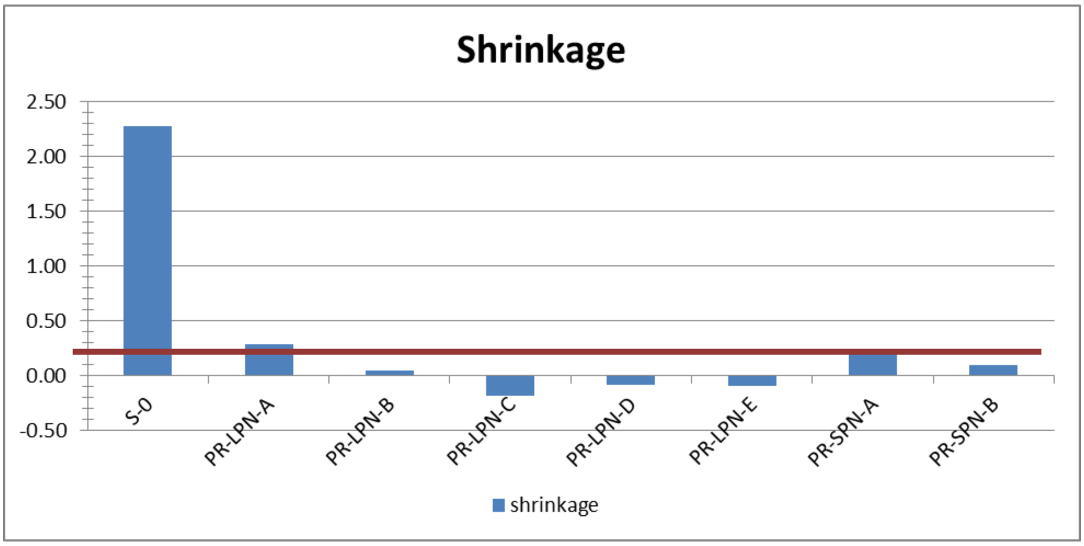

Figure 67: Comparison of shrinkage values of each sample depending on TS 2514 requirements.

Over shrinkage of S-0 was an expected result, since the sample only consists of soil and water. Over limit shrinkage of PR-LPN-A were expected since it has a low amount of pine needles with 1/2. Although pine-needle unit of PR-SPN-A is not very low (1/6), its shrinkage is also over authorized limit. According to this result, it can be deduced that SPN is not as good as LPN on regulating shrinkage in the samples.

Following charts are prepared according to the real shrinkage of samples i.e. the shrinkage depending on fresh length of samples because the drying process occurred after the samples were taken out of the mold.

According to Minke (2012), shrinkage of the material depends on the amount of fibrous materials: more the material includes fibrous materials, less the shrinkage happens. For this reason, the relation between the shrinkage value and pine needles were investigated by preparing a chart that is correlating PR-LPN-A, PR-LPN-B, PR-LPN-C, PR-LPN-D and PR-LPN-E's pine-needle amount with their shrinkage values (Figure 68). From this chart, although it is not very high, the relation between shrinkage and amount of LPN can be seen, from the value of R (0.83).

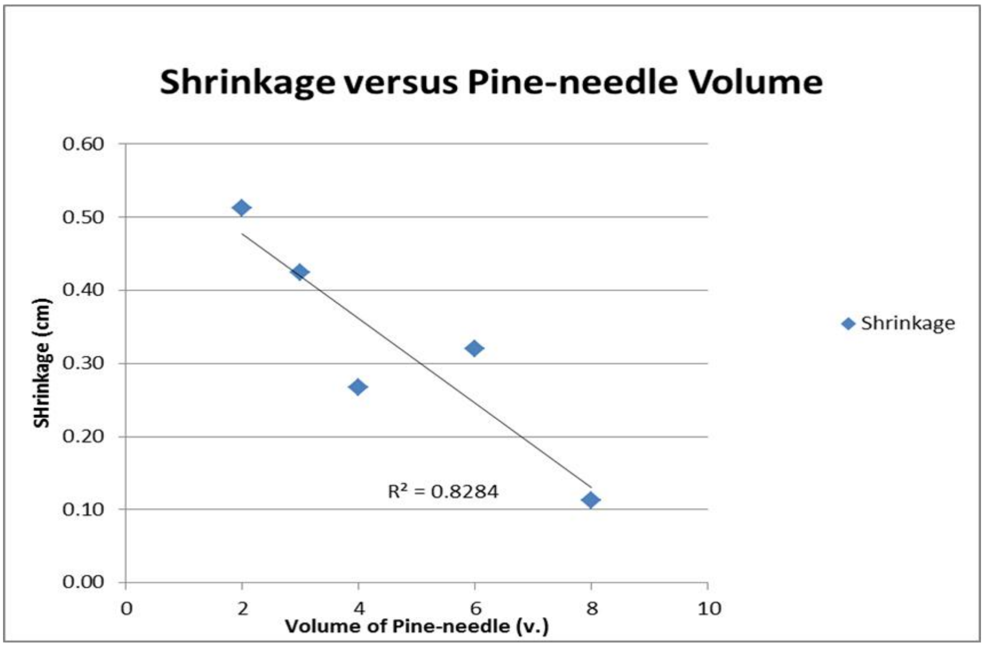

Figure 68: Effect of pine-needle (LPN) volume on shrinkage.

5.3.3. Water Absorption

Water absorption test have been running during 90 minutes with measurement of the water absorption in the sample and length of the immersed part taken every 10 minutes. After each set of samples have been tested pictures have been taken to show the state of the samples (Figure 69).

The results of water absorption were compiled in Table 13 and Table 14. The time of failure was shown for each sample in accordance with the TS 2514. As expected, the soil without reinforcement failed the fastest, followed by the sample PR-LPN-A which has the lowest amount of fiber. All the other samples passed the 45 minutes limit given by the TS 2514 and most of them even last 90 minutes before the test was terminated. Because of test failure, the measurements of PR-LPN-D could not be taken, only it is observed that it resist more than 90 minutes against disintegration.

Figure 69: State of the samples after water absorption test is terminated.

Table 13: Results on length of dissolving sample that is under the water.

Height of sample that is under water (cm)									
Minute	10th min.	20th min.	30th min.	40th min.	50th min.	60th min.	70th min.	80th min.	90th min.
S-0	1.8	-	-	-	-	-	-	-	-
PR-LPN-A	3.0	2.0	-	-	-	-	-	-	-
PR-LPN-B	-	-	3.4	2.6	1.8	1.8	1.6	0.9	0.6
PR-LPN-C	5.0	4.7	3.7	3.7	3.3	3.7	3.7	3.0	-
PR-LPN-D	-	-	-	-	-	-	-	-	-
PR-LPN-E	5.0	4.1	4.0	3.8	3.6	3.3	3.3	3.3	3.3
PR-SPN-A	5.0	5.0	4.3	3.7	3.3	1.7	1.5	-	-
PR-SPN-B	5.0	5.0	5.0	5.0	4.9	4.6	4.5	3.9	3.4

Table 14: Results on height of absorbed water on sample that is above the water.

Height of absorbed water (cm)									
Minute	10th min.	20th min.	30th min.	40th min.	50th min.	60th min.	70th min.	80th min.	90th min.
S-0	4.0	-	-	-	-	-	-	-	-
PR-LPN-A	5.0	-	-	-	-	-	-	-	-
PR-LPN-B	4.3	7.4	8.3	8.8	8.9	9.5	10.3	10.5	-
PR-LPN-C	3.7	5.0	7.0	7.3	7.3	7.7	8.3	8.0	-
PR-LPN-D	-	-	-	-	-	-	-	-	-
PR-LPN-E	5.0	5.8	6.5	7.3	8.5	8.8	9.8	10.3	10.5
PR-SPN-A	5.3	6.3	7.5	8.0	8.7	8.7	9.0	-	-
PR-SPN-B	5.3	5.3	6.3	7.8	7.9	8.4	8.8	9.0	9.3

5.3.4. Discussion on the Relation between Shrinkage and Density

More important is to compare the shrinkage to the density of samples since the density is directly related with the amount of fibers. Assuming that the correlation between shrinkage and density would be high, a scatter chart was prepared (Figure 70). In the case of plotting indistinctly the density against the shrinkage the relation is weak.

As it was underlined by different authors (Minke, 2004, Ashour and Derbala 2010), type of fibers has a direct effect on shrinkage. However, according to the Figure 71, no direct relation can be found between shrinkage and density. This behavior is due to other parameters such as quantity of water in the mix, viscosity of the slip loam and non-homogeneous mix.

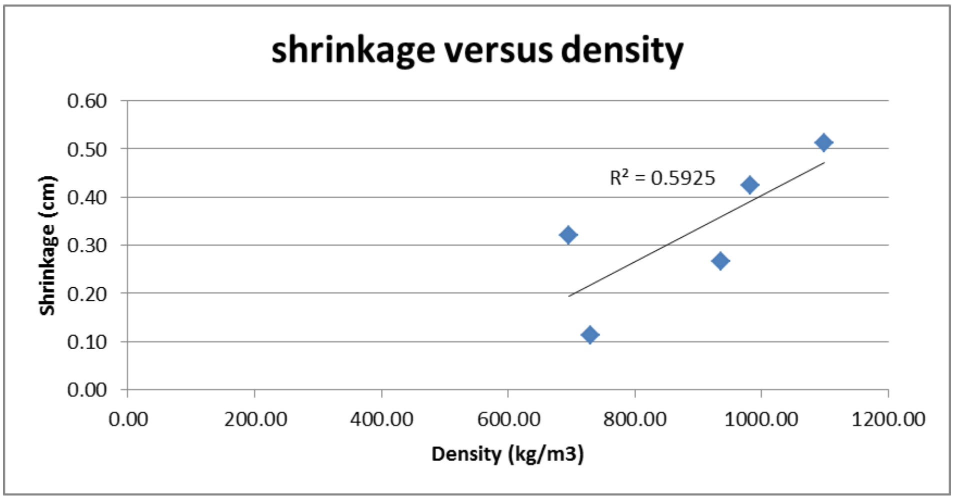

Figure 70: Corralation between shrinkage and density.

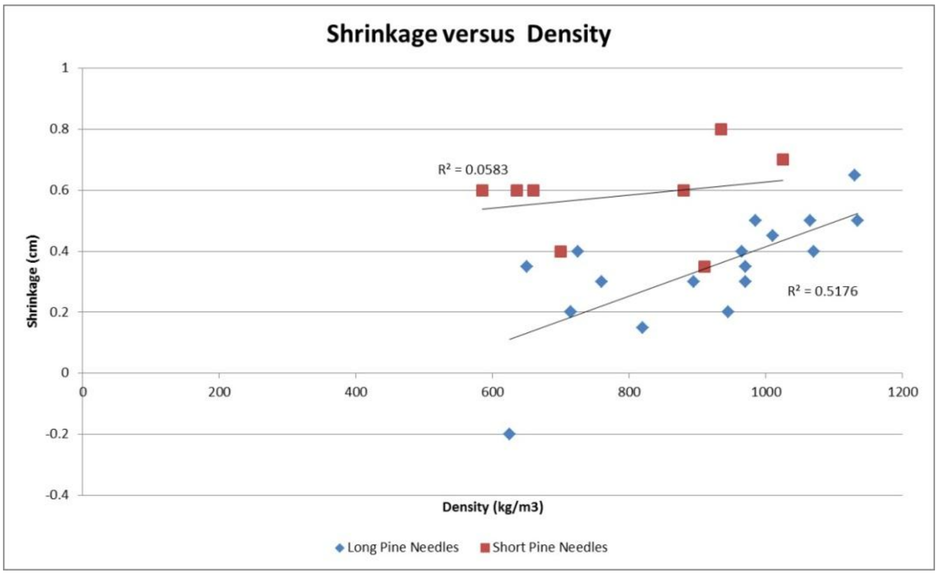

Figure 71: Relation between Shrinkage and Density of mixes.

5.3.5. Discussion on the Relation between Density and Water Absorption

The correlation of density with failure time (Figure 72) and density with height of absorbed water from the water absorption experiment (Figure 73) was searched. According to Figure 72, there is a weak relation between density and speed of failure (R^2=0.73); but it can be seen that fibers help for the cohesion of samples.

Figure 73 shows the water absorption level of S-0 and mixes with long pine-needles at 10th minute and at their failure time. It can be seen that at the beginning of the experiment, they absorb similar amount of water but by time PR-LPN-B, PR-LPN-C, PR-LPN-E are able to absorb more water without being destroyed. This result shows that samples that have higher density absorb water fast but dissolve faster while samples with lower density manage to absorb more water during longer time. It also means that the fiber in the mixes helps to have a lighter sample, but at the same time helps to keep the integrity of the sample during water absorption.

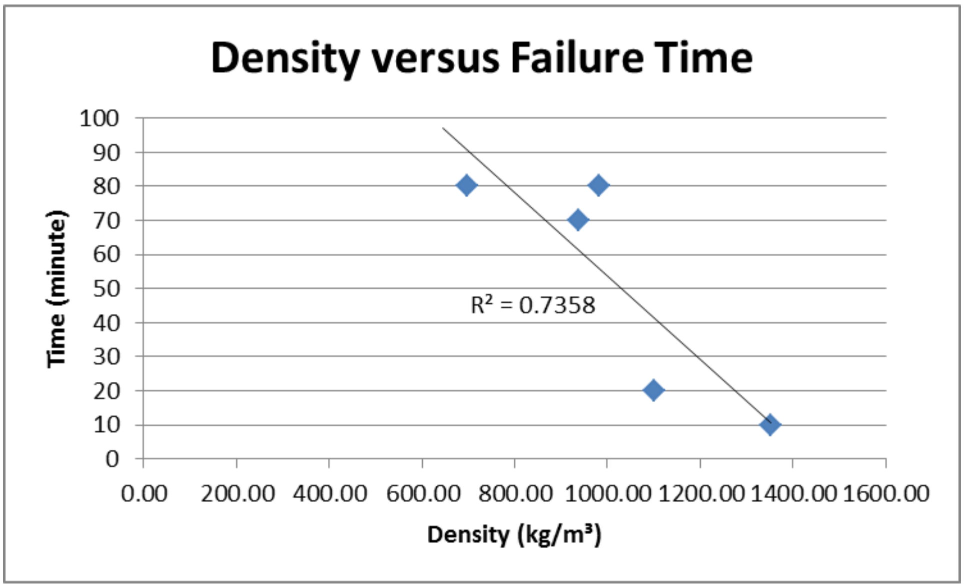

Figure 72: Correlation between density and failure time of the samples on water absorption test.

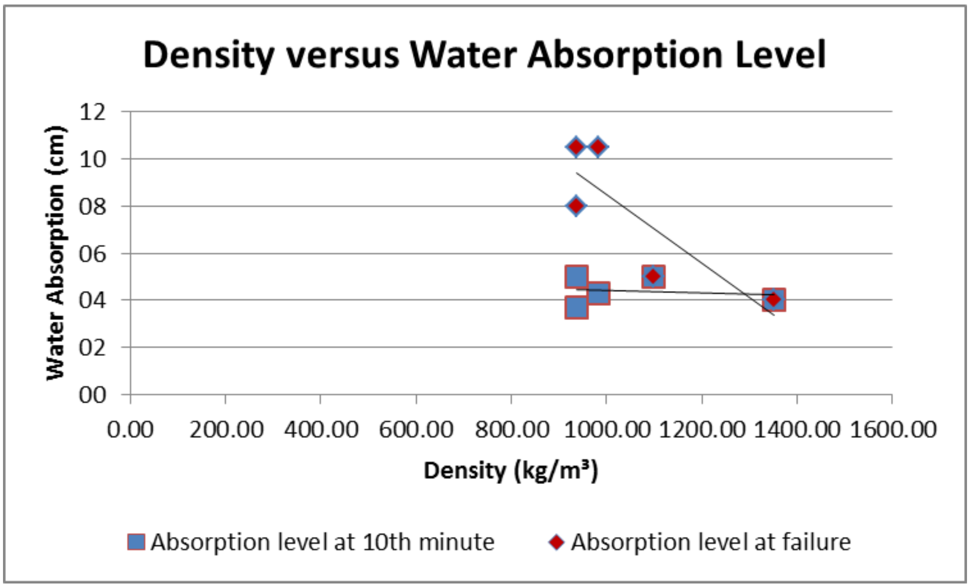

Figure 73: Correlation between density and water absorption level.

In accordance to the literature (Minke 2006), this test shows that fibers increase the resistance of earth material to water penetration and destruction. This is especially true and seen on the mixes PR-SPN-B and PR-LPN-E (same high volume of pine-needles) where the level of water in the samples is only growing up slowly by capillarity after a large increase in the first 10 minutes to reach 5 cm height. (Table 14).

Short fibers also seem to be more efficient to reduce the water capillarity absorption of the samples and to prevent their destruction. The Figure 74 shows it, with the red series being long pine-needles and blue series short pine-needles. For an equivalent density, short pine-needles have a lower level of water and are being destroyed more slowly than long pine-needles samples.

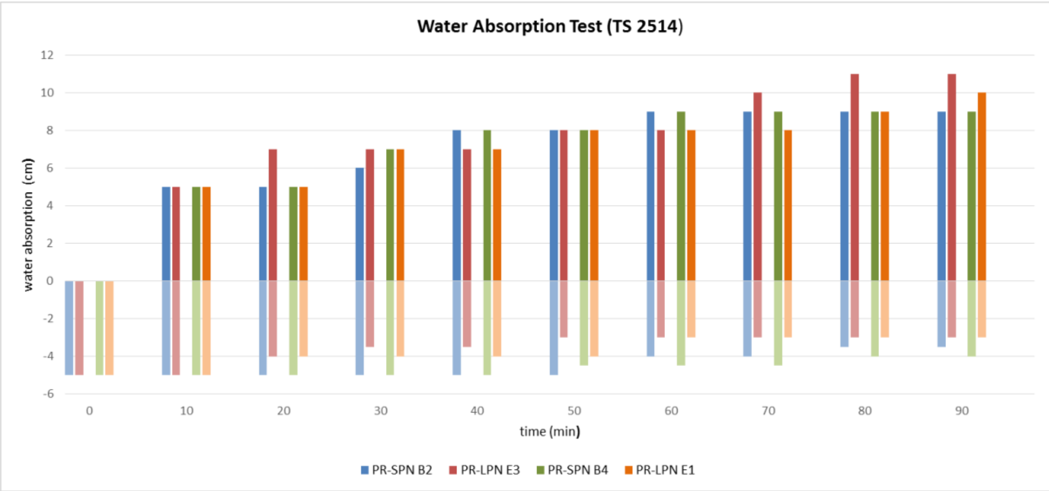

Figure 74: Results of water destruction test for PR-SPN-B2, PR-LPN-E3, PR-SPN-B4 and PR-LPN-E1. The negative numbers describe the length of the immersed part of the sample.

5.3.6. Comparison of pine needles (LPN and SPN)

One of the aims of the experiments was also to compare behaviors of two different types of pine needles, which were named as LPN (*Long Pine Needles*) and SPN (*Short Pine Needles*). Therefore, the comparison of LPN and SPN in terms of shrinkage and density were done (Figure 75). Samples are given with their type of pine-needles and their ratio of earth to pine (1: x). S-0 that was prepared with only mud was put on the figure for comparison. The density and shrinkage values of LPN-1:6 are lower than SPN-1:6. Although density value of LPN-1:8 is higher than SPN-1:8, the shrinkage value is lower. Since it was accepted that density values are irrelevant, the shrinkage values were considered more. According to this comparison, samples of LPN seems more appropriate than SPN, even if the mold sizes are not appropriate for experimenting of these mixtures.

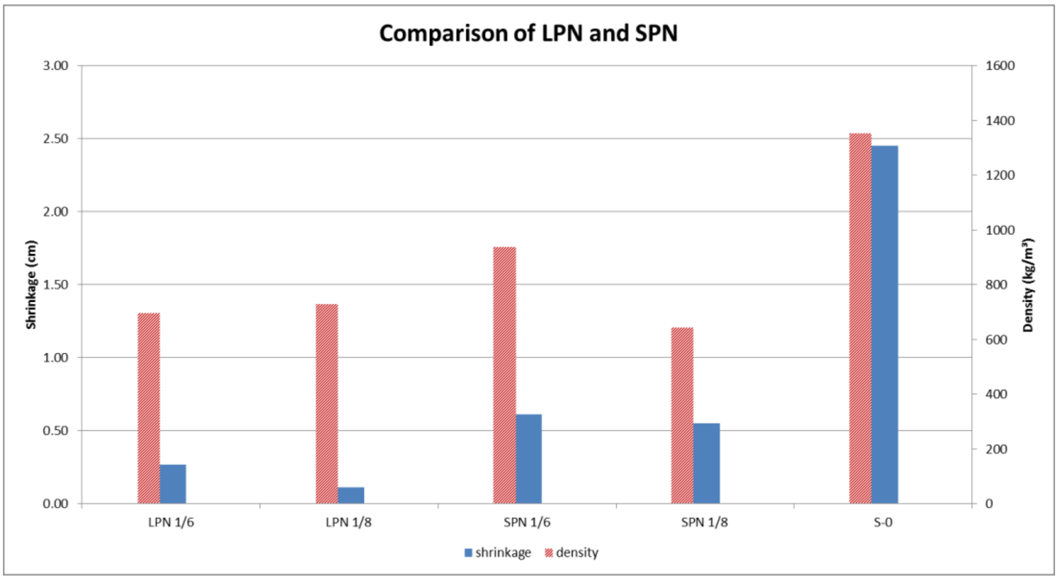

Figure 75: Comparison of LPN and SPN in terms of shrinkage and density

5.3.7. Discussion on the suitability of the mixes

To be able to compare with the authorized values of TS 2514 for water absorption, another table was prepared to show after how many minutes of immersion the samples were failed below 5 cm of water (Table 13).

Table 15 shows the results of the two tests conducted according to the TS 2514. According to the standard, each sample of each mixes should have shrinkage lower than 0.2 cm and a resistance in water longer than 45 min. Results show that mixes PR-LPN-A is not suitable for construction (in terms of water resistance and shrinkage). Despite its reasonable density, PR-SPN-A cannot qualify because of a high shrinkage.

Table 15: Results of water absorption test, density and shrinkage values of mixes are given together with which sample is suitable or not according to TS 2514.

Name	Mean Density (kg/m³)	Failure at (min) :	Shrinkage (cm)	Suitability
PR-LPN-A	1100.00	20	0.29	No
PR-LPN-B	982.50	80	0.05	Yes
PR-LPN-C	936.67		0.18	Yes
PR-LPN-D	696.67	80	0.08	Yes
PR-SPN-A	937.50	70	0.23	No
PR-SPN-B	645.00		0.15	Yes
PR-LPN-E	730.00		0.09	Yes
S-0	1352.50	10	2.28	No

5.4. Physical Properties

The results of the experiments to identify physical properties of pine needle lightweight loam are given and the discussions for each experiment are done.

Table 16 is a summary of the average characteristics of all the pine needle LWL and straw LWL mixes, mud brick, fired brick and AAC with their compositions. Characteristics of pine needle LWL show a wide range of variety because most of the parameters were changed for the production of samples.

In order to better understand this material, tests have been also made on conventional materials – fired bricks, Autoclaved Aerated Concrete (AAC) and mud-bricks – as well as on two type of straw LWL.

The type of loam, viscosity by diameter of slip loam in cm, type of pine needles, unit of pine needles for 1 unit of slip-loam are mentioned on Table 16 as well as the mean shrinkage, dry and cut density and capillary water absorption values of the samples. The table also gives the properties of the other materials tested.

Table 16: Composition and properties of the LWL mixes, mud brick, fired brick and AAC.

Name	Type of Loam	Viscosity of Loam (dia. in cm)	Type of Pine Needles	Unit of Pine Needles for 1 unit of slip loam	Dry and Cut Density (kg/m³)	Shrinkage (%)	Capillarity (mm/√min)
LPN-KERK-1	kerk	15	LPN	4	555	0.63	1.964
LPN-KERK-2	kerk	15	LPN	6	427	1.08	1.393
LPN-KERK-3	kerk	15	LPN	8	359	0.36	1.104
LPN-KERK-4	kerk	10	LPN	8	369	0.44	0.936
LPN-KERK-5	kerk	8.5	LPN	8	389	0.67	0.982
LPN-KERK-6	kerk	5	LPN	8	435	0.61	1.124
SPN-KERK-1	kerk	10	SPN	6	433	1.39	0.919
SPN-KERK-2	kerk	10	SPN	8	304	2.53	0.780
LPN-METU-1	metu	10	LPN	8	537	1.86	1.633
LPN-METU-2	metu	10	LPN	12	369	1.56	1.342
LPN-METU-3	metu	10	LPN	16	260	0.875	1.226
LPN-METU-4	metu	10	LPN	24	219	0.71	0.708
LPN-METU-5	metu	10	LPN	32	184	0.33	0.372
STRAW-KERK-1	kerk	15		6	544		0.982
STRAW-KERK-2	kerk	15		8	254		0.618
Mud Brick					1435		2.99
Brick					1538		1.49
AAC					405		0.449

For each experiment, relationship between density, shrinkage, capillary water absorption and vapor resistivity with type of pine needles and loam, viscosity and amount of pine needles were compared through bar charts.

5.4.1. Density

Two types of densities have been calculated and discussed below. Non-trimmed density is the density of the raw samples whereas trimmed density is the real density of samples after the corners being cut and the size reduced.

i. Definition of the density of samples

The density values of dry samples and the density values of trimmed dry samples showed variation. Except of LPN-KERK-4, LPN-METU-3, LPN-METU-4 and LPN-METU-5, increase of density values on trimmed dry samples can be observed

(Figure 76). The biggest difference on density is at LPN-KERK-2 with 43.67 kg/m3 (10.0%). The smallest difference on density is at LPN-KERK-4 with 2.33 kg/m3 (0.6% lower). The highest non-trimmed density for METU loam may be explained by the highest concentration of clay in the slip which may have flown to the corners and not staid as a binder in the center.

According to this result, it can be assumed that the non-homogeneous distribution of the pine-needles in the corners of the mold (Minke 2006) together with a possible slight expansion once the sample are taken out of the mold affects the volume of the samples. Therefore, for further analyses, density values of trimmed dry samples were assumed as proper densities and used.

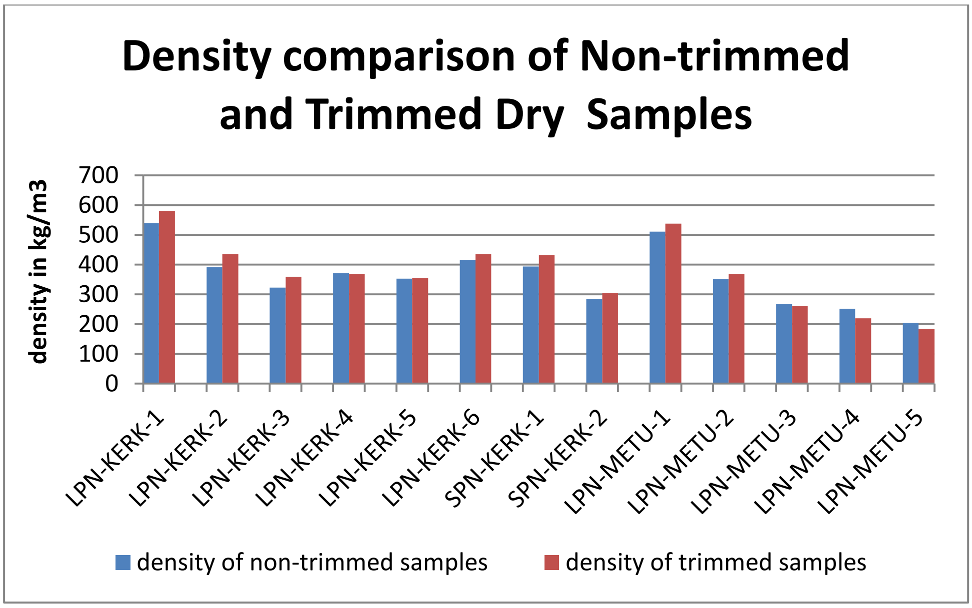

Figure 76: Comparison of density on non-trimmed samples and trimmed dry samples.

ii. Density of mixes

All the samples can be considered as LWL in terms of their densities, as defined by (Minke 2006). The density values are given in the Figure 77. The density of the trimmed dry samples is ranging from 629kg/m3 for the highest to 167Kg/m³ for the lowest, respectively LPN-KERK-1-C with 4 unit of long pine-needles for 1 unit of slip loam and LPN-METU-5-A with 32 unit of long pine-needles for 1 unit of slip loam. Considering the average densities of the mixtures, the highest density is 580.33 kg/m3 in LPN-KERK-1 and the lowest density is 184.33 kg/m3 in LPN-METU-5.

Among the samples prepared with KERK loam the highest density is 580.33 kg/m3 in LPN-KERK-1 and the lowest density is 304.33 kg/m3 in SPN-KERK-2.

Among the samples prepared with METU loam the highest density is 537.33 kg/m3 in LPN-METU-1 and the lowest density is 184.33 kg/m3 in LPN-METU-5.

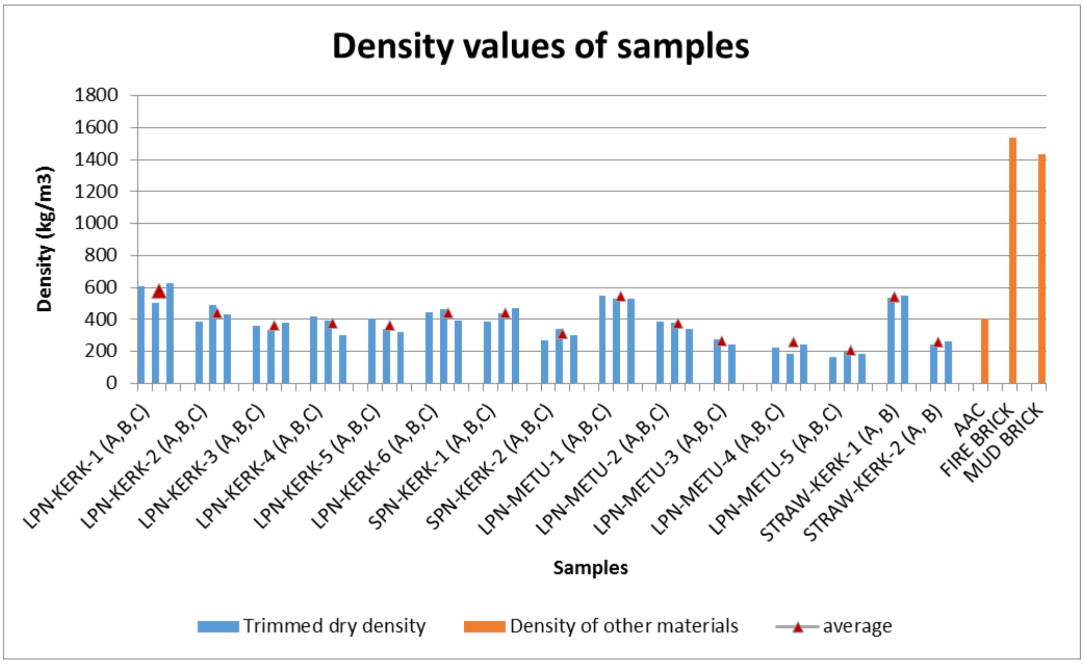

Figure 77: Density values (kg/m^3) of trimmed dry samples.

Densities of AAC block, fire brick and mud brick were measured accordingly as 405 kg/m3, 1538 kg/m3 and 1435 kg/m3. Average densities of STRAW-KERK-1 and STRAW-KERK-2 were measured accordingly as 543.5 kg/m3 and 253.5 kg/m3.

Although the results give a rough assumption of the relation between density, type of pine needles and the amount of pine needles, it can be said that amount of pine-needles and type of loam are the most important parameters on density. Therefore, analyses on following sections have been done to find out accurate relation between density and other parameters.

iii. Influence of the amount of pine-needles

Figure 78 shows the relation between density and amount of pine needles of mixes. To be able to make this comparison, two sets of mixes were chosen and in each set, mixes have the same type of loam, pine needles and the viscosity of slip loam but have a variable on the amount of pine needles:

- LPN-KERK-1, LPN-KERK-2, LPN-KERK-3 are compared which have 15 cm diameter viscosity and respectively 4, 6, 8 unit of pine needles.
- LPN-METU-1, LPN-METU-2, LPN-METU-3, LPN-METU-4, LPN-METU-5 are compared which have 10 cm diameter viscosity and respectively 8, 12, 16, 24, 32 volume of pine needles.

It can be seen that increase on the amount of pine needles has a lowering effect on density. It can also be observed that the relation between density and amount of pine-needles is weak, but the density is decreasing less than the increase of pine-needles due to its own density.

Correlation between two sets cannot be observed since the type of loam, viscosity and the amount of pine needles are different but a similar trend can be observed.

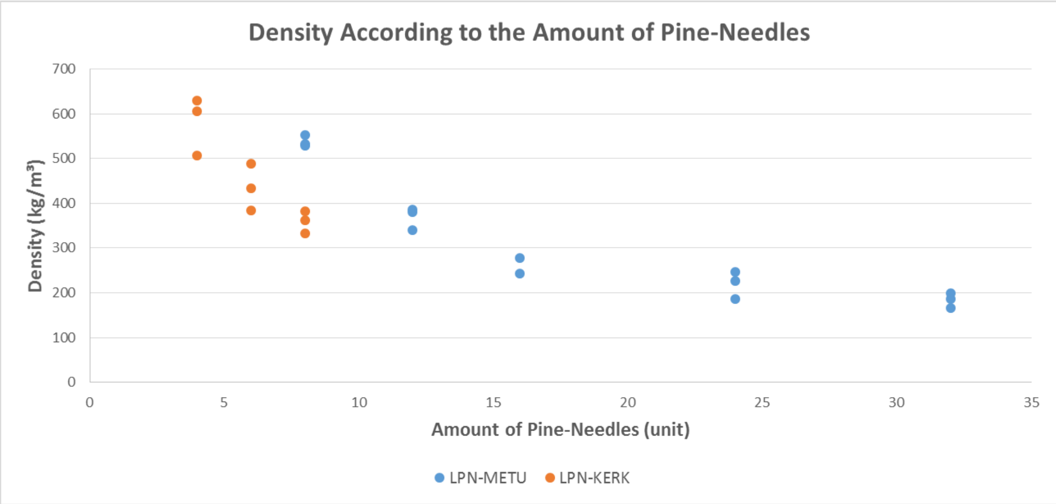

Figure 78: Relation between density and amount of pine needles.

iv. Influence of the viscosity of slip loam

To be able to define the correlation between density and the viscosity of loam used in samples, LPN-KERK-3, LPN-KERK-4, LPN-KERK-5, LPN-KERK-6 mixes that have the same type and amount of pine needles and soil but different viscosity of loam were compared in terms of their viscosity and density (Figure 79). Although a certain relation cannot be observed, it can be seen that density slightly decreases while the viscosity of the loam used increase.

The comparison of samples with same amount of pine-needles but different viscosity of loam shows that there is an increasing range of density in the samples when the viscosity gets lower. The samples with a loam viscosity of 15 cm having a range of 49kg/m³ on density while the samples with a viscosity of 5 cm having a range of 118kg/m³ on density. (Figure 80). According to this result, it may be said that the more the slip loam is liquid, the more it mixes equally with pine needles by resulting more homogenous mix.

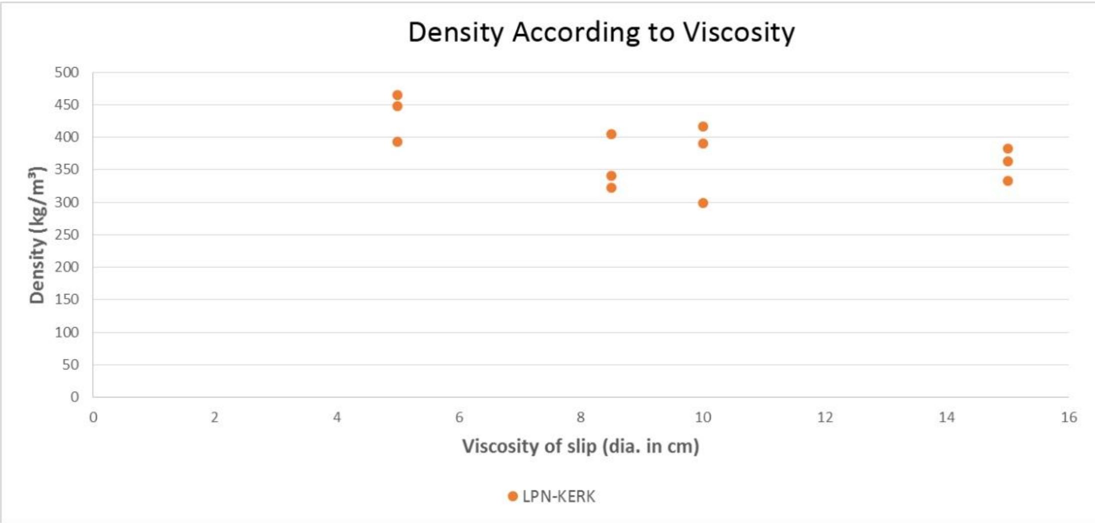

Figure 79: Relation between density and viscosity.

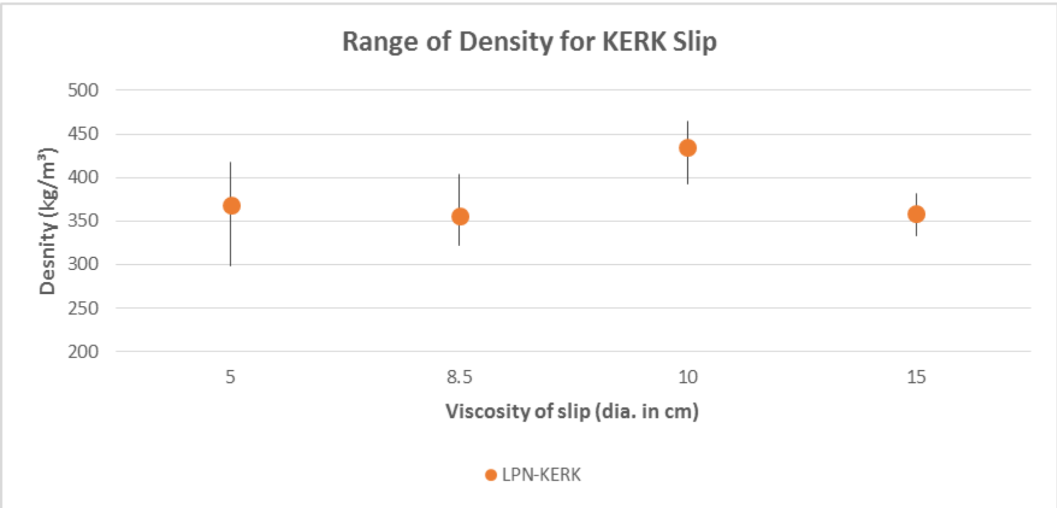

Figure 80: Range of density for KERK slip with same amount and type of pine-needles

v. Influence of the type of loam and fibers

Density comparison of LPN-KERK-6, SPN-KERK-2 and LPN-METU-1 was done (Figure 81) together with a comparison of LPN-KERK-3 and STRAW-KERK-2. Since the two sets of material have the same amount of fibers (1/8 volume) and same viscosity of slip loam (respectively 10 cm diameter and 15 cm diameter), the aim was to find out the influence of type of loam and type of fibers on density. It can be said that both- the type of loam and the type of fibers- affects the density of mix.

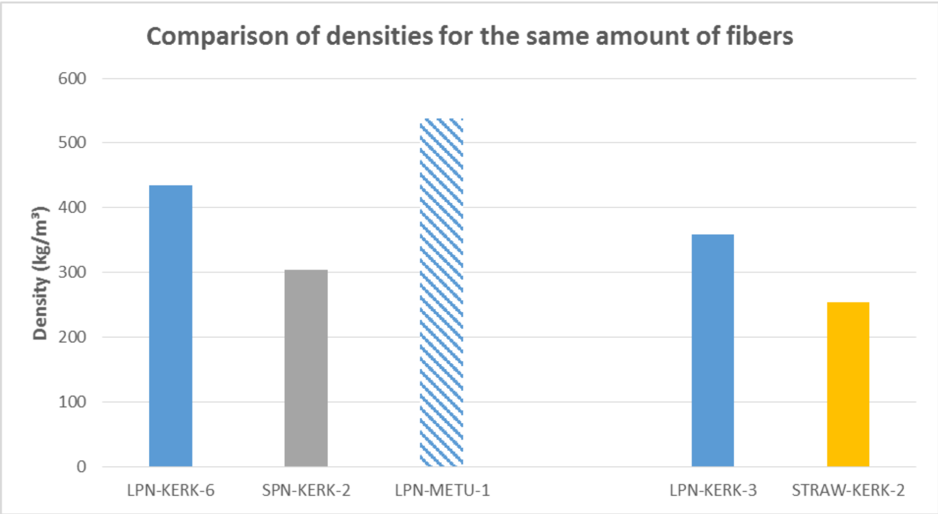

Figure 81: On the left, density comparison of LPN-KERK-6, SPN-KERK-2 and LPN-METU-1 which have the same amount of pine needles (1/8 u.) and same viscosity of slip loam (10 cm diameter). On the right, density comparison of LPN-KERK-3 and STRAW-KERK-2 with same amount of fiber (1/8 u.) and viscosity (15 cm diameter).

vi. Summary of the results

In summary, the density of LWL is closely depending on the amount of fibers in the mix as well as on the type of loam. However, it has been shown that the viscosity of the loam doesn't have a clear effect on the density but it affects the workability and reproducibility of the material. The type of fiber is also an important parameter, especially in the case of totally different fibers such as straw or pine-needles.

5.4.2. Shrinkage

The values of shrinkage are presented in a first part and their impact of the amount of fibers, density and viscosity of the slip on the material is presented.

i. Definition and results

Since the samples were prepared manually by the researcher, percentage of shrinkages on length, width and height of samples presented a large diversity. Therefore, each of them was analyzed to designate the most appropriate one to be used on further analyses. Also the average shrinkage percentage was calculated. The results are presented on Table B.3, Table B.4 and Table B.5 in Appendix B together with the average and range of shrinkage. Comparison of average shrinkage is presented in the Figure 82.

The shrinkage on length ranges between 0.33% on LPN-METU-5 and 2.53% on SPN-KERK-2. The shrinkage on width ranges between 0.33% on LPN-KERK-2 and 2.28% on LPN-METU-2. The shrinkage on height ranges between -5.75% (expansion) on LPN-METU-5 and 2.83% on SPN-KERK-2. Finally the average shrinkage of sample sides ranges between -1.38% on LPN-METU-5 and 2.1% on SPN-KERK-2. According to these results, usage of shrinkage on the width was not considered as relevant.

According to the shrinkage data, increasing expansion of the samples are seen on LPN-METU-2, 3, 4, 5. Since two volumes of mix were compressed in one volume of mold, the expansion occurs on height even taking the samples out of the mold after 12 hours. The quantity of expansion is directly related with the amount of pine needles.

Figure 82 shows the average shrinkage of the sample as defined above.

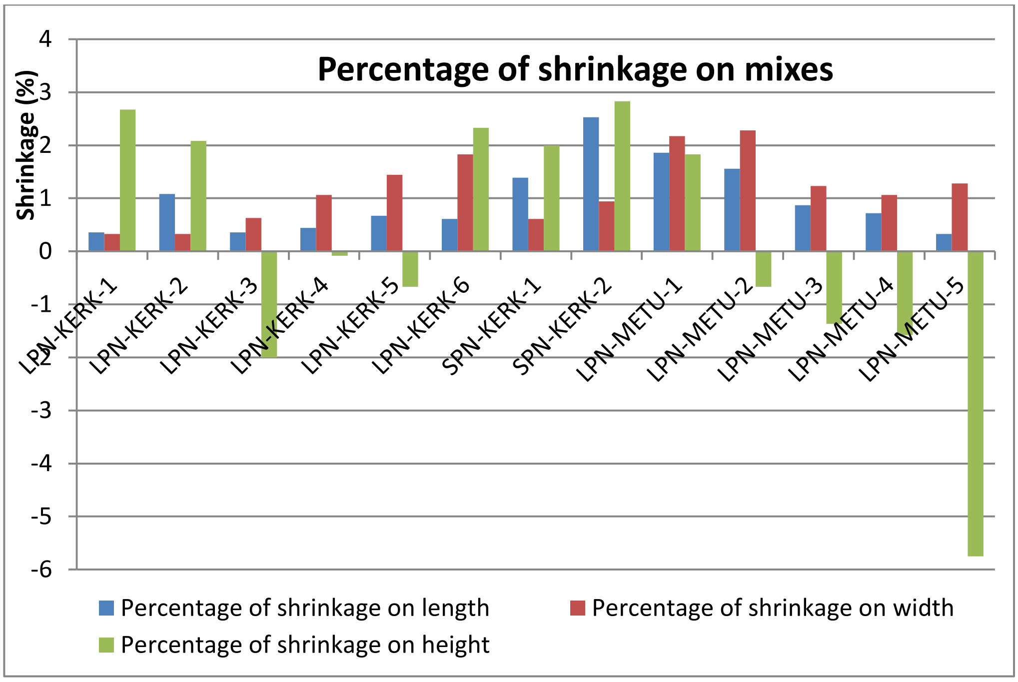

Figure 82: Percentage of shrinkage on length, width and height of each mix.

Figure 82 shows that on LPN-METU-1, 2, 3, 4, 5 samples, shrinkage on width decreases respectively while the amount of pine needles in samples decreases. Although there is a fluctuation on the shrinkage on length, it shows a tendency to decrease. Percentage of shrinkage on length for LPN-KERK-3, 4, 5, 6 samples with same volume of pine needles and different viscosity of slip loams (respectively15, 5, 8.5, and 10 cm) tend to decrease. These results show that samples with high viscosity of slip loam –which contain less loam-, shrink less compared to the samples with low viscosity of slip. Percentage of shrinkage on height does not give any reliable result.

Shrinkage on height follow similar decreasing behavior when checked on LPN-KERK-1,2,3 and LPN-METU-1,2,3,4,5. However, as the mixes contain more pine-needle, expansion is observed. Since two volumes of mix were compressed in one volume of mold, the expansion occurs on height even taking the samples out of the mold after 12 hours. The quantity of expansion is directly proportional with the amount of pine needles.

Interestingly, the comparison of SPN-KERK-1 and 2 shows that the percentage of shrinkage on length, width and height increase when the amount of pine needles increases. The shrinkage data is compared with the density to understand if the short-pine needles have an adversary effect on shrinkage.

ii. Influence of the volume of pine-needles and density

Figure 83 shows the samples' shrinkage according to the amount of pine-needles. The mixes made with METU loam and long-pine needles show a typical behavior with the shrinkage getting smaller as the proportion of pine-needles raises. The trend line with 0.8211 of R^2 value also discloses the high relation between shrinkage and the amount of pine needles. In the opposite, the spread of the LPN-KERK samples shows that the proportion of pine-needles doesn't directly affect the shrinkage. This behavior is even clearer when the shrinkage is plotted against the density (Figure 84). But as it has been seen previously, the range of density of LPN-KERK mixes is large especially with a low proportion of pine-needles. It may be due to the non-homogeneity of used LPN-KERK samples. It is possible to get such results on samples that are prepared manually directly on site.

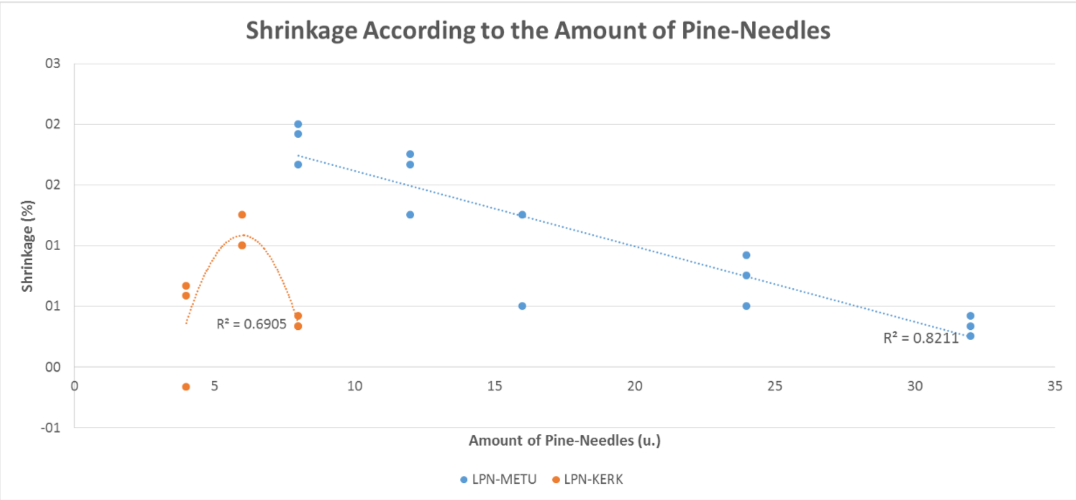

Figure 83: Comparison of average shrinkage and pine needles by using samples of LPN-KERK (1, 2, 3) and LPN-METU (1, 2, 3, 4, 5). In each set of samples, type of slip loam, PN and viscosity are the same, only the volume of PN is variable.

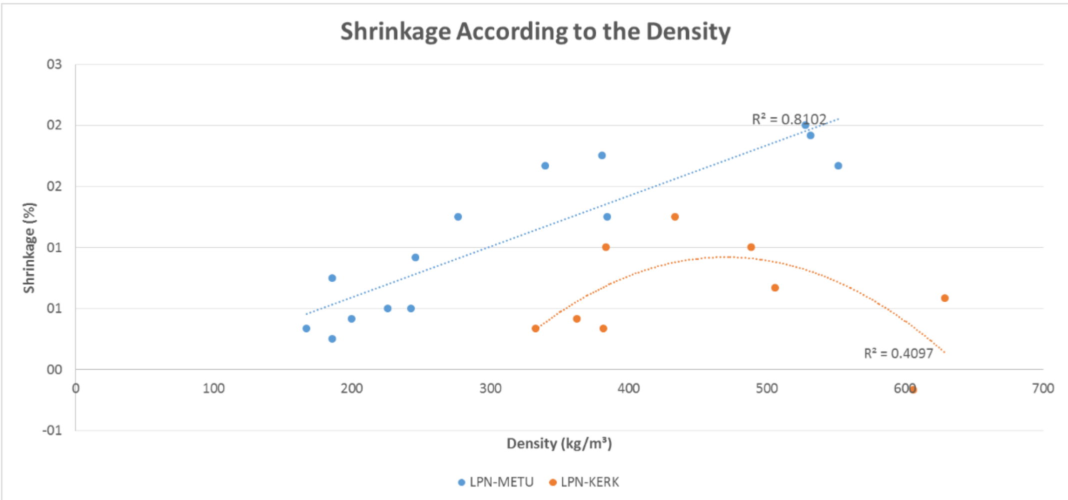

Figure 84: Comparison of average shrinkage and density by using samples of LPN-KERK (1, 2, 3) and LPN-METU (1, 2, 3, 4, 5). In each set of samples, type of slip loam, PN and viscosity are the same, only the volume of PN is variable.

iii. Influence of the viscosity

Another chart is prepared to identify the relation between shrinkage and viscosity of slip loam (Figure 85). There is a wide range of shrinkage values on each mix but from the average shrinkage values it can be seen that while the viscosity of slip loam on LPN-KERK samples increase, the shrinkage value decreases. Nevertheless, number of samples that were analyzed is not enough to identify a clear relation between shrinkage and viscosity of slip loam on this research.

iv. Influence of the type of loam and type of pine-needles

Figure 86 is prepared to see the influence of type of pine needles and slip loam on shrinkage. As it is seen, shrinkage of LPN-KERK-6 (0.4%) is lower than shrinkage of LPN-METU-1 (1.9%). This result shows that the type of loam –especially the percentage of clay and sand- has a big impact on shrinkage. Also SPN-KERK-2 has a much higher shrinkage value (2.5%) than LPN-KERK-6. It can be understood that long pine needles (LPN) help to avoid too much shrinkage compared to short pine needles (SPN).

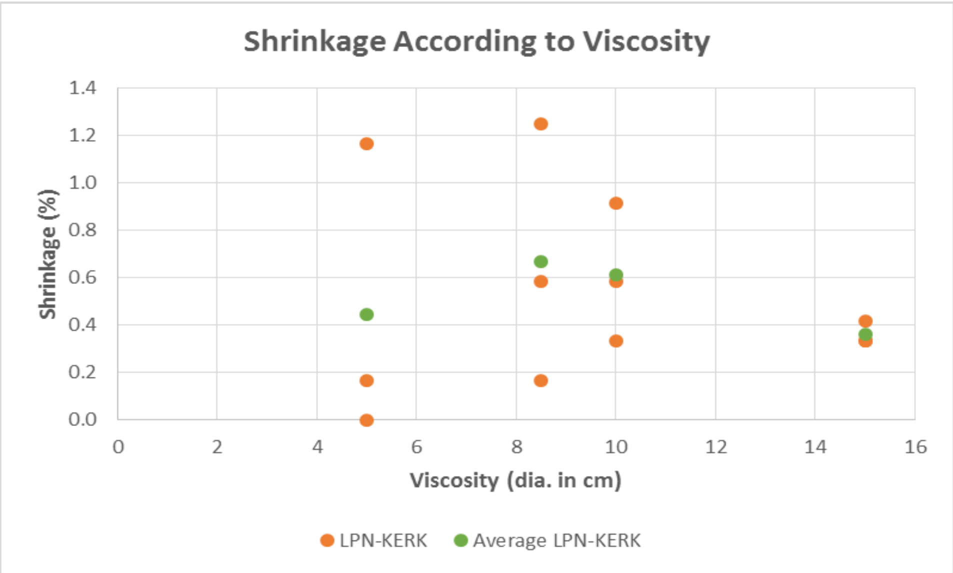

Figure 85: Comparison of average shrinkage and viscosity of slip loams by using samples of LPN-KERK (3, 4, 5, 6). In this set of samples, type of slip loam, type and volume of PN are the same, only the viscosity of slip loam is variable.

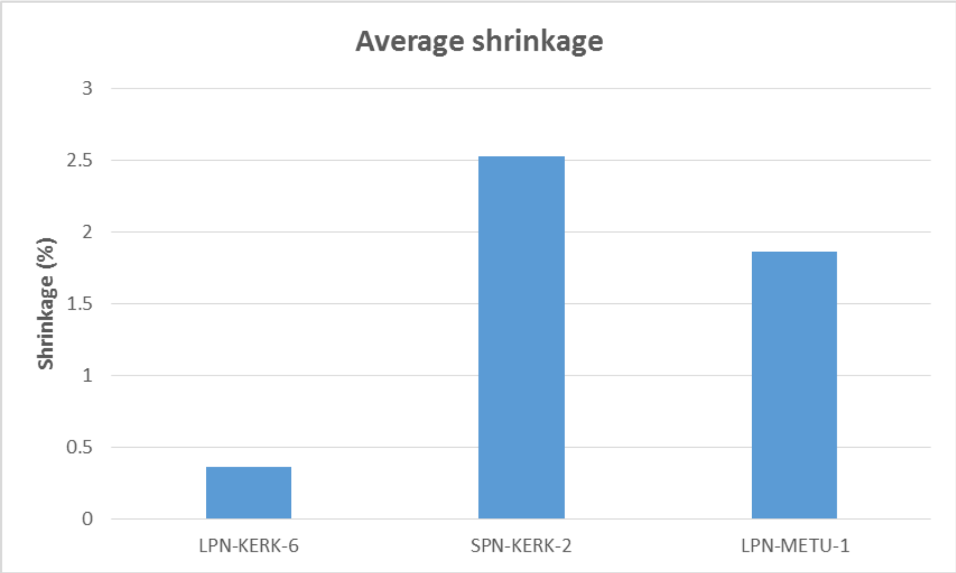

Figure 86: Comparison of shrinkage with type of pine needles and slip loam. LPN-KERK-4 and LPN-METU-1 have 10 cm diameter viscosity and 1/8 volume of PN but different type of slip loam. SPN-KERK-2 has 10 cm diameter viscosity and same volume of PN (1/8) with LPN-KERK-4 but different type of PN.

v. Summary

The most important factor in reducing the shrinkage is increasing the amount of pine-needles in the mix. However, a too large proportion of pine-needles in the mix may have adverse effect on shrinkage (if blocks are considered) since the material starts to expand by reacting against the vertical compression it has taken.

The type of pine-needle and the type of loam also seems to have a large effect on the shrinkage of the material. Long-pine-needles seem to be more appropriate than short ones.

Also mixes prepared with METU loam (as a more clayey material) have a higher shrinkage.

5.4.3. Capillary Water Absorption

Capillary water absorption results of each sample are given together with the average values of all the mixes (Figure 87). Maximum CWA (Capillary Water Absorption) of samples is 2.01 kg/m2h0.5 for LPN-KERK-1-C and minimum CWA is 0.26

kg/m2h0.5 for LPN-METU-5-C. Maximum CWA of mixes is 1.87 kg/m2h0.5 for LPN-KERK-1 mix and minimum CWA of mixes is 0.32 kg/m2h0.5 for LPN-METU-5 mix. CWA is ranging from 1.87 kg/m2h0.5 to 1.17 kg/m2h0.5 for LPN-KERK (4 to 8 units of pine-needles) and 1.56 kg/m2h0.5 to 0.32 kg/m2h0.5 for LPN-METU (8 to 32 units of pine-needles).

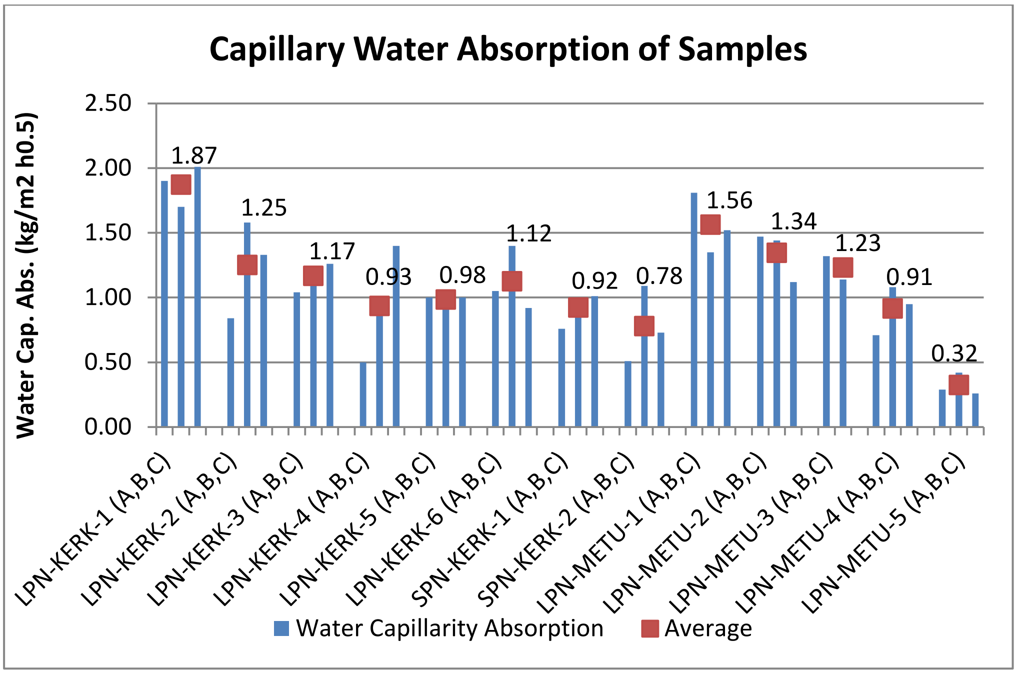

Figure 87: Capillarity water absorption values of each sample and average CWA values of each mix is given.

i. Influence of the amount of pine-needles and density

Figure 88 and Figure 89 show that the amount of pine needles and the density of material have a significant effect on water absorption of the sample. It can be seen that with the same viscosity of slip loam of samples, the increase of pine needle volume helps to absorb less and less water. Trend line of LPN-KERK samples show a more sudden decline compared to LPN-METU samples trend line. This may be the result of the difference of density of the material, with the LPN-KERK-3 having a very lower density than the LPN-METU-1 for the same proportion of pine-needles.

Even if the relation is weak the trend is to get a higher WCA with higher density, as underlined also by Minke (2006). Moreover, the equation of the trend lines on Figure 89 shows that both lines are almost parallel so that the capillarity is almost only depending on the density.

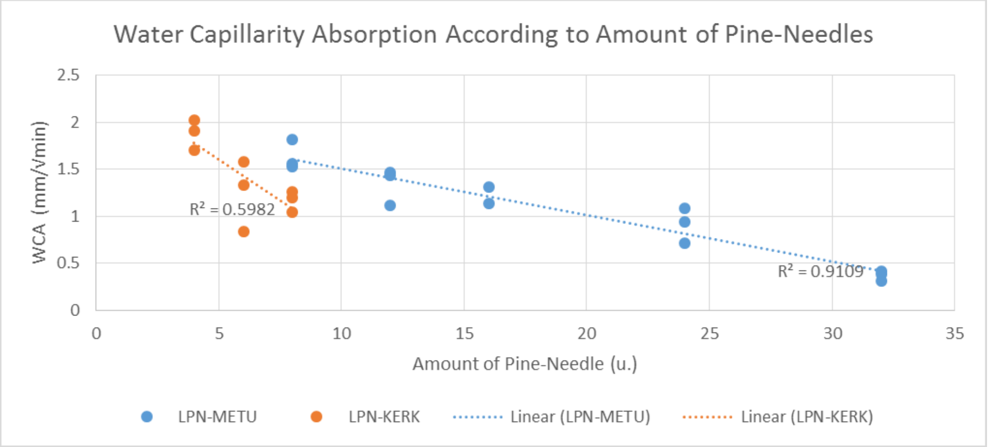

Figure 88: The relation between water capillarity and amount of pine needles. The comparison is made of sample sets with same type of loam, pine needles and value of slip viscosity but varying pine needle quantity.

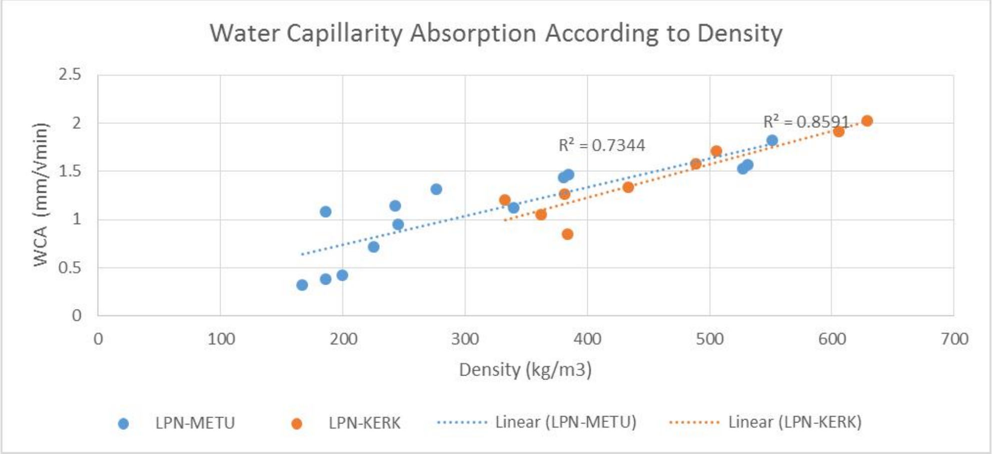

Figure 89: The relation between water capillarity and density. The comparison is made of sample sets with same type of loam, pine needles and value of slip viscosity but varying pine needle quantity.

ii. Influence of viscosity

Figure 90 shows the effect of viscosity on water capillary absorption by comparing LPN-KERK samples with 8 v. of PN and varying viscosity of slip loam. The results show that there is no direct relation between viscosity of the slip and water capillarity.

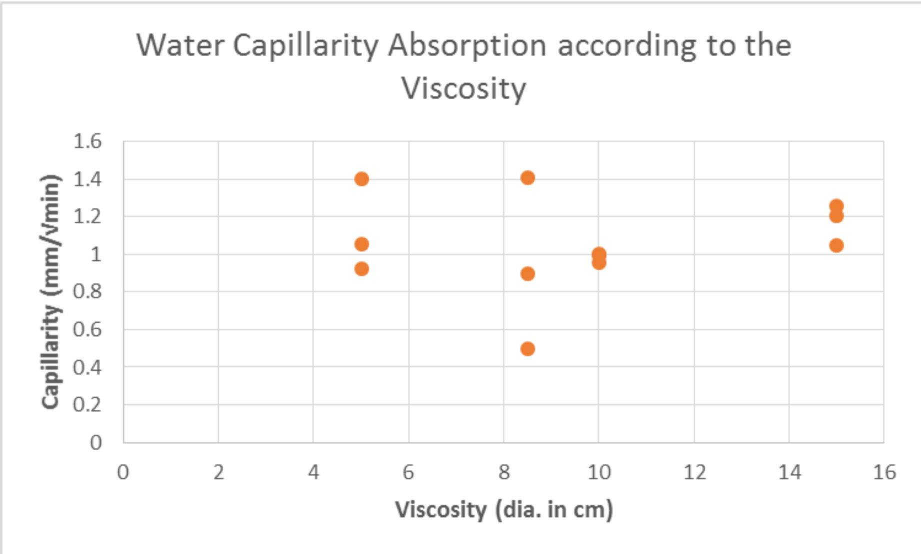

Figure 90: It shows the relation between water capillarity absorption and liquidity of slip loam by comparing their viscosity. Samples with same type and amount of pine needles, soil but different viscosity of slip loam are used.

iii. Influence of the type of loam and type of pine-needles

Figure 91 shows the comparison on CWA values of mixes with same amount of pine-needles but different materials (short and long pine-needles, KERK and METU Loam). In average, mixes with LPN absorb more water compare to mixes with SPN (16%), while mixes with METU loam absorb more water (43%) compare to mixes with KERK loam. The type of loam is influencing more than the type of pine-needles. On the other hand, according to previous results and Figure 92, capillary water absorption may be more directly related to the density of the studied samples since LPN-METU-1 has a higher density than LPN-KERK-6.

On the other hand, STRAW-KERK-2 and LPN-KERK-3 are compared which have same amount of fibrous materials and soil but different type of fibrous materials. The effect of density on CWA can also be seen on this comparison. It can also be said that mixes with LPN tends to absorb more water and creates a mix with higher density.

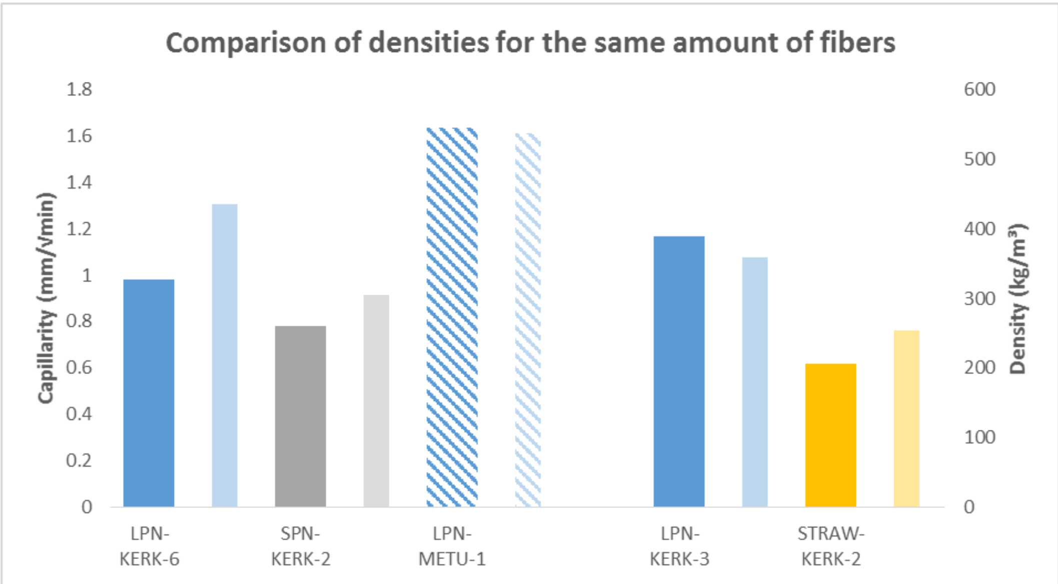

Figure 91: Comparison on CWA values of LPN-KERK-6, SPN-KERK-2 and LPN-METU-1 mixes are done. First columns of each set represent CWA values, while the second columns of each set represent density values.

iv. Comparison with other materials

The Figure 92 shows the average CWA of the different samples together with other typical building materials – locally produced fired bricks, AAC (400kg/m³), and local mud-bricks (coming from a nearby destroyed house) – as well as 2 type of straw LWL. As comparison, the data taken from Minke (2006) are plotted in the graph. It can be seen that whereas the density and CWA of fired bricks and mud-bricks are very high, the average CWA of AAC and straw LWL (research data) are in the same range than pine-needle LWL. Data from Minke (2006) differ probably because of the testing set-up. However, with the densities of straw LWL of both experiments being close to the ones of pine-needles LWL, it can be assumed that the pine needles LWL and straw LWL have close properties despite having different type of fillers but their properties are different from other type of fillers such as mineral.

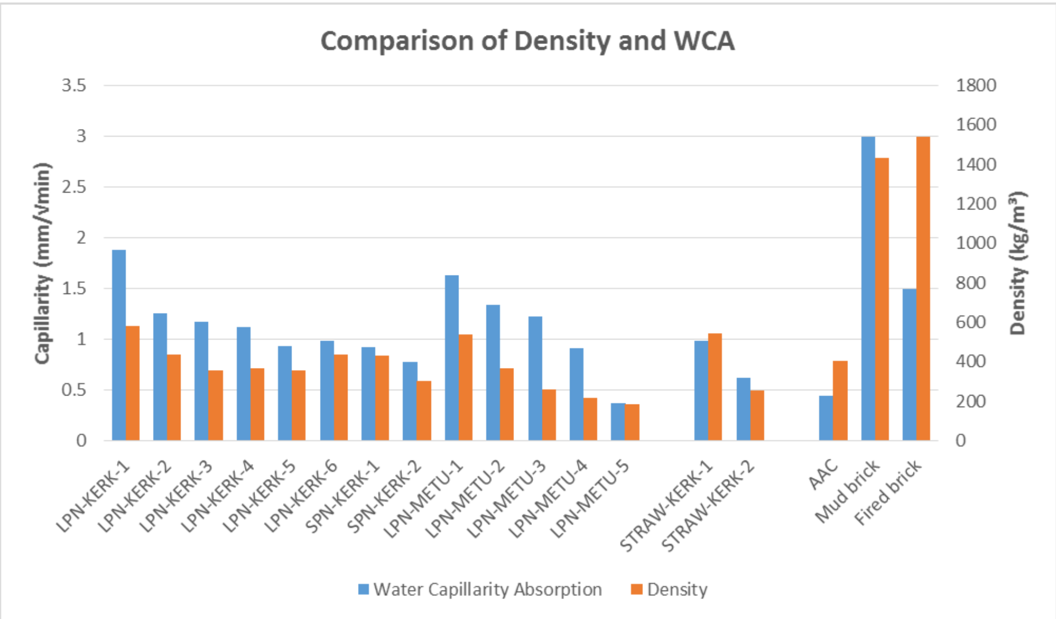

Figure 92: It shows the relation between water capillarity absorption and density. The comparison of all the mixes and AAC, fire brick and mud brick are done.

v. Physical observations

A last feature of some sample is their behavior when wet. Samples with low density tend to separate and lose their cohesion after they reach high water content. This behavior was especially observed on samples LPN-METU-5 and SPN-KERK-2 but also mud-brick and at a lower degree on LPN-METU-4. This may be due to the duration of the test.

The experiments showed that the densities of the samples are important to define their capillarity even if there is no direct relation between the density and water absorption. For different composition of the material it has been also seen that samples made of SPN has a lower capillarity but also a lower cohesion. Nevertheless, the capillarity of the LWL samples is close to other building materials like mud bricks or fire bricks. Only AAC has a really low capillarity.

5.5. Material Performance

In this section, the hygric properties and thermal performance of the light weight loam samples are discussed. To this end the vapor resistivity measurements and thermal data (tempertature and humidity measurements) are explained in the following sections.

5.5.1. Vapor Resistivity

Table 17 summarizes the results of vapor resistivity test for pine-needle LWL and straw LWL. Also a chart has been prepared (Figure 93) to compare relative humidity (RH) values of LPN-KERK-2-C, LPN-KERK-3-A, LPN-KERK-6-A, SPN-KERK-2-B, LPN-METU-1-A, LPN-METU-2-A, LPN-METU-4-A and STRAW-KERK-2. Some general observations can be made from this first figure which are:

a- All the samples demonstrate similar behavior – within a 12% RH range – when they are subjected to fast change of humidity level.

b- During a short period of time with cyclic changes of humidity, the RH values of samples also fluctuates with delay but the range is smaller than exterior RH value.

c- During a long period of time, the RH values of samples decrease and tend to reach average exterior RH value.

However, due to the short duration of the experiment, humidity balance in the samples has not been reached and just trends have been recorded.

Table 17: Relative Humidity and Density Values of Test Samples. RH values are presented separately for two phases of the experiment: high humidity ambient during first 36 hours and low humidity ambient during last 36 hours. Also external humidity and density values of samples are given for comparison.

		Duration							
		High Humidity in % (first 36 hours)				Low Humidity-cyclic changes- in % (last 36 hours)			
	Density	Max.	Min.	Range	Average	Max.	Min.	Range	Average
External Humidity	x	73.80	57.13	16.66	66.39	52.28	8.21	44.07	29.32
LPN-KERK-2-C	489.00	62.20	56.70	5.50	60.22	62.70	31.70	31.00	41.95
LPN-KERK-3-A	363.00	57.10	51.80	5.30	54.71	58.50	35.00	23.50	43.47
LPN-KERK-6-A	448.00	57.00	51.70	5.30	54.48	58.00	32.60	25.40	39.40
SPN-KERK-2-B	339.00	59.20	54.80	4.40	56.89	59.60	33.30	26.30	43.47
LPN-METU-1-A	552.00	54.90	53.20	1.70	54.14	53.70	41.20	12.50	46.95
LPN-METU-2-A	385.00	50.00	48.10	1.90	48.96	50.40	33.70	16.70	40.44
LPN-METU-4-A	226.00	59.60	55.60	4.00	57.64	60.10	33.80	26.30	42.70
STRAW-KERK-2	254.00	69.30	60.00	9.30	66.34	71.10	36.80	34.30	47.32

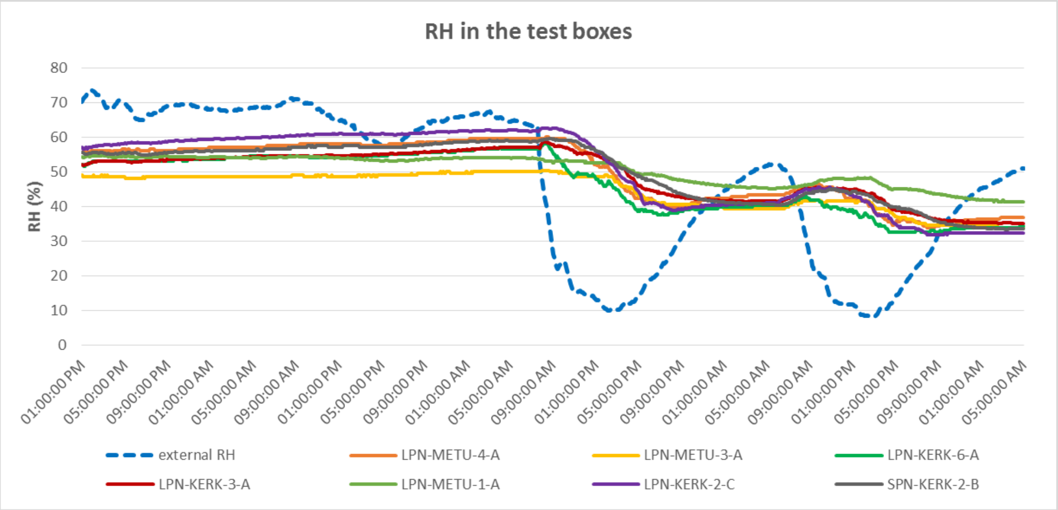

Figure 93: Humidity level in the test boxes.

i. Vapor resistivity of samples

The vapor resistivity of samples is summarized at Figure 94 and Figure 95 according to the level of humidity in high humidity period (between 50% to 70% RH) and low humidity period (between 5% to 55% RH). In case of external humidity level between 50% to 70%, samples LPN-METU-1, 2 have higher humidity resistivity than other samples since their relative humidity is 54.14% and 48.96% in average with low range of humidity difference whereas the exterior humidity level was 66.39% in average with peaks until 73.80% during 36 hours. This outcome is reinforced by the fact that in case of cyclic changes of humidity (green line on the Figure 94), the same samples still have the lowest range of variations 12.50% and 16.70% respectively for LPN-METU-1-A and LPN-METU-2-A whereas the exterior humidity is ranging from 8.21% to 52.28%.

The lowest resistivity is seen on the sample LPN-KERK-2-C with a range of 31.00% and a low humidity average. This shows that the exterior changes are impacting the interior air. For all samples, it can be seen than in case of cyclic changes, despite having a buffering and moderating effect, the material still allows transfer of humidity.

ii. Influence of density

Influence of density on vapor resistivity is searched by comparing LWL mixes both in high humidity period (between 50% to 70% RH) and low humidity period (between 5% to 55% RH) in Figure 94 and Figure 95. It can be seen that the vapor resistivity is higher with a high density (for the sample LPN-METU-1-A, the difference between RH during high humidity period and low humidity period is 7.2% whereas for the sample LPN-METU-4-A, it is 14.9%) and the range of sample LPN-METU-1-A is smaller than the range of sample LPN-METU-4-A for both periods. However, these results are only for one type of clay and a generalization may be difficult to be done since for the samples LPN-KERK-2-C and LPN-KERK-3-A, the behavior seems to be different.

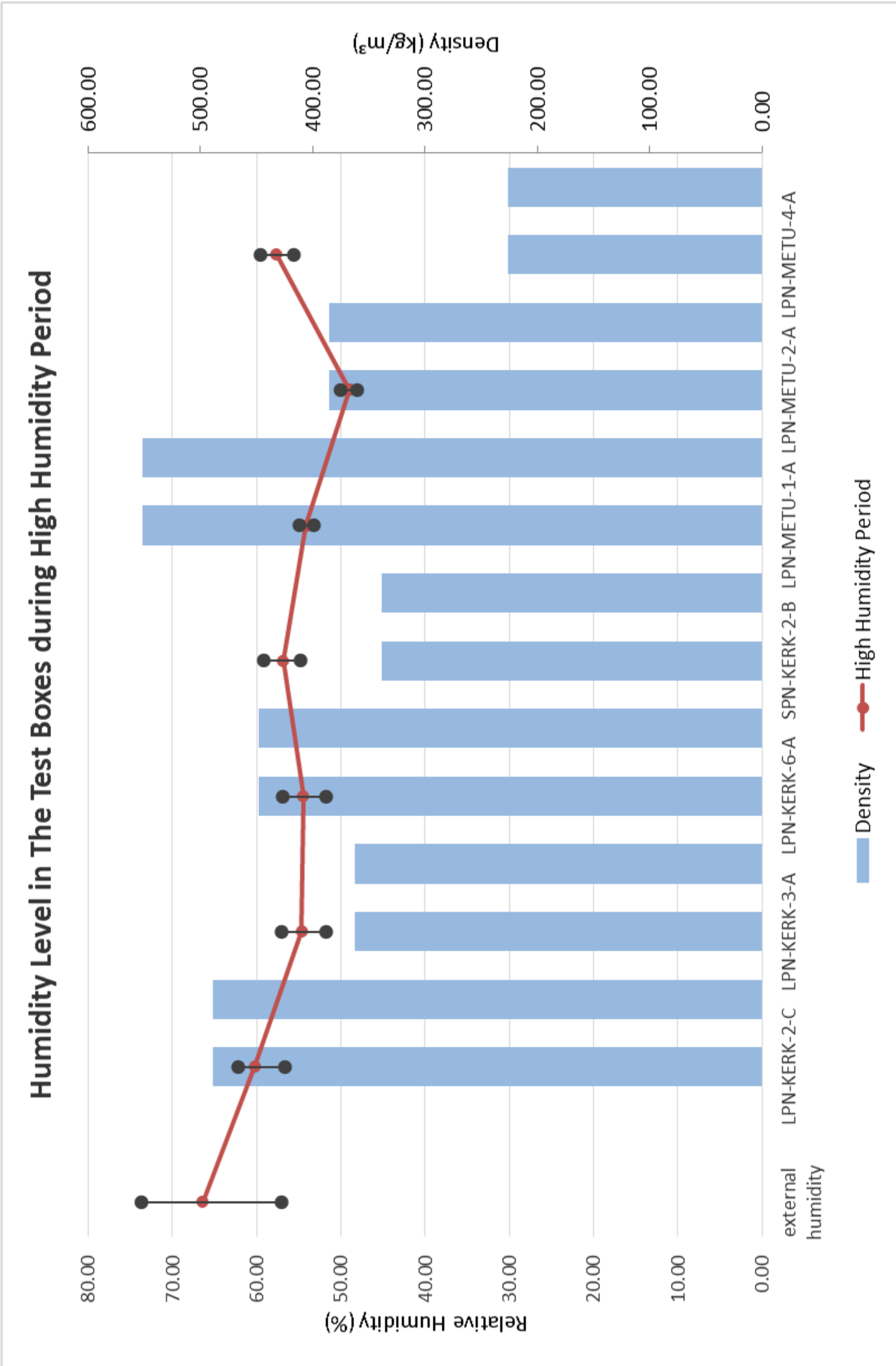

Figure 94: Relative humidity comparison of pine-needle LWL samples during high humidity period. The red trend-line represents the RH values of samples during high humidity period. Also the range and average of RH and density values of each sample are given.

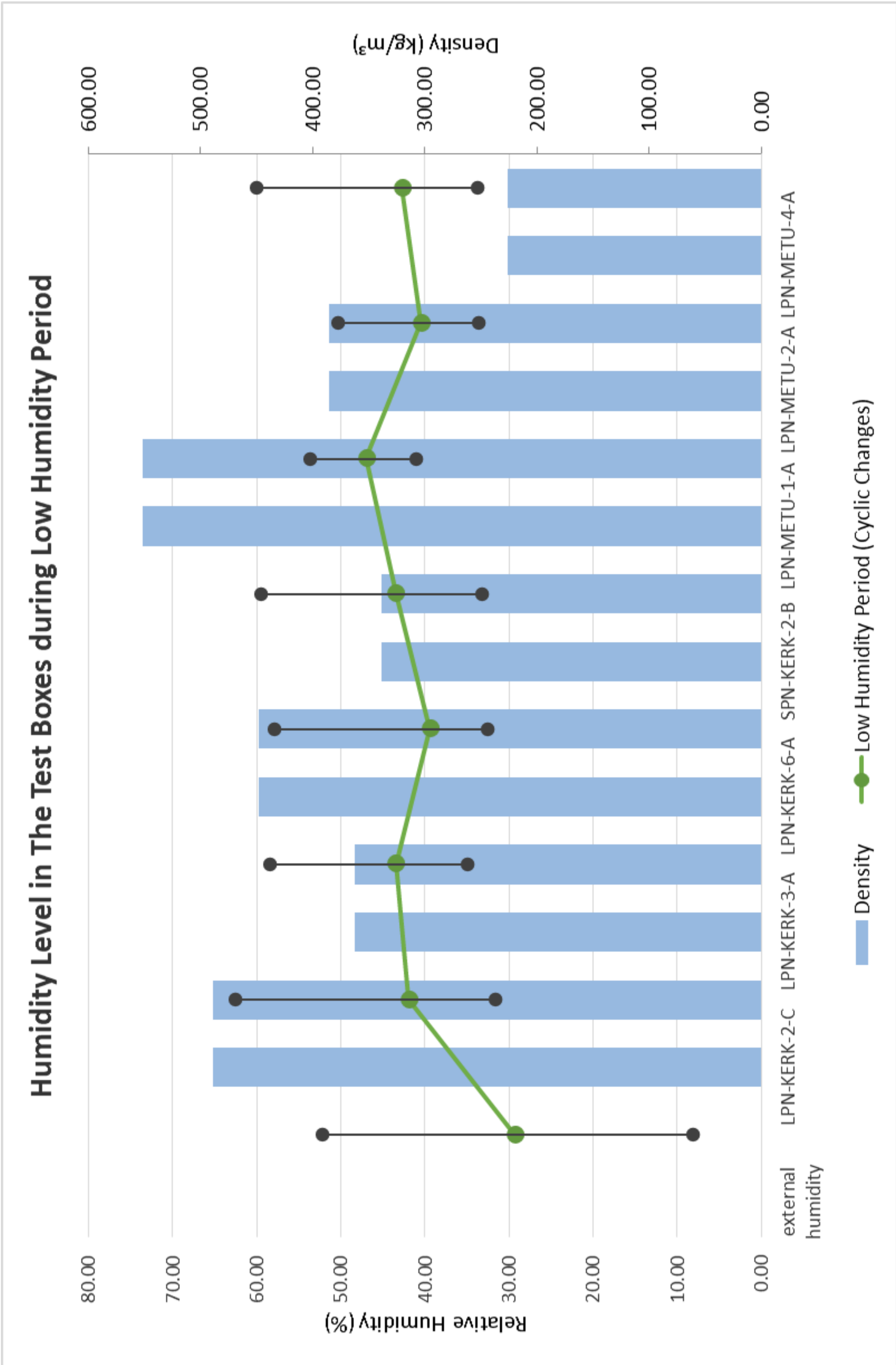

Figure 95: Relative humidity comparison of pine-needle LWL samples during low humidity period. The green trend-line represents the RH values of samples during low humidity period. Also the range and average of RH and density values of each sample are given.

ii. Influence of the materials

The RH comparison in high and low humidity periods between samples of LPN-KERK-3-A, SPN-KERK-2-B and LPN-METU-2-A which have a similar density but different composition show that the type of loam/viscosity of slip and type of fibers are very influent on the vapor resistivity of the material and that sample with METU loam have a smaller range of RH (Figure 96 and Figure 97).

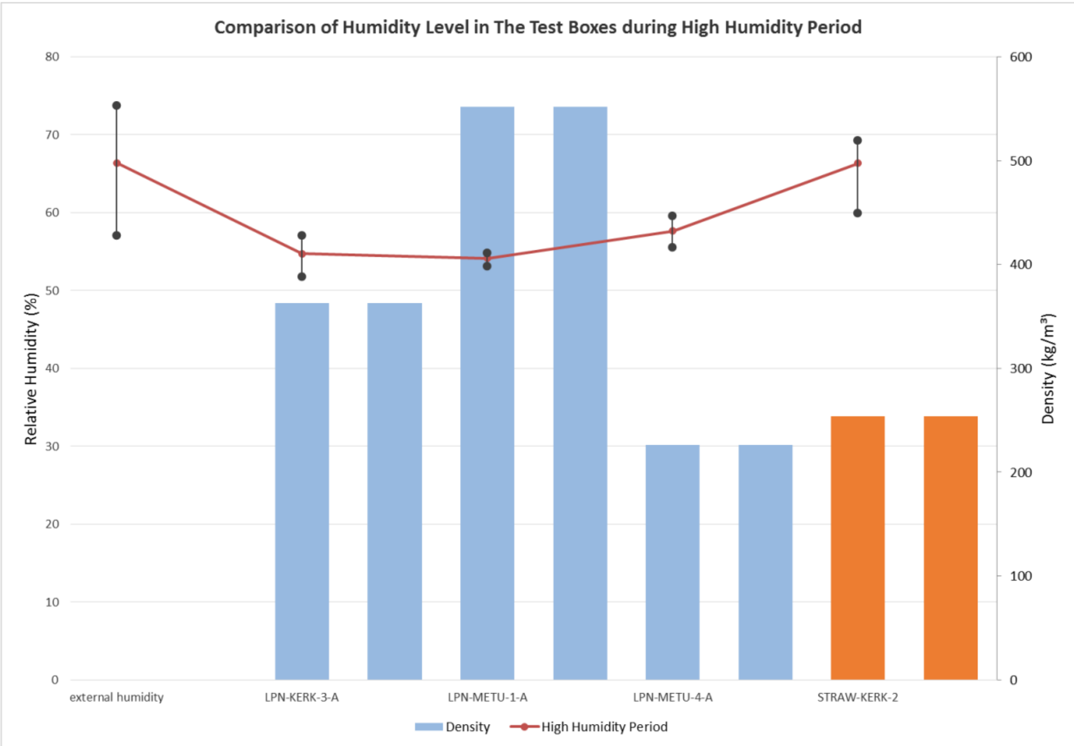

Figure 96: Relative humidity comparison of LPN-KERK-3A, LPN-METU-1-A, LPN-METU-4-A and STRAW-KERK-2 samples. The red trend-line represents the RH values of samples during high humidity period. Also the range and average of RH and density values of each sample are given.

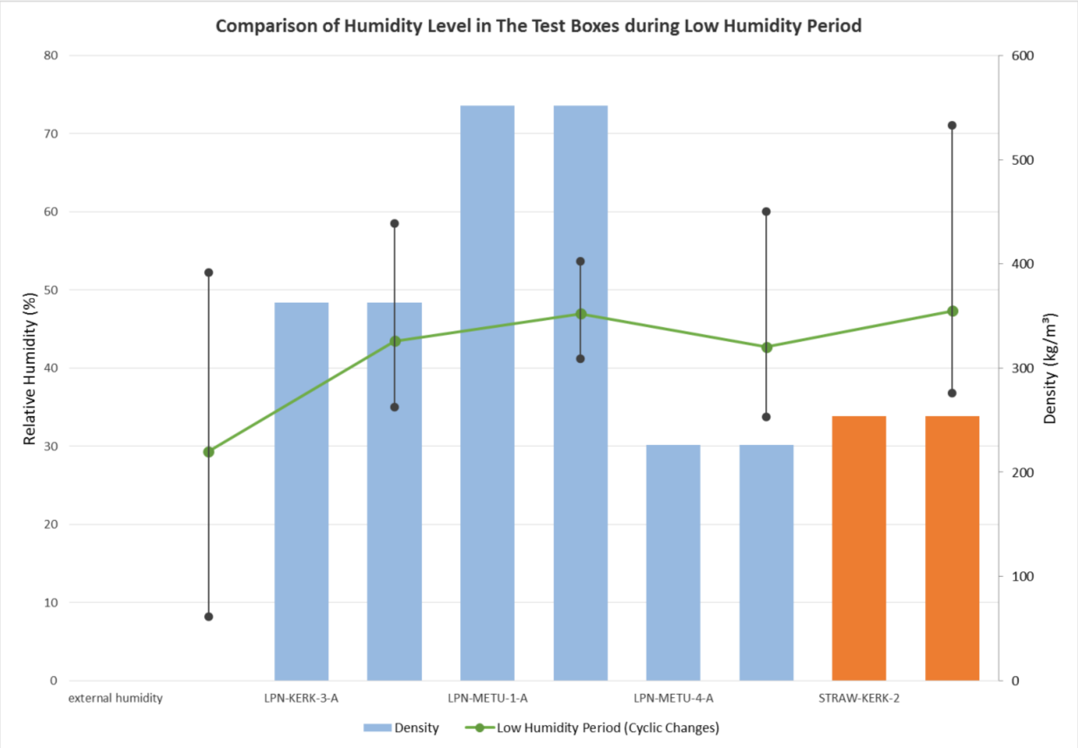

Figure 97: Relative humidity comparison of LPN-KERK-3A, LPN-METU-1-A, LPN-METU-4-A and STRAW-KERK-2 samples. The green trend-line represents the RH values of samples during low humidity period. Also the range and average of RH and density values of each sample are given.

The comparison between samples LPN-KERK-6-A, SPN-KERK-2-B and LPN-METU-1-A which have the same amount of pine-needles and viscosity but different materials shows that the METU loam is having a lower range of RH and lower difference between averages in the boxes compare to KERK loam. The RH level in the boxes with KERK loam is similar. This shows that the type of loam used have more importance than the type of fiber, in the case of using pine-needles.

To be able to identify the effect of pine needles and straw in LWL on vapor resistivity, STRAW-KERK-2 is compared with LPN-METU-4-A in terms of close density, with LPN-METU-1-A in terms of same amount of fibers but density difference and with LPN-KERK-3-A in terms of fibrous material difference (Figure 96 and Figure 97).

In comparison of LPN-KERK-3-A and STRAW-KERK-2, it can be seen that average RH of sample with pine needle is lower than sample with straw during both high and low humidity periods. The range of RH with straw sample in high humidity period (9.30%) is almost two times bigger than the range of RH with pine needle sample (5.30%). During low humidity period the range of RH with straw sample (34.30%) is also much higher than the range of RH with pine needle sample (23.50%).

In comparison of LPN-METU-1-A and STRAW-KERK-2, it can be seen that average RH of sample with pine needle is also lower than sample with straw during both high and low humidity periods. The range of RH with straw sample in high humidity period (9.30 %) is almost six times bigger than the range of RH with pine needle sample (1.70 %). During low humidity period the range of RH with straw sample (34.30 %) is almost three times bigger than the range of RH with pine needle sample (12.50 %).

In comparison of LPN-METU-4-A and STRAW-KERK-2, Figure 96 shows that the difference of average RH of samples in both high and low humidity period is very high. During high humidity period the range of RH with straw sample (9.30 %) is more than two times bigger than the range of RH with pine needle sample (4.00 %). During low humidity period the range of RH with straw sample (34.30 %) is also higher than the range of RH with pine needle sample (26.30 %).

In each comparison, it can be seen that mixes with pine needles have a higher humidity resistivity and lower range of RH compared to mixes with straw. It may be due to the amount of the water absorbed by straw and ability to transfer the humidity through the material.

iii. Summary

The analyses show that pine needle LWL have a higher humidity resistivity and higher capacity to regulate humidity compared to straw LWL.

Materials with high density have a higher capacity to store and release humidity.

Type of loam also influences the moisture regulation properties of the material. The more the loam is clayey, the more the material can regulate humidity.

5.5.2. Thermal Behavior

The thermal and relative humidity (RH) data of the boxes both in METU Campus and Kerkenes Eco-Center were evaluated in terms of cold weather in winter time, hot weather in summer time, heated ambience and rapid change of temperature. Comparison of ambience, exterior and surface temperature and RH of the boxes were done together with the comparison of mixes. Thermal boxes in Kerkenes Eco-Center allowed to make a comparison of pine-needle LWL, straw LWL, woodchip LWL and mud-brick while the thermal boxes in METU Campus allowed to make a comparison of pine-needle LWL, polystyrene and AAC.

i. Comparison on thermal behavior of boxes in summer

Thermal behavior comparison of boxes made of LPN-METU-1, LPN-METU-2, LPN-METU-4, polystyrene and AAC are done during summer on Figure 98. The temperature ranges between 18ºC and 40ºC.

It can be seen that LPN-METU-1,2,4 boxes have a higher temperature in average compared to AAC box. Since the color of AAC box is white and LWL boxes are darker –without any plaster- , probably LWL boxes absorbed more heat and this has resulted the average temperature difference.

On the other hand, although LPN-METU-1,2,4 boxes absorbed more heat, they were also able to keep more heat. It can be seen by comparing LPN-METU-1,2,4 boxes and polystyrene box: the highest temperature on all the boxes are close to each other but polystyrene box lost more heat than LWL boxes (Figure 98). Also LPN-METU-4 has the lowest difference between low and high temperature among all the boxes. That means it provides a better thermal insulation compared to other boxes.

Relative humidity comparison of LPN-METU-1, LPN-METU-2 and LPN-METU-4, polystyrene and AAC boxes is illustrated on Figure 99. First observation is the big difference of relative humidity between AAC and other boxes together with exterior RH. Since the data was taken in June, it was most likely raining and the materials were wet or not totally dry. It can be told that AAC is not able to regulate the humidity and release the humidity to exterior; therefore it keeps the humidity inside the box.

Additionally, density of AAC (405 kg/m^3) is higher than the densities of LPN-METU-2 (369 kg/m^3) and LPN-METU-4 (219 kg/m^3), except of LPN-METU-1 (537 kg/m^3). High density of AAC may have caused a longer duration of drying, which has resulted a more humid ambience. A detailed research should be done to identify the effect of density on relative humidity of the materials.

On the other hand, polystyrene box follows the same behavior of exterior. This may be because the box was not sealed properly.

LPN-METU-1, 2, 4 boxes have a lower average humidity compared to exterior and also the difference between high and low RH is the lower. This is because LWL mixes are able to absorb the humidity and release it: in brief they regulate the humidity better than AAC and polystyrene.

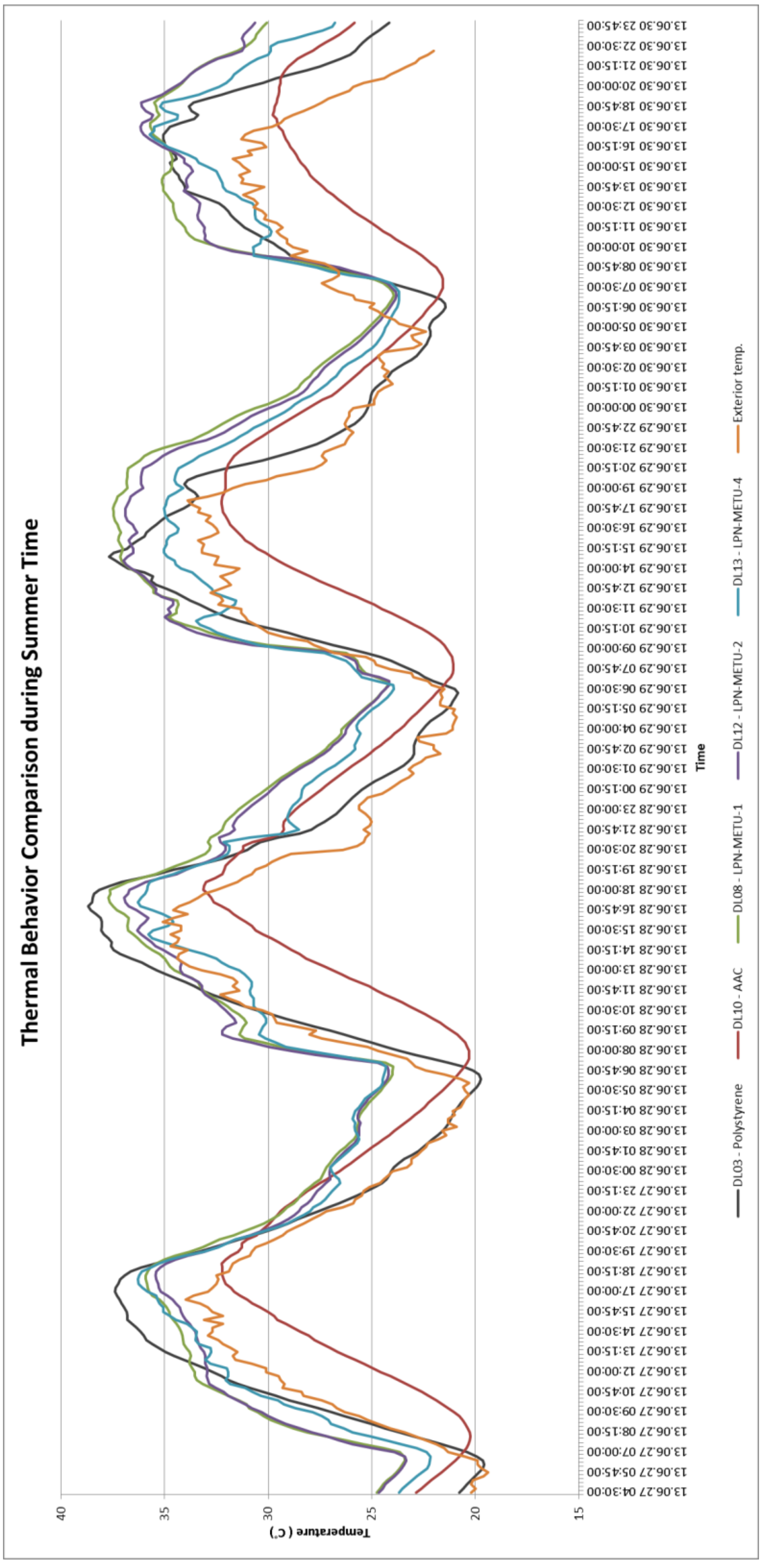

Figure 98: Thermal Behavior comparison during summer time.

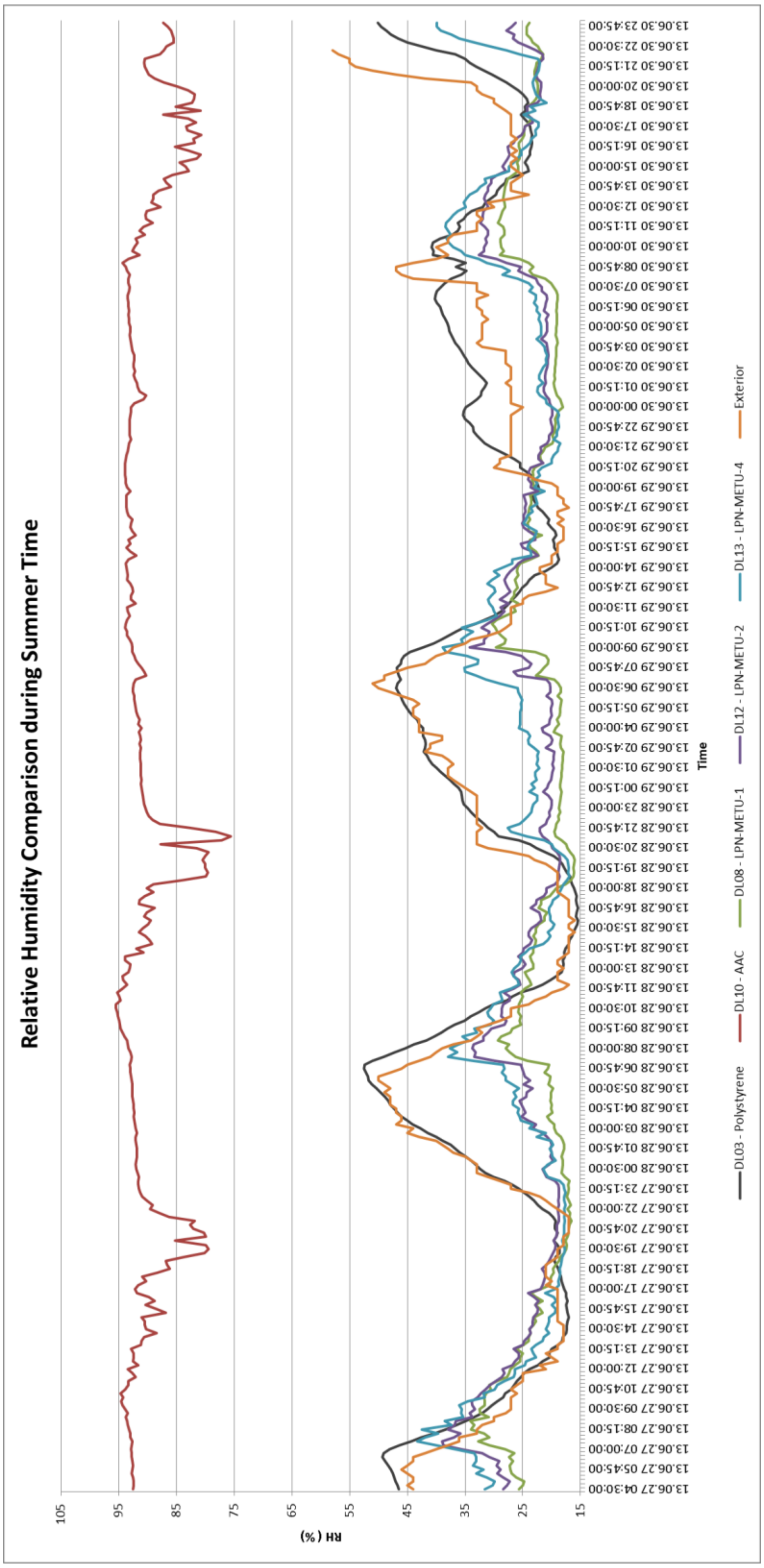

Figure 99: Relative Humidity comparison during summer time.

ii. Comparison on thermal behavior of boxes in winter

Thermal behavior comparison of boxes made of LPN-METU-1, LPN-METU-2, LPN-METU-4, polystyrene and autoclaved aerated concrete (AAC) are done during winter on Figure 100. The temperature ranges between -5ºC and 10ºC.

It can be seen that LPN-METU-1 and LPN-METU-2 show a very similar behavior while the behavior of LPN-METU-4 shows a little bit difference. In general, it can be said that their temperature delay compared to the exterior temperature. Although the exterior temperature goes down, lowest temperature of LPN-METU-1,2,4 boxes are always higher and nearly constant. This means that LPN-METU-1,2,4 mixes are able to keep the ambient temperature but also they are able to store some heat and release it after as a thermal mass behavior.

AAC box has a lower difference between low and high temperature and average temperature compared to pine-needle LWL samples. On the other hand, polystyrene box has the biggest difference between low and high temperature.

Relative humidity comparison of LPN-METU-1, LPN-METU-2 and LPN-METU-4 (Figure 101) shows that they are able to absorb humidity and release it during a long time. All the boxes have higher RH than exterior humidity level. This is probably because of rainy or snowy weather conditions that kept the boxes wet and the humidity inside the walls has been released inside the boxes. It can be seen that LPN-METU-4 is able to release the humidity faster and also its average RH is lower than LPN-METU-1 and LPN-METU-2. Two rapid changes of RH in LPN-METU-1 box should be due to a failure on the data logger. As a brief, it can be told that all the mixes have a lower difference between low and high RH compared to exterior.

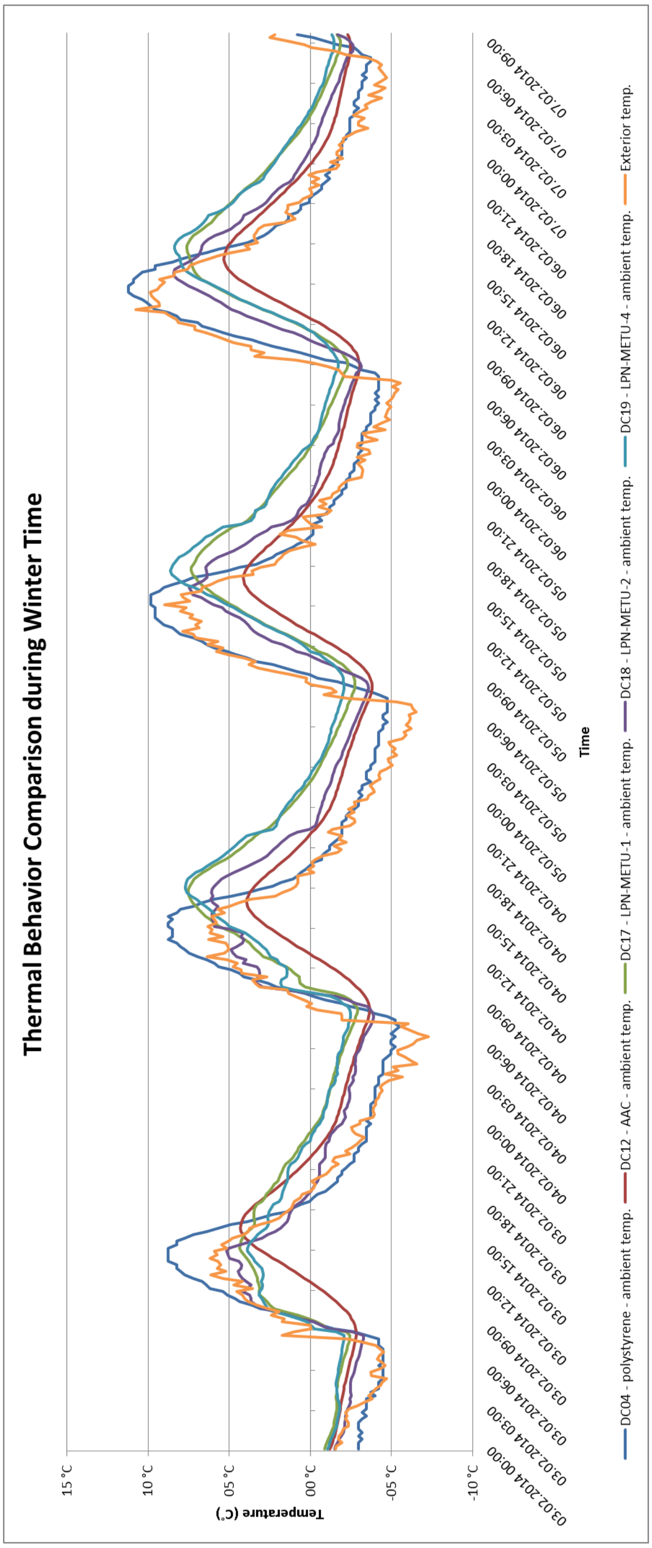

Figure 100: Thermal Behavior comparison during winter time.

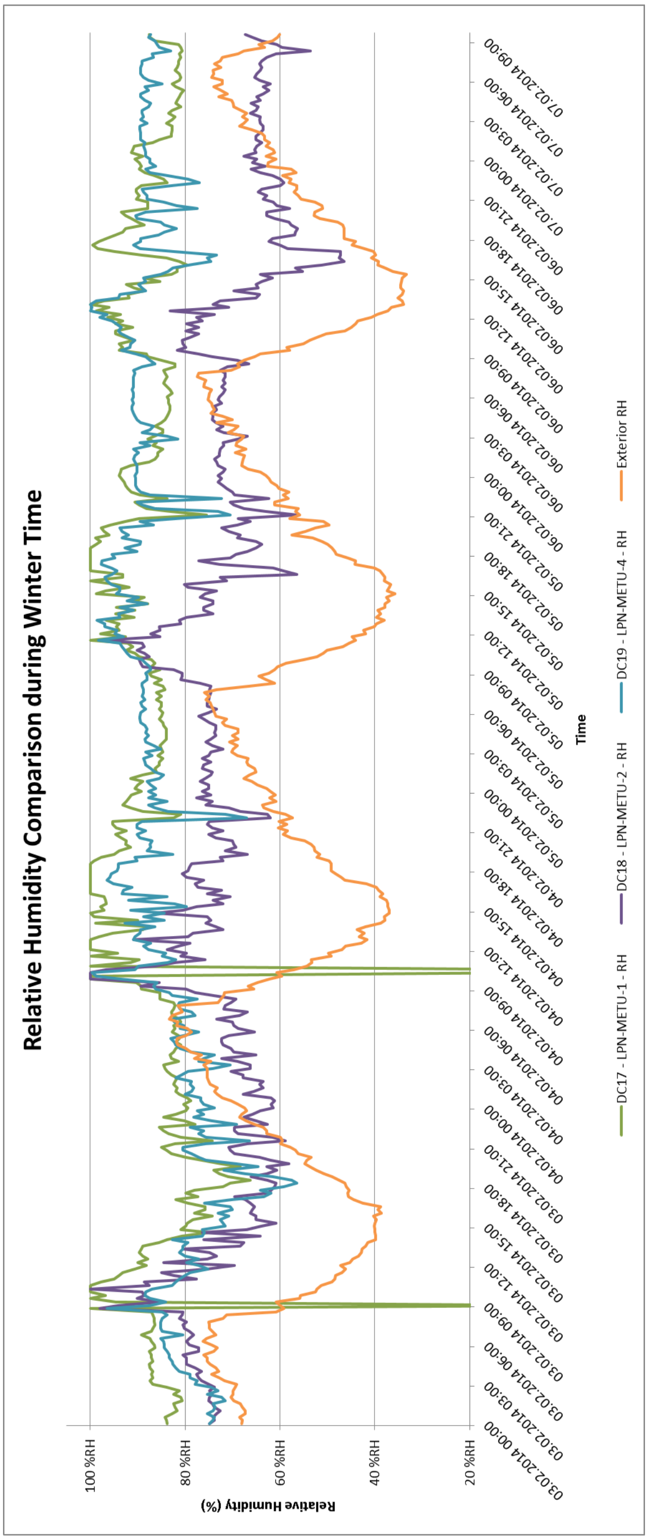

Figure 101: Relative Humidity comparison during winter time.

iii. Comparison on thermal behavior of boxes in heated ambience

To be able to identify the behavior of the boxes in heated ambience, candles were put inside the boxes, lighted and the box was closed. The results can be seen on Figure 102 and Figure 103.

On Figure 102, the dotted line represents the starting of candle lighting. It can be seen that LPN-KERK-3 and STRAW-KERK-2 reach higher temperature compared to woodchip LWL and mud-brick because they have a better thermal insulation.

On the other hand, when the candle was totally burned out, LPN-KERK-3 and STRAW-KERK-2 lost the heat faster than mud-brick and woodchips LWL. Also LPN-KERK-3 and STRAW-KERK-2 started to gain heat faster than mud-brick and woodchips-LWL (Figure 102). This result shows that woodchips-LWL and mud-brick have a higher thermal capacity than LPN-KERK-3 and STRAW-KERK-2.

On Figure 103, it can be seen that STRAW-KERK-1 and STRAW-KERK-2 boxes have reached to a higher temperature than LPN-KERK-3 box. Also LPN-KERK-3 box kept its ambient heat for longer time than STRAW-KERK-1 and STRAW-KERK-2 boxes. These results show that straw-LWL has a higher thermal insulation while pine-needles LWL has a higher thermal capacity.

At the same time, surface temperature of south walls from inside and outside were taken from STRAW-KERK-1 and LPN-KERK-3 boxes. Internal surface temperatures follow a similar trend-line with their ambient temperature. But the external surface temperatures of both boxes show a similar behavior with exterior temperature and reach a higher temperature at a shorter time because of their dark color. This result shows that both STRAW-KERK-1 and LPN-KERK-3 have high thermal insulation behavior.

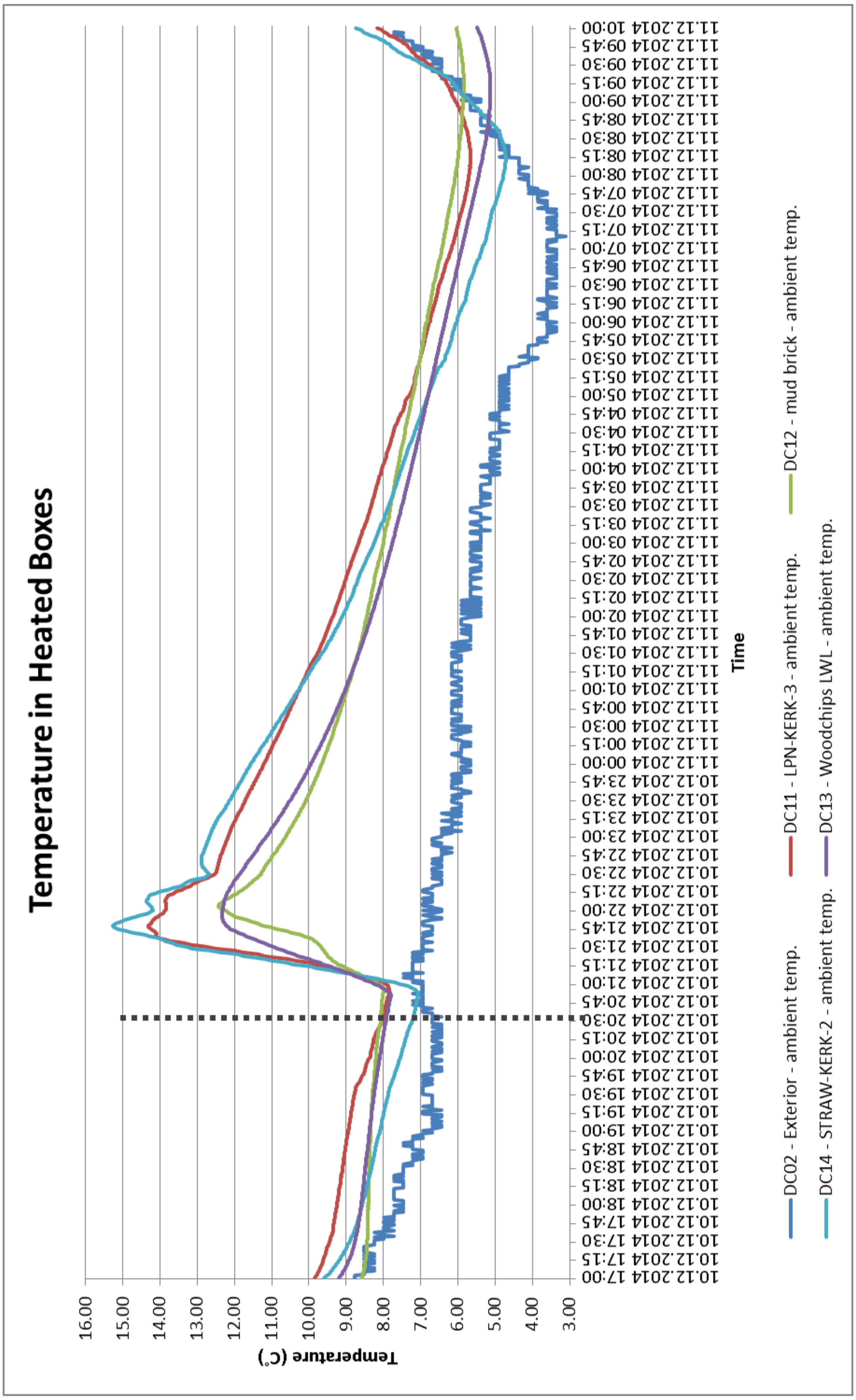

Figure 102: Thermal behavior of boxes in a heated ambience.

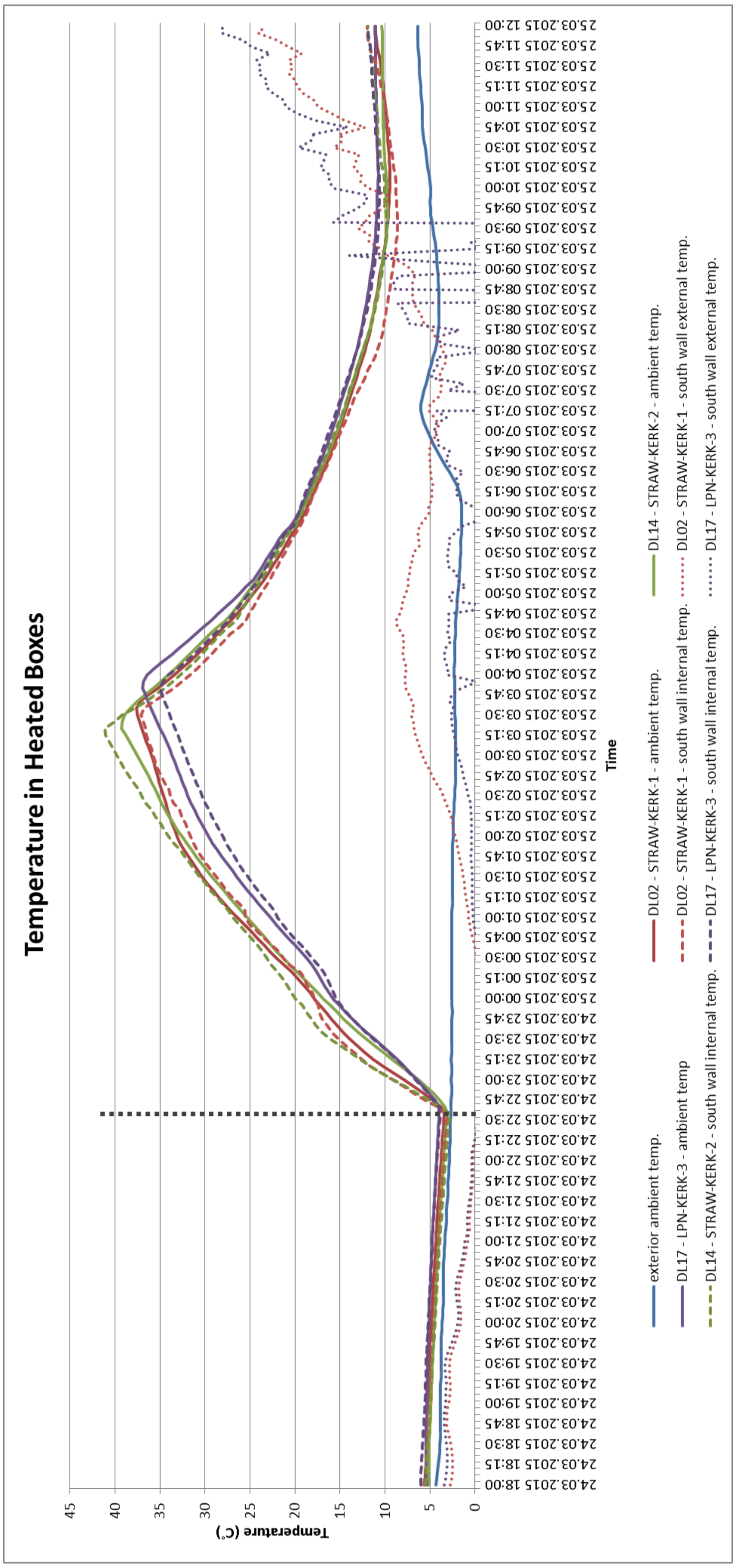

Figure 103: Thermal behavior of boxes in a heated ambience.

iv. Comparison on thermal behavior of boxes in rapid change of temperature

Another comparison was made to see the thermal behavior of boxes in rapid change of temperature (Figure 104). Also relative humidity behavior of boxes was compared under same conditions (Figure 105).

On Figure 104, it can be seen that STRAW-KERK-1, STRAW-KERK-2 and LPN-KERK-3 shows a similar thermal insulation behavior by reaching higher temperature than exterior and keeping it. On the other hand, woodchips-LWL box shows a thermal mass behavior by having a lower difference of high and low temperature, storing and releasing the heat in a longer time. It can also be understood from the delay of woodchips-LWL trend-line compared to exterior temperature trend-line.

On Figure 105, it can be seen that LPN-KERK-3 regulates the relative humidity than STRAW-KERK-1 and STRAW-KERK-2 by having a more constant trend line. At the same time, thermal mass behavior of woodchips LWL can also be seen on Figure 105 since it stores and releases the RH during a longer time and the difference on highest and lowest RH is lower than the other boxes.

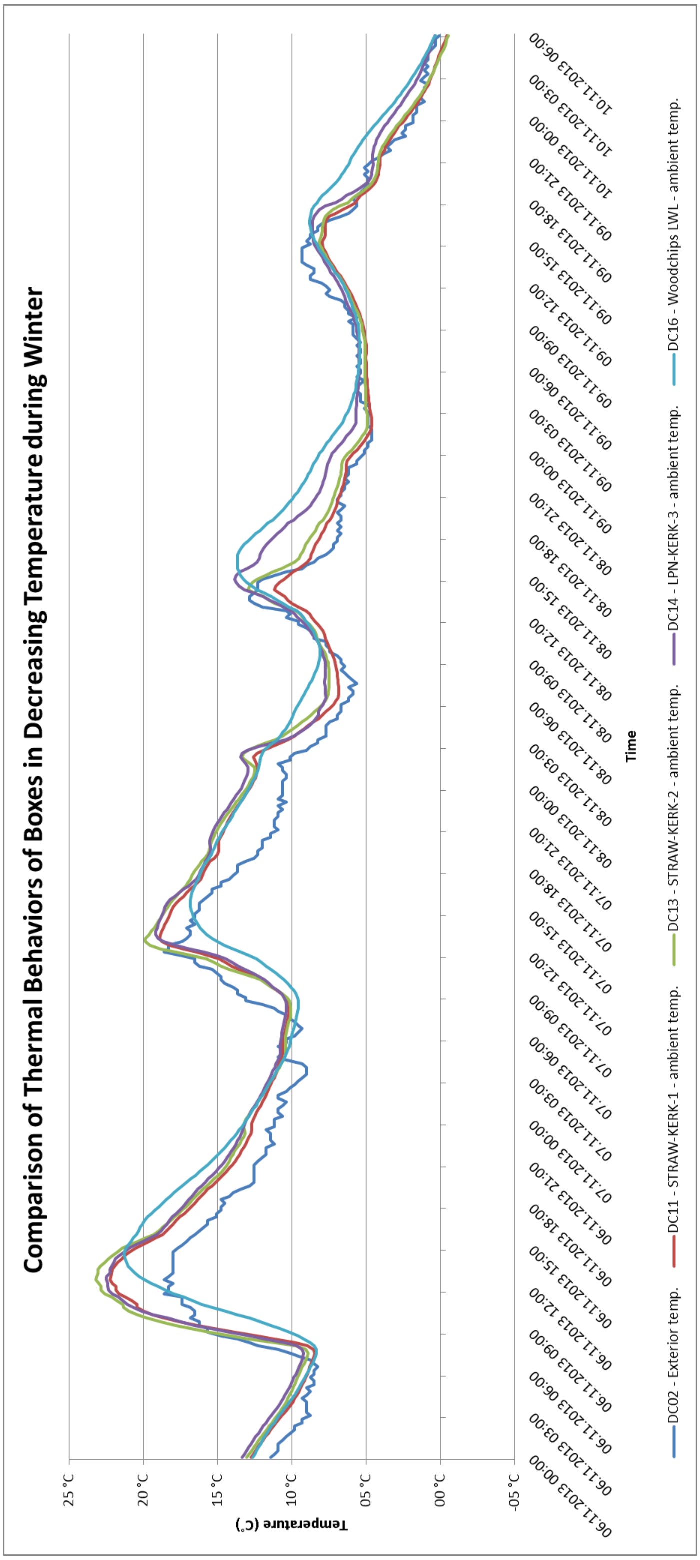

Figure 104: Comparison of Thermal Behaviors of Boxes in Decreasing Temperature during winter.

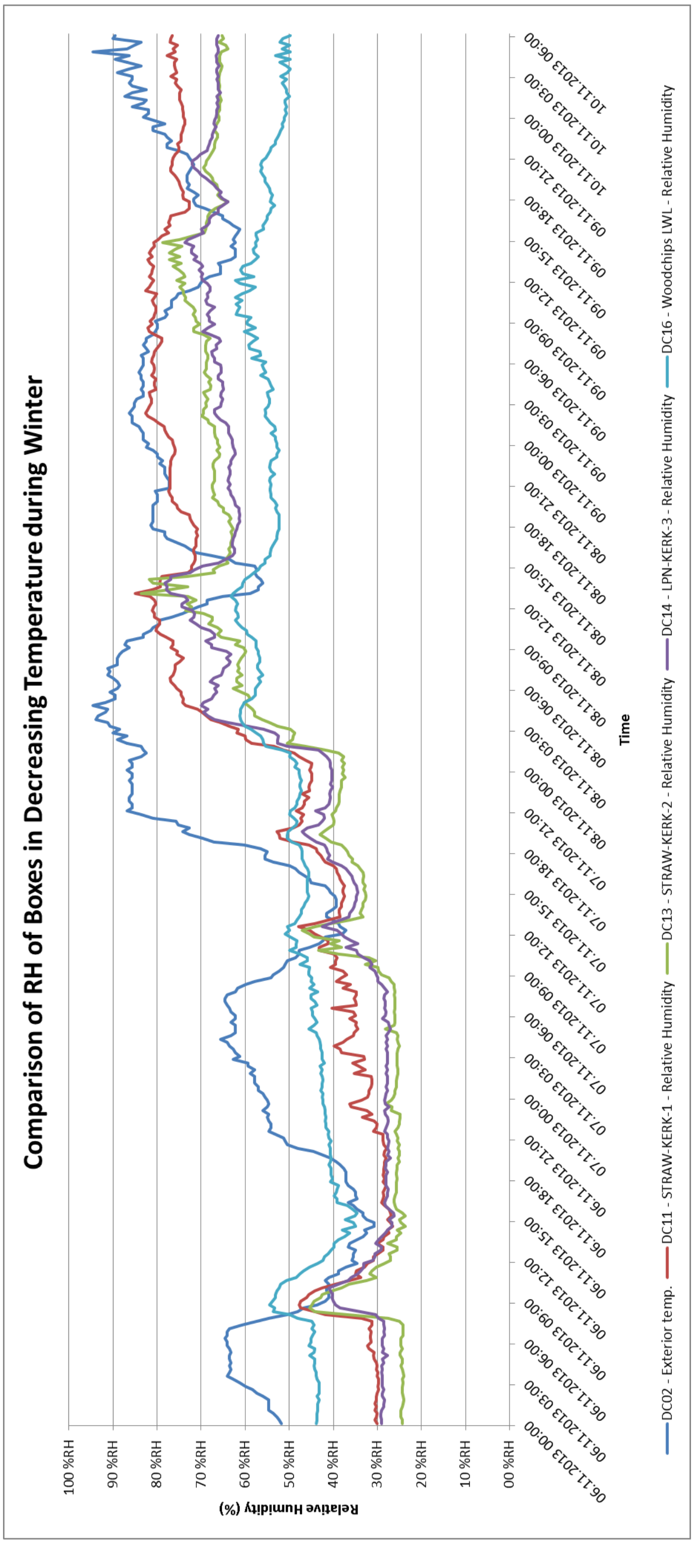

Figure 105: Comparison of RH of Boxes in Decreasing Temperature during winter.

v. Comparison on surface and ambient thermal behavior of boxes

Another comparison has been made to see the thermal insulation quality of pine-needles LWL. For this, comparison on ambient temperature of LPN-KERK-3 box and interior surface and exterior surface temperatures of its south wall is prepared as Figure 106.

It can be seen that ambient and interior surface temperature on south wall have almost the same behavior and higher than the exterior temperature. On the other hand, exterior surface temperature on south wall reaches highest and lowest temperatures because of its dark color. It can also be seen that LPN-KERK-3 box does not reach the lowest exterior temperature by keeping the heat inside. These results also show that pine-needle LWL has a thermal insulation property.

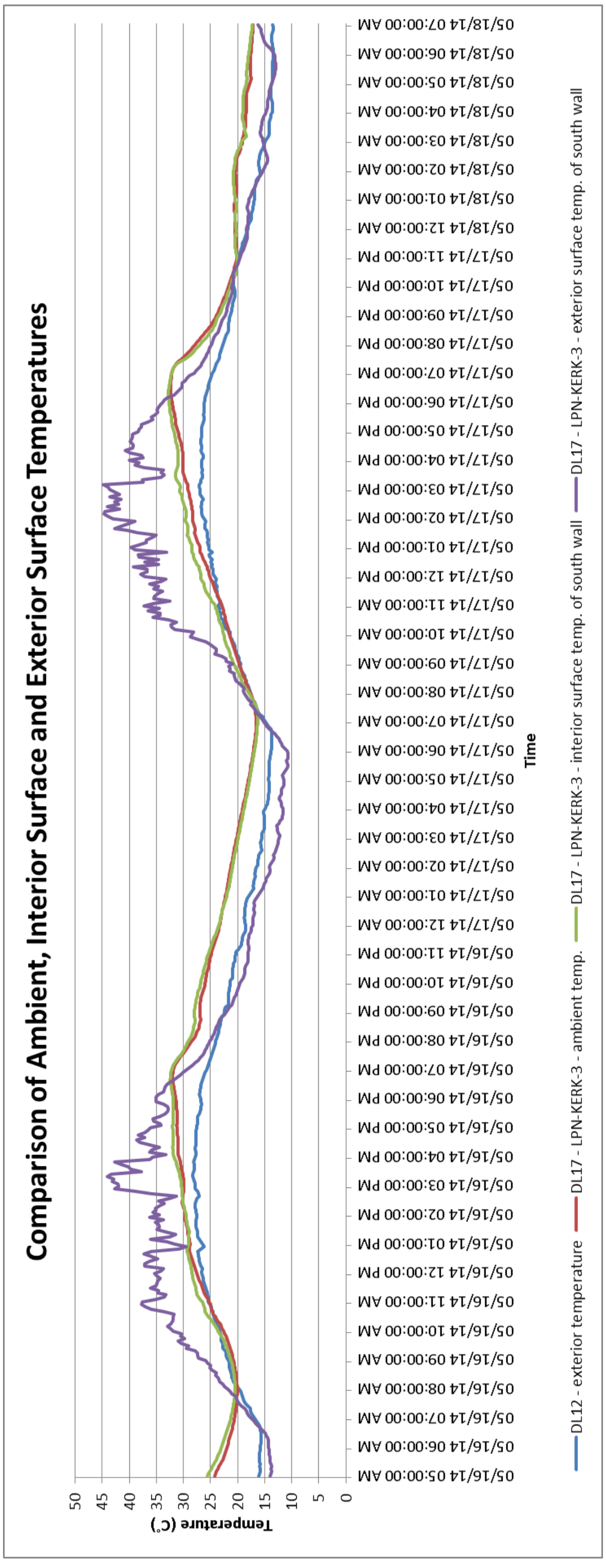

Figure 106: Comparison of Ambient, Interior Surface and Exterior Surface Temperatures.

CHAPTER 6

CONCLUSION

Lightweight loam (LWL) is a modern building material derived from the daub (straw and earth mixed) used in wattle and daub construction. Its insulation properties have been long recognized in Germany and the material is nowadays used in the main-stream industry for renovation of half-timbered historical building as well as for new projects. In addition to straw that is the historical filler mixed with a small quantity of liquid clayey loam (slip) to achieve a low density material, other fillers such as wooden chips, saw-dust, perlite or expanded clay have been proven efficient for fast and mechanized construction or ready-made bagged preparations. Development of ready-to-use blocks and panels as well as regulations for LWL constructions are undertaken in France, Germany and Great-Britain. Other fiber-based fillers such as lavender straw, hemp straw or corn stalk are being experimented in France in order to use local resources. In Turkey, because of the low availability of straw – used as a fodder for animals – research on alternative fillers is needed to develop the possibility of such constructions.

6.1. Experimental Results

In this thesis, usage of pine-needle which is widely available in the county has been tested. The results of the exploratory research have shown that despite minor disadvantages, pine-needle LWL compare well with straw LWL and could be used to develop a low-cost and appropriate insulation material. Innovative usage of pine-needles in lightweight loam construction has been assessed and its properties defined and compared to other building materials. Exploratory work has been done to determine the most suitable production of material, different mixes have been produced and their properties determined.

6.1.1. Pine-needle Lightweight Loam Production

Different types of production have been tested. The best way to produce pine-needle LWL is to follow the production process of straw-LWL but to adapt the viscosity of the slip to the non-absorbing behavior of the pine-needles.

Production of lightweight pressed bricks has been tested too but the design of the press doesn’t lead to appropriate results.

6.1.2. Physical Properties of Pine-needle Lightweight Loam

Shrinkage, density and water absorption on different mixes of LWL have been calculated for different type of clay and pine-needles.

Shrinkage is not an important issue – with shrinkage lower than 2cm per meter – but expansion of the material is, if the formwork is removed before proper drying is achieved. Shrinkage is higher with small fibers and high density mixes than with low density mixes.

In accordance with the literature (Minke 2006), density is highly dependent on the amount of fibers and the type of clay. A more clayey loam will make denser material and more fibers will make a lowest density material. However, really low density samples have been produced with high clay content loam – density ranges between 184 kg/m^3 and 580 kg/m^3 - but the suitability of the lightest ones is questioned due to their lightness. Lower densities than straw LWL can be achieved with pine-needles due to the lower compressibility of the fibers.

The water capillarity absorption capacity of pine-needle LWL has also been assessed. The capacity is directly related with the density of the material, i.e. the loam type and amount of fibers. The water capillarity absorption will increase with a higher density and a high clay content loam. In comparison with straw LWL, pine-needle LWL has higher capillarity absorption for the same density.

6.1.3. Hygro-thermal Behavior of Pine-needle Lightweight Loam

The hygro-thermal behavior of pine-needle LWL have been studied in both cold and warm, humid and dry environments under real and simulated weather conditions. Results of these experiments show a similar behavior of the different pine-needle samples and similar behavior with straw samples. Accordingly, all the materials have a high capacity to regulate the ambient moisture level independently of their density. However, higher density samples regulate better the humidity but have a lower heat resistivity. Despite very different composition of the mixes – from 24 to 8 units of pine-needles for 1 unit of soil – hygro-thermal behavior of LWL mixes are not very different from each other especially when compared to AAC or polystyrene (EPS). The behavior is very similar between straw LWL and pine-needle LWL which show the suitability of the material as an insulation material.

6.2. Observational Results

More than just the results of tests undertaken and described in the thesis, some other conclusions can be made from the observations of the material and their production. These observations are not quantitative but may also explain some shortcuts and interpretation of results shown in the thesis.

The first observation is the difficulty to work with pine-needles. Unlike straw which often came as bale, pine-needles need to be collected on the ground and cleaned from impurities. Moreover, pine-needles are hard, brittle and prickly and are not soften with the absorption of water – which is not absorbed at all – and then are difficult to keep in shape.

The second observation is the good shape of the lightweight – especially the test boxes – after two winters without protection. In opposite of mud and pressed brick which have been destroyed by the heavy precipitations, LWL boxes have survived. Some materials have been lost due to erosion and the walls have settled under the weight of the cover (especially for the lightest one) but no full collapse had happen.

The third observation is the ease to work with very clayey loam. Not only the material shows better properties, but also the production process is facilitated and a larger amount of pine-needle can be used – in the thesis until 32 unit of pine-needle for 1 volume of slip – which allows producing more insulating materials.

6.3. Recommendations

This thesis has been a first step in the study of an innovative use of pine-needles and the production of a new earthen insulation material. However, more work is needed to assess its suitability as a construction material despite its comparable hygro-thermal behavior with straw LWL.

6.3.1. Recommendation for Methodology

The slip should be measured not only in term of viscosity but also by weight of dry earth and weight of water.

The proportion of materials in the mixes should be assess in unit but also in weight so more suitable comparison can be made if the shape/size of unit bucket differs.

Mixing methodology and production process should be assessing to be able to replicate the material.

6.3.2. Recommendation for Further Research

The first recommendation is to test the material for its mechanical properties and especially settlement on a long period. Compressive strength and surface hardness test are needed to assess the possibility of usage in a frame wall and maybe because of the hardness on pine-needles in a load-bearing construction.

The second recommendation is to test the pine-needles LWL in a humid environment. Thanks to the high water/humidity absorption of straw, straw-LWL has a fast drying behavior. The drying behavior of pine-needle LWL is yet unknown and its behavior as wall submitted to cycles of high humidity is a question. The decomposition of pine-needle should be researched and safety usage limits should be assessed.

The third recommendation is to test the material in a larger scale, on a scale 1 wall and observe is behavior and the ease or difficulty of production of the wall and from the observation, to assess a production and building process which may be different than for straw LWL.

6.3.3. Recommendation for Pine-needle LWL Construction

Despite uncertainties due to the lack of research and test on the material, it is possible to use pine-needle LWL in a framed construction.

According to the results of the test and the literature, a very clayey earth will be the most suitable binder to use. It also will allow better moisture absorption.

Long pine needles seems to be more appropriate and are giving better results in term of resistance to water and a lower water absorption.

A very low density material is possible to achieve but it not advised due to the risk of settlement. A ratio of 24 unit of pine-needle for 1 unit of loam is the maximum suitable material that has been used in this thesis.

Through the results of the tests and the recommendations given, it is hoped that the natural builder community will take hold of the material, use it and spread it as it is seen that its properties are comparable to straw LWL. Therefore pine-needle LWL will be useful for countries without straw available.

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APPENDIX A

DATA RELATED TO PHYSICAL PROPERTIES OF PRELIMINARY SAMPLES

Raw data of preliminary tests are given on determination of physical properties of pine needle lightweight loam. Tables include weight, density, shrinkage and water absorption values of preliminary samples produced.

Table 18: Weight measurements and density values of preliminary samples.

	Weight 02.05.13	Weight 06.05.13	Weight 13.05.13	Density
unit	gr	gr	gr	kg/m3
PR-LPN-A1	292.00	218.00	214.00	1070.00
PR-LPN-A2	293.00	218.00	213.00	1065.00
PR-LPN-A3	313.00	234.00	227.00	1135.00
PR-LPN-A4	308.00	232.00	226.00	1130.00
mean	**301.50**	**225.50**	**220.00**	**1100.00**
PR-LPN-B1	273.00	199.00	193.00	965.00
PR-LPN-B2	284.00	209.00	202.00	1010.00
PR-LPN-B3	277.00	205.00	197.00	985.00
PR-LPN-B4	270.00	200.00	194.00	970.00
mean	**276.00**	**203.25**	**196.50**	**982.50**
PR-LPN-C1	265.00	188.00	179.00	895.00
PR-LPN-C2	284.00	204.00	194.00	970.00
PR-LPN-C3	280.00	201.00	189.00	945.00
mean	**276.33**	**197.67**	**187.33**	**936.67**
PR-LPN-D1	181.00	132.00	130.00	650.00
PR-LPN-D2	201.00	148.00	145.00	725.00
PR-LPN-D3	197.00	146.00	143.00	715.00
mean	**193.00**	**142.00**	**139.33**	**696.67**
PR-SPN-A1	248.00	189.00	182.00	910.00
PR-SPN-A2	258.00	197.00	187.00	935.00
PR-SPN-A3	243.00	184.00	176.00	880.00
PR-SPN-A4	282.00	212.00	205.00	1025.00
mean	**257.75**	**195.50**	**187.50**	**937.50**

Table 18 continued:

	Weight 02.05.13	Weight 06.05.13	Weight 13.05.13	Density
unit	gr	gr	gr	kg/m3
PR-SPN-B3	204.00	140.00	132.00	660.00
PR-SPN-B4	218.00	145.00	140.00	700.00
mean	**200.75**	**135.00**	**129.00**	**645.00**
PR-LPN-E1	226.00	160.00	153.00	760.00
PR-LPN-E2	190.00	130.00	125.00	625.00
PR-LPN-E3	240.00	172.00	164.00	820.00
PR-LPN-E4	215.00	148.00	143.00	715.00
mean	**217.75**	**152.50**	**146.25**	**730.00**
S-0-A	373.00	291.00	285.00	1425.00
S-0-B	343.00	267.00	262.00	1310.00
S-0-C	330.00	259.00	253.00	1265.00
S-0-D	368.00	288.00	282.00	1410.00
mean	**353.50**	**276.25**	**270.50**	**1352.50**

Table 19: Length measurements and shrinkage values of preliminary samples.

	Length 02.05.13	Length 06.05.13	Length 13.05.13	Shrinkage 06.05.13	Shrinkage 13.05.13
unit	cm		cm	mm	mm
PR-LPN-A1	20.20	19.80	19.80	0.20	0.40
PR-LPN-A2	20.30	19.80	19.80	0.20	0.50
PR-LPN-A3	20.20	19.80	19.70	0.20	0.50
PR-LPN-A4	20.20	19.60	19.55	0.40	0.65
mean	**20.23**	**19.75**	**19.71**	**0.25**	**0.51**
PR-LPN-B1	20.20	19.90	19.80	0.10	0.40
PR-LPN-B2	20.40	20.10	19.95	-0.10	0.45
PR-LPN-B3	20.40	20.00	19.90	0.00	0.50
PR-LPN-B4	20.50	20.35	20.15	-0.35	0.35
mean	**20.38**	**20.09**	**19.95**	**-0.09**	**0.43**
PR-LPN-C1	20.40	20.20	20.10	-0.20	0.30
PR-LPN-C2	20.45	20.20	20.15	-0.20	0.30
PR-LPN-C3	20.50	20.30	20.30	-0.30	0.20
mean	**20.45**	**20.23**	**20.18**	**-0.23**	**0.27**
PR-LPN-D1	20.40	20.05	20.05	-0.05	0.35
PR-LPN-D2	20.50	20.20	20.10	-0.20	0.40
PR-LPN-D3	20.30	20.10	20.10	-0.10	0.20
mean	**20.40**	**20.12**	**20.08**	**-0.12**	**0.32**

Table 19 continued:

	Length 02.05.13	Length 06.05.13	Length 13.05.13	Shrinkage 06.05.13	Shrinkage 13.05.13
unit	cm		cm	mm	mm
PR-SPN-A1	20.50	20.15	20.15	-0.15	0.35
PR-SPN-A2	20.50	19.95	19.70	0.05	0.80
PR-SPN-A3	20.40	20.10	19.80	-0.10	0.60
PR-SPN-A4	20.50	20.10	19.80	-0.10	0.70
mean	**20.48**	**20.08**	**19.86**	**-0.07**	**0.61**
PR-SPN-B1	20.40	19.90	19.80	0.10	0.60
PR-SPN-B2	20.50	20.10	19.90	-0.10	0.60
PR-SPN-B3	20.40	20.05	19.80	-0.05	0.60
PR-SPN-B4	20.30	20.10	19.90	-0.10	0.40
mean	**20.40**	**20.04**	**19.85**	**-0.04**	**0.55**
PR-LPN-E1	20.10	20.20	19.80	-0.20	0.30
PR-LPN-E2	20.00	20.20	20.20	-0.20	-0.20
PR-LPN-E3	20.20	20.25	20.05	-0.25	0.15
PR-LPN-E4	20.50	20.40	20.30	-0.40	0.20
mean	**20.20**	**20.26**	**20.09**	**-0.26**	**0.11**
S-0-A	20.10	17.70	17.50	2.30	2.60
S-0-B	20.20	17.90	17.70	2.10	2.50
S-0-C	20.10	17.70	17.70	2.30	2.40
S-0-D	20.30	18.00	18.00	2.00	2.30
mean	**20.18**	**17.83**	**17.73**	**2.18**	**2.45**

APPENDIX B

DATA RELATED TO PHYSICAL PROPERTIES OF SAMPLES

Raw data on physical properties of pine needle lightweight loam mixes together with straw LWL, AAC, polystyrene and mud brick samples are given. Tables include composition of samples as well as density, shrinkage and water absorption values of preliminary samples produced.

Table 20: Composition of pine needle lightweight loam mixes.

Name	type of loam	viscosity of loam in diameter (cm)	type of pine needles	volume of pine needles for 1 volume of slip-loam
LPN-KERK-1-A	kerk	15	1	4
LPN-KERK-1-B	kerk	15	1	4
LPN-KERK-1-C	kerk	15	1	4
LPN-KERK-2-A	kerk	15	1	6
LPN-KERK-2-B	kerk	15	1	6
LPN-KERK-2-C	kerk	15	1	6
LPN-KERK-3-A	kerk	15	1	8
LPN-KERK-3-B	kerk	15	1	8
LPN-KERK-3-C	kerk	15	1	8
LPN-KERK-4-A	kerk	5	1	8
LPN-KERK-4-B	kerk	5	1	8
LPN-KERK-4-C	kerk	5	1	8
LPN-KERK-5-A	kerk	8.5	1	8
LPN-KERK-5-B	kerk	8.5	1	8
LPN-KERK-5-C	kerk	8.5	1	8
LPN-KERK-6-A	kerk	10	1	8
LPN-KERK-6-B	kerk	10	1	8
LPN-KERK-6-C	kerk	10	1	8
SPN-KERK-1-A	kerk	10	2	6
SPN-KERK-1-B	kerk	10	2	6
SPN-KERK-1-C	kerk	10	2	6
SPN-KERK-2-A	kerk	10	2	8
SPN-KERK-2-B	kerk	10	2	8
SPN-KERK-2-C	kerk	10	2	8

Table 20 continued:

Name	type of loam	viscosity of loam in diameter (cm)	type of pine needles	volume of pine needles for 1 volume of slip-loam
LPN-METU-1-A	metu	10	1	8
LPN-METU-1-B	metu	10	1	8
LPN-METU-1-C	metu	10	1	8
LPN-METU-2-A	metu	10	1	12
LPN-METU-2-B	metu	10	1	12
LPN-METU-2-C	metu	10	1	12
LPN-METU-3-A	metu	10	1	16
LPN-METU-3-B	metu	10	1	16
LPN-METU-4-A	metu	10	1	24
LPN-METU-4-B	metu	10	1	24
LPN-METU-4-C	metu	10	1	24
LPN-METU-5-A	metu	10	1	32
LPN-METU-5-B	metu	10	1	32
LPN-METU-5-C	metu	10	1	32

Table 21: Density values of pine needle LWL and straw LWL samples

Name	Non-trimmed Density (kg/m³)	Trimmed Dry Density (kg/m³)	Difference between Non Trimmed and Trimmed Density (%)	Average Non-Trimmed Density (kg/m³)	Average Trimmed Density (kg/m³)	Difference between Average Non-Trimmed and Average Trimmed Density (%)
LPN-KERK-1-A	550	606	10.2%			
LPN-KERK-1-B	480	506	5.4%	539	580	7.1%
LPN-KERK-1-C	588	629	7.0%			
LPN-KERK-2-A	365	384	5.2%			
LPN-KERK-2-B	419	489	16.7%	392	436	10.0%
LPN-KERK-2-C		434				
LPN-KERK-3-A		363				
LPN-KERK-3-B	293	333	13.7%	323	359	10.1%
LPN-KERK-3-C	353	382	8.2%			
LPN-KERK-4-A	380	417	9.7%			
LPN-KERK-4-B	376	390	3.7%	371	369	-0.6%
LPN-KERK-4-C	357	299	-16.2%			
LPN-KERK-5-A	384	404	5.2%			
LPN-KERK-5-B	357	340	-4.8%	353	355	0.8%
LPN-KERK-5-C	317	322	1.6%			

Table 21 continued:

Name	Non-trimmed Density (kg/m³)	Trimmed Dry Density (kg/m³)	Difference between Non Trimmed and Trimmed Density (%)	Average Non-Trimmed Density (kg/m³)	Average Trimmed Density (kg/m³)	Difference between Average Non-Trimmed and Average Trimmed Density (%)
LPN-KERK-6-A		448		417	435	4.3%
LPN-KERK-6-B	454	465	2.4%			
LPN-KERK-6-C	379	393	3.7%			
SPN-KERK-1-A	362	388	7.2%	394	433	8.9%
SPN-KERK-1-B	401	437	9.0%			
SPN-KERK-1-C	419	473	12.9%			
SPN-KERK-2-A	274	270	-1.5%	285	304	6.5%
SPN-KERK-2-B		339				
SPN-KERK-2-C	295	304	3.1%			
LPN-METU-1-A		552		511	537	4.9%
LPN-METU-1-B	497	532	7.0%			
LPN-METU-1-C	525	528	0.6%			
LPN-METU-2-A		385		352	369	4.7%
LPN-METU-2-B	371	381	2.7%			
LPN-METU-2-C	332	340	2.4%			
LPN-METU-3-A	281	277	-1.4%	267	260	-2.7%
LPN-METU-3-B	253	243	-4.0%			
LPN-METU-4-A		226		252	219	-14.9%
LPN-METU-4-B	228	186	-18.4%			
LPN-METU-4-C	276	246	-10.9%			
LPN-METU-5-A	190	167	-12.1%	204	184	-10.8%
LPN-METU-5-B	212	200	-5.7%			
LPN-METU-5-C	211	186	-11.8%			
STRAW-KERK-1-A	494	535	8.3%	486	544	10.7%
STRAW-KERK-1-B	477	552	15.7%			
STRAW-KERK-2-A		244		234	254	7.7%
STRAW-KERK-2-B	234	263	12.4%			

Table 22: Length measurements and shrinkage on length.

Name	Cut Length	Length	Average Length	Percentage of Shrinkage on Length	Average Shrinkage on Length
LPN-KERK-1-A	20.55	30.05	29.89	-0.17	0.36
LPN-KERK-1-B	20.28	29.80		0.67	
LPN-KERK-1-C	20.30	29.83		0.58	
LPN-KERK-2-A	19.95	29.70	29.81	1.00	1.08
LPN-KERK-2-B	20.18	29.70		1.00	
LPN-KERK-2-C	20.18	29.63		1.25	
LPN-KERK-3-A	19.98	29.88	29.84	0.42	0.36
LPN-KERK-3-B	20.53	29.90		0.33	
LPN-KERK-3-C	19.98	29.90		0.33	
LPN-KERK-4-A	20.48	29.95	29.83	0.17	0.44
LPN-KERK-4-B	20.63	30.00		0.00	
LPN-KERK-4-C	13.88	29.65		1.17	
LPN-KERK-5-A	20.05	29.63	29.75	1.25	0.67
LPN-KERK-5-B	20.70	29.95		0.17	
LPN-KERK-5-C	20.70	29.83		0.58	
LPN-KERK-6-A	20.85	29.83	29.65	0.58	0.61
LPN-KERK-6-B	20.30	29.90		0.33	
LPN-KERK-6-C	20.90	29.73		0.92	
SPN-KERK-1-A	19.95	29.38	29.43	2.08	1.39
SPN-KERK-1-B	20.05	29.63		1.25	
SPN-KERK-1-C	20.08	29.75		0.83	
SPN-KERK-2-A	20.08	29.38	29.38	2.08	2.53
SPN-KERK-2-B	20.28	29.25		2.50	
SPN-KERK-2-C	19.88	29.10		3.00	
LPN-METU-1-A	20.73	29.50	29.51	1.67	1.86
LPN-METU-1-B	20.43	29.43		1.92	
LPN-METU-1-C	19.90	29.40		2.00	
LPN-METU-2-A	20.70	29.63	29.67	1.25	1.56
LPN-METU-2-B	20.43	29.48		1.75	
LPN-METU-2-C	20.40	29.50		1.67	
LPN-METU-3-A	19.75	29.63	29.74	1.25	0.87
LPN-METU-3-B	20.50	29.85		0.50	

(all measurement in cm)

Table 22 continued:

Name	Cut Length	Length	Average Length	Percentage of Shrinkage on Length	Average Shrinkage on Length
LPN-METU-4-A	20.00	29.85	29.78	0.50	0.72
LPN-METU-4-B	20.15	29.78		0.75	
LPN-METU-4-C	20.15	29.73		0.92	
LPN-METU-5-A	20.75	29.90	29.90	0.33	0.33
LPN-METU-5-B	20.75	29.88		0.42	
LPN-METU-5-C	20.75	29.93		0.25	

(all measurement in cm)

Table 23: Width measurements and shrinkage on width.

Name	Cut Width	Width	Average Width	Percentage of Shrinkage on Width	Average Shrinkage on Width
LPN-KERK-1-A	10.45	15.18	13.38	-1.17	10.80
LPN-KERK-1-B	10.18	14.97		0.23	
LPN-KERK-1-C	8.68	10.00		33.33	
LPN-KERK-2-A	10.10	14.83	14.95	1.17	0.33
LPN-KERK-2-B	10.20	14.83		1.17	
LPN-KERK-2-C	10.35	15.20		-1.33	
LPN-KERK-3-A	9.83	14.70	14.91	2.00	0.63
LPN-KERK-3-B	10.03	15.07		-0.44	
LPN-KERK-3-C	9.98	14.95		0.33	
LPN-KERK-4-A	10.03	14.90	14.84	0.67	1.06
LPN-KERK-4-B	10.38	15.00		0.00	
LPN-KERK-4-C	10.50	14.63		2.50	
LPN-KERK-5-A	9.70	14.78	14.78	1.50	1.44
LPN-KERK-5-B	9.90	14.80		1.33	
LPN-KERK-5-C	10.00	14.78		1.50	
LPN-KERK-6-A	9.98	14.85	14.73	1.00	1.83
LPN-KERK-6-B	9.78	14.55		3.00	
LPN-KERK-6-C	9.83	14.78		1.50	
SPN-KERK-1-A	9.58	15.00	14.91	0.00	0.61
SPN-KERK-1-B	9.68	14.93		0.50	
SPN-KERK-1-C	10.38	14.80		1.33	
SPN-KERK-2-A	10.40	15.03	14.86	-0.17	0.94
SPN-KERK-2-B	10.28	14.75		1.67	
SPN-KERK-2-C	9.75	14.80		1.33	

(all measurement in cm)

Table 23 continued:

Name	Cut Width	Width	Average Width	Percentage of Shrinkage on Width	Average Shrinkage on Width
LPN-METU-1-A	10.20	14.68	14.68	2.17	2.17
LPN-METU-1-B	10.50	14.68		2.17	
LPN-METU-1-C	10.03	14.68		2.17	
LPN-METU-2-A	10.20	14.88	14.66	0.83	2.28
LPN-METU-2-B	10.05	14.55		3.00	
LPN-METU-2-C	9.60	14.55		3.00	
LPN-METU-3-A	9.80	14.87	14.82	0.89	1.23
LPN-METU-3-B	9.68	14.77		1.56	
LPN-METU-4-A	10.50	14.93	14.84	0.50	1.06
LPN-METU-4-B	9.95	14.75		1.67	
LPN-METU-4-C	10.25	14.85		1.00	
LPN-METU-5-A	10.50	14.80	14.81	1.33	1.28
LPN-METU-5-B	10.63	14.83		1.17	
LPN-METU-5-C	10.13	14.80		1.33	

(all measurement in cm)

Table 24: Height measurements and shrinkage on height.

Name	Cut Height	Height	Average Height	Percentage of Shrinkage on Height	Average Shrinkage on Height
LPN-KERK-1-A	7.40	9.55	9.73	4.50	2.67
LPN-KERK-1-B	8.13	9.65		3.50	
LPN-KERK-1-C	8.68	10.00		0.00	
LPN-KERK-2-A	8.13	9.80	9.84	2.00	2.08
LPN-KERK-2-B	7.05	9.88		1.25	
LPN-KERK-2-C	9.33	9.70		3.00	
LPN-KERK-3-A	9.65	10.13	10.06	-1.25	-2.00
LPN-KERK-3-B	8.08	10.00		0.00	
LPN-KERK-3-C	8.53	10.48		-4.75	
LPN-KERK-4-A	7.38	10.58	10.29	-5.75	-0.08
LPN-KERK-4-B	7.00	10.00		0.00	
LPN-KERK-4-C	7.00	9.45		5.50	
LPN-KERK-5-A	6.23	9.83	9.99	1.75	-0.67
LPN-KERK-5-B	7.58	10.15		-1.50	
LPN-KERK-5-C	7.00	10.23		-2.25	

(all measurement in cm)

Table 24 continued:

Name	Cut Height	Height	Average Height	Percentage of Shrinkage on Height	Average Shrinkage on Height
LPN-KERK-6-A	8.08	9.53	9.71	4.75	2.33
LPN-KERK-6-B	7.63	9.90		1.00	
LPN-KERK-6-C	7.53	9.88		1.25	
SPN-KERK-1-A	7.28	9.33	9.66	6.75	2.00
SPN-KERK-1-B	6.13	10.00		0.00	
SPN-KERK-1-C	6.63	10.08		-0.75	
SPN-KERK-2-A	6.75	9.63	9.56	3.75	2.83
SPN-KERK-2-B	6.75	9.50		5.00	
SPN-KERK-2-C	9.23	10.03		-0.25	
LPN-METU-1-A	9.43	9.78	9.80	2.25	1.83
LPN-METU-1-B	7.85	9.83		1.75	
LPN-METU-1-C	8.20	9.85		1.50	
LPN-METU-2-A	9.78	10.28	10.13	-2.75	-0.67
LPN-METU-2-B	8.18	9.98		0.25	
LPN-METU-2-C	9.63	9.95		0.50	
LPN-METU-3-A	8.00	10.08	10.14	-0.75	-1.37
LPN-METU-3-B	7.75	10.20		-2.00	
LPN-METU-4-A	9.90	10.13	10.19	-1.25	-1.58
LPN-METU-4-B	7.13	10.25		-2.50	
LPN-METU-4-C	9.73	10.10		-1.00	
LPN-METU-5-A	9.95	10.55	10.64	-5.50	-5.75
LPN-METU-5-B	10.25	10.73		-7.25	
LPN-METU-5-C	10.13	10.45		-4.50	

(all measurement in cm)

Table 25: Water absorption raw data of each sample.

Water absorption will be measured by absorbed water compare to the surface (kg/m2)							
Minute	**0**	**1**	**5**	**14**	**30**	**55**	**surface**
LPN-KERK-1-A	1024	1159	1239	1298	1367	1428	21474.75
LPN-KERK-1-B	912	1053	1121	1194	1244	1279	20629.81
LPN-KERK-1-C	1218	1350	1427	1524	1576	1625	21162.75
LPN-KERK-2-A	647	716	750	772	802	828	20149.5
LPN-KERK-2-B	743	860	921	975	1026	1072	20578.5
LPN-KERK-2-C	927	980	1030	1072	1114	1163	20881.13
LPN-KERK-3-A	764	833	868	899	937	965	19625.44
LPN-KERK-3-B	598	671	705	742	790	828	20576.31
LPN-KERK-3-C	685	803	862	895	938	970	19925.06

Table 25 continued:

Minute	0	1	5	14	30	55	surface
LPN-KERK-4-A	690	799	829	869	893	933	20526.19
LPN-KERK-4-B	639	752	797	827	851	882	21398.44
LPN-KERK-4-C	349	423	442	458	470	492	14568.75
LPN-KERK-5-A	552	616	643	671	704	741	19448.5
LPN-KERK-5-B	564	667	722	753	769	804	20493
LPN-KERK-5-C	517	568	605	642	669	704	20700
LPN-KERK-6-A	822	885	920	956	997	1024	20797.88
LPN-KERK-6-B	754	833	885	936	971	1016	19843.25
LPN-KERK-6-C	679	767	797	829	859	889	20534.25
SPN-KERK-1-A	596	703	729	753	786	797	19900.13
SPN-KERK-1-B	570	664	691	722	750	790	19398.38
SPN-KERK-1-C	593	882	909	943	974	1018	20827.81
SPN-KERK-2-A	434	519	546	557	586	587	20878
SPN-KERK-2-B	566	630	667	706	751	774	20832.56
SPN-KERK-2-C	585	649	683	710	736	739	19378.13
LPN-METU-1-A	1193	1252	1295	1370	1439	1490	21139.5
LPN-METU-1-B	959	1084	1143	1189	1237	1273	21446.25
LPN-METU-1-C	928	1011	1058	1109	1158	1207	19949.75
LPN-METU-2-A	827	882	930	993	1038	1080	21114
LPN-METU-2-B	697	760	815	864	913	951	20527.13
LPN-METU-2-C	695	770	792	832	874	906	19584
LPN-METU-3-A	480	540	571	630	661	702	19355
LPN-METU-3-B	449	510	541	591	622	653	19833.75
LPN-METU-4-A	554	599	626	646	673	697	21000
LPN-METU-4-B	313	375	395	403	419	532	20049.25
LPN-METU-4-C	577	635	681	706	730	769	20603.38
LPN-METU-5-A	388	455	475	486	487	501	21787.5
LPN-METU-5-B	492	550	560	578	590	610	22046.88
LPN-METU-5-C	439	498	525	532	537	539	21009.38
STRAW-KERK-1-A	988	1113	1150	1183	1215	1247	19875
STRAW-KERK-1-B	988	1079	1109	1142	1181	1203	21189.88
STRAW-KERK-2-A	596	671	698	724	745	764	21216
STRAW-KERK-2-B	569	648	666	693	711	727	22255.88
FIRED-BRICK	1718	1762	1809	1827	1880	1939	17787
AAC	909	973	983	998	1013	1033	20826
MUD-BRICK	1610	1762	1836	1951	2085	2140	20737.5

APPENDIX C

DATA RELATED TO MATERIAL PERFORMANCES

Raw data on thermal performances of pine needle lightweight loam mixes together with straw LWL, AAC, polystyrene and mud brick samples are given. Vapor resistivity data tables include composition of samples as well as density, shrinkage and water absorption values of preliminary samples produced.

Table 26: Raw Data of the Vapor Resistivity Test for LPN-METU-4-A, LPN-METU-3-A, LPN-KERK-6-A and LPN-KERK-3-A

	Exterior		DC01		DC02		DC04		DC12	
Sample			LPN-METU-4-A		LPN-METU-3-A		LPN-KERK-6-A		LPN-KERK-3-A	
DATE	T. (°C)	RH (%)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)
13.6.18 13:00	20.5	70.2	55.6	20.2	49.1	20.5	52.2	20.5	20.4	52
13.6.18 13:15	19.8	71.6	55.6	20.2	48.6	20.5	51.7	20.5	20.3	52
13.6.18 13:30	19.5	72.6	55.6	20.2	48.6	20.8	52.2	19.9	20.2	52.3
13.6.18 13:45	19.4	73.7	55.6	20.2	48.6	20.5	52.6	20.2	20.2	52.5
13.6.18 14:00	19.4	73.6	56.1	19.9	48.6	19.9	53.1	19.9	20.1	52.8
13.6.18 14:15	19.4	72.8	56.1	19.9	48.6	19.9	53.1	19.9	20	53
13.6.18 14:30	19.4	72.4	56.1	19.9	48.6	19.9	53.1	19.5	20	53
13.6.18 14:45	19.5	71.7	56.1	19.9	48.6	19.9	53.1	19.5	19.9	53.2
13.6.18 15:00	19.6	70.1	56.1	19.2	48.6	19.9	53.1	19.5	19.9	53
13.6.18 15:15	19.6	68.4	56.1	19.5	48.6	19.9	53.1	19.2	19.8	53
13.6.18 15:30	19.5	68.4	56.1	19.5	48.6	19.9	53.1	19.2	19.7	53
13.6.18 15:45	19.4	68.9	55.6	19.5	48.6	19.9	53.1	19.2	19.7	53.2
13.6.18 16:00	19.3	68.7	56.1	19.2	48.6	19.9	53.1	19.2	19.6	53.2
13.6.18 16:15	19.3	69.9	56.1	19.5	48.6	19.9	53.1	19.2	19.5	53.2
13.6.18 16:30	19.5	70.8	56.1	19.2	48.6	19.9	53.1	18.9	19.5	53.2
13.6.18 18:15	20.2	65.2	56.6	19.2	48.1	19.9	53.1	19.2	19.5	52.8
13.6.18 18:30	20	64.9	56.1	18.9	48.1	19.9	53.1	19.2	19.4	52.8
13.6.18 18:45	19.8	65.1	56.1	18.9	48.6	20.2	53.1	19.2	19.4	53
13.6.18 19:00	19.7	65.6	56.1	18.9	48.6	20.2	53.1	19.2	19.4	53.2
13.6.18 19:15	19.6	66.7	56.1	19.2	48.6	20.2	53.1	19.2	19.3	53.2
13.6.18 19:30	19.6	66.5	56.6	18.9	48.6	19.5	53.1	19.2	19.3	53.2
13.6.18 19:45	19.6	67.1	56.6	18.9	48.6	20.2	53.1	19.2	19.3	53.2
13.6.18 20:00	19.5	67.2	56.1	18.9	48.6	20.2	53.1	19.2	19.2	53.2

Table 26 continued:

	Exterior		DC01		DC02		DC04		DC12	
Sample			LPN-METU-4-A		LPN-METU-3-A		LPN-KERK-6-A		LPN-KERK-3-A	
DATE	T. (°C)	RH (%)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)
13.6.18 20:15	19.5	67.7	56.1	19.2	48.6	19.9	53.1	18.6	19.2	53.2
13.6.18 20:30	19.4	68	56.1	18.9	48.6	19.9	53.1	18.6	19.2	53.5
13.6.18 20:45	19.4	68.6	56.1	18.9	48.6	19.5	53.1	18.6	19.1	53.2
13.6.18 21:00	19.4	69.1	56.1	18.9	48.6	19.5	53.1	18.9	19.1	53.5
13.6.18 21:15	19.3	69.4	56.1	18.9	48.6	19.5	53.1	18.9	19.1	53.5
13.6.18 21:30	19.3	69.2	56.1	18.6	48.6	19.5	53.1	18.9	19.1	53.7
13.6.18 21:45	19.2	69.3	56.1	18.6	48.6	19.5	53.6	19.2	19	53.5
13.6.18 22:00	19.2	69.3	56.6	18.6	48.6	19.5	53.6	18.9	19	53.5
13.6.18 22:15	19.2	69.4	56.6	18.6	48.6	19.5	53.6	18.9	19	53.7
13.6.18 22:30	19.2	69.6	56.6	18.6	48.6	19.5	53.1	18.9	19	53.7
13.6.18 22:45	19.2	69.5	56.6	18.6	48.6	19.5	53.1	18.6	18.9	53.7
13.6.18 23:00	19.1	69.7	56.6	18.9	48.6	19.5	53.6	18.6	18.9	53.7
13.6.18 23:15	19.1	69.3	56.6	18.9	48.6	19.5	53.6	18.6	18.9	53.7
13.6.18 23:30	19	68.9	56.6	18.9	48.6	19.5	53.6	18.3	18.8	53.9
13.6.18 23:45	19	68.7	56.6	18.9	48.6	19.5	53.6	18.6	18.8	53.9
13.6.19 00:00	18.9	68.6	56.6	18.6	48.6	19.2	53.6	18.6	18.8	53.9
13.6.19 00:15	18.9	68.4	56.6	18.6	48.6	19.2	53.6	18.6	18.8	53.9
13.6.19 00:30	18.9	68.3	56.6	18.6	48.6	19.2	53.6	18.6	18.7	53.9
13.6.19 00:45	18.9	68.1	56.6	18.6	48.6	19.2	53.6	18.6	18.7	53.9
13.6.19 01:00	18.8	68	57.1	18.6	48.6	19.2	53.6	18.6	18.7	53.9
13.6.19 01:15	18.8	68.1	57.1	18.6	48.6	18.9	53.6	18.9	18.6	53.9
13.6.19 01:30	18.8	68.1	57.1	18.3	48.6	18.9	53.6	18.9	18.6	54.2
13.6.19 01:45	18.7	68.2	57.1	18	48.6	18.9	53.6	18.6	18.6	54.2
13.6.19 02:00	18.7	67.8	57.1	18	48.6	18.9	53.6	18.6	18.5	53.9
13.6.19 02:15	18.7	67.8	57.1	18	48.6	18.9	53.6	18.6	18.5	53.9
13.6.19 02:30	18.6	67.6	57.1	18.3	48.6	18.9	54.1	18.6	18.5	54.2
13.6.19 02:45	18.6	67.6	57.1	18.3	48.6	18.9	54.1	18.6	18.5	54.2
13.6.19 03:00	18.5	67.7	57.1	18.3	48.6	18.9	54.1	18.3	18.4	54.2
13.6.19 03:15	18.5	67.7	57.1	18.3	48.6	18.9	54.1	18.3	18.4	54.2
13.6.19 03:30	18.4	67.8	57.1	18	48.6	18.9	54.1	18.3	18.4	54.2
13.6.19 03:45	18.4	68	57.1	18.3	48.6	18.9	54.1	18	18.3	54.2
13.6.19 04:00	18.3	68.1	57.1	18.3	48.6	18.9	54.1	18	18.3	54.4
13.6.19 04:15	18.3	68.1	57.1	18.3	48.6	18.6	54.1	18	18.3	54.4
13.6.19 04:30	18.2	68.2	57.1	18	48.6	18.6	54.1	18	18.2	54.4
13.6.19 04:45	18.2	68.4	57.1	18	48.6	18.6	54.6	18.3	18.2	54.4
13.6.19 05:00	18.1	68.5	57.1	17.4	48.6	18.3	54.6	18.3	18.2	54.4
13.6.19 05:15	18.1	68.8	57.1	18	48.6	18.3	54.6	18.3	18.1	54.4
13.6.19 05:30	18	68.6	57.1	18	48.6	18.6	54.6	18	18.1	54.7
13.6.19 05:45	18	68.5	57.1	18	48.6	18.6	54.6	18	18	54.7
13.6.19 06:00	18	68.7	57.1	17.4	48.6	18.3	54.6	18	18	54.4
13.6.19 06:15	18	68.7	57.6	17.4	48.6	18.3	54.6	18	18	54.4
13.6.19 06:30	18	68.6	57.6	17.7	48.6	18.3	54.6	18	18	54.7
13.6.19 06:45	18	68.6	57.6	17.7	48.6	18.3	54.6	18	17.9	54.7
13.6.19 07:00	18	69.1	57.6	17.7	48.6	18.3	54.6	18	17.9	54.7
13.6.19 07:15	18	69.1	57.6	17.7	48.6	18.3	54.6	17.4	17.9	54.7
13.6.19 07:30	18	69.3	57.6	17.7	48.6	18	54.6	17.4	17.9	54.7

Table 26 continued:

	Exterior		DC01		DC02		DC04		DC12	
Sample			LPN-METU-4-A		LPN-METU-3-A		LPN-KERK-6-A		LPN-KERK-3-A	
DATE	T. (°C)	RH (%)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)
13.6.19 07:45	18	70	57.6	17.7	48.6	18	54.6	17.4	17.9	54.7
13.6.19 08:00	18	70.3	57.6	17.7	48.6	18	54.6	17.4	17.9	54.7
13.6.19 08:15	18.1	70.8	57.6	17.7	48.6	18	54.6	17.4	17.8	54.7
13.6.19 08:30	18.1	71.2	57.6	17.4	48.6	18	54.6	17.4	17.8	54.4
13.6.19 08:45	18.1	70.8	57.6	17.4	49.1	18	54.6	17.4	17.8	54.7
13.6.19 09:00	18.2	71	57.6	17.4	49.1	18	54.6	17.4	17.8	54.7
13.6.19 09:15	18.2	71.1	57.6	17.4	49.1	18	54.6	17.4	17.9	54.7
13.6.19 09:30	18.2	70.6	58.1	17.4	49.1	18	54.6	18	17.9	54.7
13.6.19 09:45	18.2	70.2	58.1	17.4	48.6	18	54.6	17.4	17.9	54.7
13.6.19 10:00	18.3	69.8	58.1	17.4	48.6	18	54.6	18	17.9	54.7
13.6.19 10:15	18.3	69.7	58.1	17.4	48.6	18.3	54.1	18	17.9	54.4
13.6.19 10:30	18.3	69.7	58.1	17.4	48.6	18	54.1	18	17.9	54.4
13.6.19 10:45	18.4	68.4	58.1	17.4	48.6	18	54.1	18	17.9	54.7
13.6.19 11:00	18.4	67.9	58.1	17.4	49.1	18	54.1	18	17.9	54.7
13.6.19 11:15	18.4	67.9	58.1	17.7	48.6	18.3	54.1	17.7	17.9	54.7
13.6.19 11:30	18.5	67.6	58.1	17.7	49.1	18	54.1	17.7	17.9	54.7
13.6.19 11:45	18.5	67.1	58.1	17.7	49.1	18	54.1	17.7	18	54.9
13.6.19 12:00	18.6	66.3	58.1	17.7	48.6	18.3	54.1	17.7	18	54.9
13.6.19 12:15	18.6	66	58.1	17.7	48.6	18.3	54.1	17.7	18	54.9
13.6.19 12:30	18.7	65.3	58.1	17.7	48.6	18.6	54.1	17.7	18	54.7
13.6.19 12:45	18.7	65	58.1	17.7	48.6	18.3	54.1	17.7	18	54.7
13.6.19 13:00	18.7	65.1	58.1	17.7	48.6	18.6	54.1	17.7	18	54.7
13.6.19 13:15	18.8	64.9	58.1	17.7	48.6	18.6	54.1	18	18	54.7
13.6.19 13:30	18.9	64.7	58.1	17.7	48.6	18.6	54.6	18	18.1	54.7
13.6.19 13:45	18.9	63.8	58.1	17.7	48.6	18.6	54.6	18	18.1	54.7
13.6.19 14:00	19	63.2	58.1	17.7	48.6	18.6	54.6	18	18.1	54.7
13.6.19 14:15	19.1	63.5	58.1	18	48.6	18.6	54.6	18	18.1	54.9
13.6.19 14:30	19.2	62.2	58.1	18	48.6	18.6	54.6	18	18.2	54.9
13.6.19 14:45	19.4	61.5	58.1	18	49.1	18.6	54.6	18	18.2	54.9
13.6.19 15:00	19.5	61.2	58.1	18.3	49.1	18.6	54.6	18	18.2	54.9
13.6.19 15:15	19.7	60.9	57.6	18.3	49.1	18.6	54.6	18	18.3	54.7
13.6.19 15:30	19.9	60.1	57.6	18.3	48.6	18.6	54.6	18.3	18.4	54.9
13.6.19 15:45	20.1	59.4	57.6	18.3	49.1	18.9	54.6	18.3	18.4	54.9
13.6.19 16:00	20.2	58.8	57.6	18.3	48.6	18.6	54.6	18.3	18.5	54.9
13.6.19 16:15	20.3	58.9	57.6	18.3	49.1	18.9	54.6	18.3	18.5	55.1
13.6.19 16:30	20.3	58.4	57.6	18.6	49.1	19.2	54.6	18.3	18.6	55.1
13.6.19 16:45	20.4	58.1	57.6	18.6	49.1	19.2	54.6	18.6	18.6	54.9
13.6.19 17:00	20.5	57.7	57.6	18.6	49.1	18.9	54.6	18.6	18.7	55.1
13.6.19 17:15	20.7	57.3	57.6	18.9	49.1	19.2	54.6	18.6	18.8	55.1
13.6.19 17:30	20.7	57.2	57.6	18.9	49.1	19.2	54.6	18.6	18.8	55.1
13.6.19 17:45	20.8	57.4	58.1	18.9	49.1	19.5	55.1	18.6	18.9	55.4
13.6.19 18:00	20.7	57.5	58.1	18.9	49.1	19.5	55.1	18.6	18.9	55.4
13.6.19 18:15	20.7	57.6	58.1	18.9	49.1	19.2	55.1	18.9	19	55.1
13.6.19 18:30	20.7	57.8	58.1	18.9	49.1	19.5	55.1	18.6	19	55.4
13.6.19 18:45	20.8	58.7	58.1	18.6	49.1	19.5	55.1	18.6	19.1	55.4
13.6.19 19:00	20.8	59.5	58.1	18.6	49.1	20.2	55.1	18.6	19.1	55.4

Table 26 continued:

	Exterior		DC01		DC02		DC04		DC12	
Sample			LPN-METU-4-A		LPN-METU-3-A		LPN-KERK-6-A		LPN-KERK-3-A	
DATE	T. (°C)	RH (%)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)
13.6.19 19:15	20.7	60.1	58.1	18.6	49.1	20.2	55.1	18.6	19.1	55.4
13.6.19 19:30	20.6	60.7	58.1	18.6	49.1	20.2	55.1	18.6	19.1	55.4
13.6.19 19:45	20.5	61.2	58.1	18.9	49.1	20.2	55.1	18.9	19.2	55.4
13.6.19 20:00	20.4	61.7	58.1	18.9	49.1	20.2	55.1	18.9	19.2	55.6
13.6.19 20:15	20.4	62	58.6	19.2	49.1	20.2	55.1	18.9	19.2	55.6
13.6.19 20:30	20.3	62.3	58.6	19.2	49.5	19.9	55.5	18.9	19.2	55.6
13.6.19 20:45	20.2	62.6	58.6	19.2	49.5	19.9	55.5	19.2	19.2	55.6
13.6.19 21:00	20.2	63	58.1	19.2	49.5	19.9	55.5	19.2	19.2	55.9
13.6.19 21:15	20.2	63.5	58.6	18.9	49.5	19.9	55.5	18.9	19.2	55.6
13.6.19 21:30	20.2	64.1	58.6	18.9	49.5	19.9	55.5	19.2	19.2	55.6
13.6.19 21:45	20.1	64.8	58.6	18.9	49.5	19.9	55.5	18.6	19.2	55.9
13.6.19 22:00	20.1	64.6	58.6	18.9	49.5	19.9	55.5	18.6	19.2	55.9
13.6.19 22:15	20.1	64.9	58.6	18.9	49.5	19.5	55.5	18.6	19.2	55.9
13.6.19 22:30	20	64.7	58.6	18.9	50	20.2	55.5	18.9	19.2	55.9
13.6.19 22:45	20	64.5	58.6	19.2	50	20.2	56	18.9	19.2	56.1
13.6.19 23:00	20	64.9	58.6	19.2	49.5	20.2	56	18.9	19.1	56.1
13.6.19 23:15	20	65.2	59.1	18.9	50	20.2	55.5	18.9	19.1	55.9
13.6.19 23:30	20	65.5	59.1	19.2	49.5	19.9	55.5	18.9	19.2	56.1
13.6.19 23:45	19.9	65.5	59.1	19.2	49.5	19.9	55.5	19.2	19.1	56.1
13.6.20 00:00	19.9	65.7	59.1	18.6	49.5	19.9	56	19.2	19.1	56.1
13.6.20 00:15	19.9	65.9	59.1	18.6	49.5	19.9	56	19.2	19.1	56.3
13.6.20 00:30	19.9	66	59.1	18.6	49.5	19.5	56	18.6	19.1	56.3
13.6.20 00:45	19.8	66.1	59.1	18.9	49.5	19.9	56	18.6	19.1	56.3
13.6.20 01:00	19.8	66.3	59.1	18.9	50	19.2	56	18.6	19.1	56.6
13.6.20 01:15	19.7	66.4	59.6	18.9	49.5	19.9	56	18.9	19.1	56.3
13.6.20 01:30	19.7	66.5	59.6	18.9	49.5	19.2	56	18.9	19.1	56.6
13.6.20 01:45	19.7	66.8	59.6	18.9	50	19.2	56.5	18.9	19	56.3
13.6.20 02:00	19.6	66.9	59.6	18.9	50	19.2	56.5	18.9	19	56.6
13.6.20 02:15	19.6	66.1	59.6	18.9	50	19.5	56.5	19.2	19	56.8
13.6.20 02:30	19.5	66.6	59.6	18.6	50	19.5	56.5	18.9	19	56.6
13.6.20 02:45	19.5	66.6	59.6	18.6	50	19.5	56.5	18.9	19	56.8
13.6.20 03:00	19.5	67.3	59.6	18.6	50	19.5	56.5	18.6	18.9	56.8
13.6.20 03:15	19.4	67.1	59.6	18.6	50	19.2	56.5	18.6	18.9	56.8
13.6.20 03:30	19.4	66.2	59.6	18.6	50	19.5	56.5	18.3	18.9	57.1
13.6.20 03:45	19.3	65.5	59.6	18.3	50	19.5	56.5	18.6	18.9	56.8
13.6.20 04:00	19.2	65.7	59.6	18.6	50	19.5	57	18.6	18.8	56.8
13.6.20 04:15	19.2	65.5	59.6	18.6	50	19.2	56.5	18.9	18.8	57.1
13.6.20 04:30	19.1	65.3	59.6	18.6	50	19.2	56.5	18.9	18.8	57.1
13.6.20 04:45	19	64.7	59.6	18.6	50	19.2	56.5	18.9	18.7	57.1
13.6.20 05:00	19	64.4	59.6	18.6	50	19.2	56.5	18.9	18.7	57.1
13.6.20 05:15	18.9	64.7	59.6	18.3	50	19.5	56.5	18.9	18.6	57.1
13.6.20 05:30	18.9	64.8	59.6	18.3	50	18.9	56.5	18.6	18.6	57.1
13.6.20 05:45	18.8	64.7	59.6	18.3	50	18.9	56.5	18.6	18.6	57.1
13.6.20 06:00	18.8	64.4	59.6	18.3	50	18.9	56.5	18.6	18.5	57.1
13.6.20 06:15	18.7	64.2	59.6	18.3	50	18.9	56.5	18.6	18.5	57.1
13.6.20 06:30	18.7	63.8	59.6	18.3	50	18.9	56.5	18.6	18.4	57.1

Table 26 continued:

	Exterior		DC01		DC02		DC04		DC12	
Sample			LPN-METU-4-A		LPN-METU-3-A		LPN-KERK-6-A		LPN-KERK-3-A	
DATE	T. (°C)	RH (%)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)
13.6.20 06:45	18.6	63.5	59.6	18.3	50	18.9	56.5	18.6	18.4	57.1
13.6.20 07:00	18.5	63.2	59.6	18.3	50	18.9	56.5	18.6	18.3	57.1
13.6.20 07:15	18.5	63.1	59.6	18	50	18.9	56.5	18.3	18.3	57.1
13.6.20 07:30	18.5	63.3	59.6	18	50	18.9	56.5	18.3	18.3	57.1
13.6.20 07:45	21.9	53.5	59.6	18	50	18.9	56.5	18	18.2	56.8
13.6.20 08:00	24.1	48	59.6	18.3	50.4	18.9	57.5	18.3	18.8	58.3
13.6.20 08:15	26.3	42.8	59.6	18.9	50.4	19.5	58	19.5	19.7	58.5
13.6.20 08:30	28.5	39	60.1	19.5	50.4	20.2	58	21.4	20.7	58.3
13.6.20 08:45	31.7	33.6	59.6	20.2	50	21.1	56.5	22.7	21.8	58
13.6.20 09:00	35.5	28	59.6	21.1	50	22.4	55.5	24.1	22.9	57.8
13.6.20 09:15	39.2	23.3	59.6	22.1	50	23.4	54.6	26.1	24	57.3
13.6.20 09:30	39.9	22.3	59.6	23.4	50	24.4	54.1	26.9	25.1	57.5
13.6.20 09:45	37.5	23.8	59.6	24.4	50	25.4	53.1	29.1	26.4	57.3
13.6.20 10:00	37.8	24	59.6	25.4	49.5	26.5	51.7	30.2	27.7	57.1
13.6.20 10:15	40	22.5	59.1	26.5	49.5	27.9	51.2	31.4	29	56.8
13.6.20 10:30	43.2	19.6	59.1	28.3	49.5	29.1	50.2	32.2	30.3	56.8
13.6.20 10:45	45.5	16.9	58.6	29.1	49.1	30.6	48.8	33.5	31.5	56.3
13.6.20 11:00	46.9	15.4	57.6	30.2	48.6	31.8	48.8	34.3	32.6	55.6
13.6.20 11:15	47.5	15	57.1	31.8	48.6	32.6	49.3	35.2	33.7	55.1
13.6.20 11:30	47.6	15.5	56.6	33.5	48.6	34.3	49.3	35.7	34.8	55.4
13.6.20 11:45	48.1	15.3	56.1	34.3	48.6	36.1	49.3	37	35.8	55.1
13.6.20 12:00	49.1	14.6	56.1	35.2	48.6	36.6	49.3	38	36.9	55.6
13.6.20 12:15	49.5	14.5	55.2	36.6	48.6	38.5	49.3	38.9	38	55.6
13.6.20 12:30	49.9	13.9	54.2	38.5	48.6	39.4	48.8	38.9	39	55.4
13.6.20 12:45	50.2	14.3	53.2	39.4	48.6	40.4	49.3	40.4	40.1	55.1
13.6.20 13:00	50.6	13.1	52.2	40.4	48.6	42.6	48.3	41	41	54.9
13.6.20 13:15	51.1	12.8	51.8	42.6	48.6	42.6	47.8	41	41.9	54.7
13.6.20 13:30	52.2	12.1	51.3	43.7	48.6	42.6	47.3	42	42.5	54.2
13.6.20 13:45	53.8	11	51.8	43.1	48.6	43.7	45.9	42.6	42.9	53.7
13.6.20 14:00	55.3	10.5	51.3	44.2	49.1	44.8	46.4	43.1	43.3	53.5
13.6.20 14:15	56.4	9.8	50.8	44.8	48.6	44.8	47.3	44.2	43.7	53
13.6.20 14:30	56.4	10.4	49.8	46	48.6	44.8	46.4	43.7	44	52.5
13.6.20 14:45	56.7	10.4	48.9	44.8	47.7	46	45.4	44.8	44.3	52.3
13.6.20 15:00	57.7	10.2	47.9	45.4	47.2	46	44.9	44.2	44.5	52.5
13.6.20 15:15	56.4	10.4	47	45.4	46.3	46.6	44	44.2	44.5	52
13.6.20 15:30	52.9	11.5	46.1	45.4	45.9	46.6	43.1	44.8	44.5	51.3
13.6.20 15:45	51.1	12.4	45.1	46	45.9	48.5	42.2	44.8	44.3	50.8
13.6.20 16:00	51.4	12	44.2	46	45.5	48.5	41.3	43.7	44.1	49.4
13.6.20 16:15	51.8	11.9	44.2	45.4	45	48.5	41.3	43.1	43.8	48.7
13.6.20 16:30	50.2	12.5	43.3	45.4	45	48.5	40.3	43.7	43.5	48
13.6.20 16:45	47.5	13.1	42.3	44.2	43.7	48.5	39	42.6	43	46.8
13.6.20 17:00	45.7	14.3	42.3	43.1	43.2	47.9	39	42	42.3	46
13.6.20 17:15	44.1	15	42.3	43.1	43.2	48.5	39	41.5	41.5	45.8
13.6.20 17:30	40.8	16.1	42.3	42	42.8	47.9	38.5	39.9	40.6	45.1
13.6.20 17:45	39	17.7	42.3	41.5	42.3	46	38.5	38.9	39.6	45.1
13.6.20 18:00	37.7	18.7	42.3	41	41.9	46.6	38.5	38	38.7	44.9

Table 26 continued:

	Exterior		DC01		DC02		DC04		DC12	
Sample			LPN-METU-4-A		LPN-METU-3-A		LPN-KERK-6-A		LPN-KERK-3-A	
DATE	T. (°C)	RH (%)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)
13.6.20 18:15	36.3	19.2	42.3	38.9	41.9	45.4	38.5	37.5	37.8	44.6
13.6.20 18:30	34.9	19.6	41.4	38.9	41.5	44.8	38	36.1	36.8	44.4
13.6.20 18:45	33.4	20.5	41	38.5	41	43.1	38	35.7	35.9	44.2
13.6.20 19:00	32.1	21.6	40.5	37	40.6	42.6	37.6	34.3	35	43.9
13.6.20 19:15	30.8	23.3	40.5	36.6	41	42	38	33.9	34	43.7
13.6.20 19:30	29.3	23.6	40	35.7	40.6	40.4	37.6	32.6	33.1	43.5
13.6.20 19:45	27.7	24.8	40	34.3	40.6	38.9	37.6	31.8	32.1	43.5
13.6.20 20:00	26.2	25.8	39.6	33	40.6	37.5	38	31	31.1	43.2
13.6.20 20:15	24.9	27	39.6	31.4	40.6	36.1	38	29.4	30.1	43
13.6.20 20:30	23.8	28.3	39.6	30.6	40.6	34.3	38	28.3	29.2	43
13.6.20 20:45	22.9	29.6	40	29.4	40.6	32.6	38.5	27.6	28.2	42.8
13.6.20 21:00	22.2	31.1	40	28.3	40.6	31.4	38.5	26.9	27.4	42.6
13.6.20 21:15	21.5	32.4	40	27.2	40.6	30.2	39	26.1	26.5	42.6
13.6.20 21:30	20.9	33.3	40	26.9	40.6	29.1	39	25.1	25.7	42.6
13.6.20 21:45	20.3	34.5	40.5	25.8	40.6	28.3	39	24.1	24.9	42.3
13.6.20 22:00	19.9	35.5	41	25.4	40.6	26.5	39.4	23.7	24.2	42.3
13.6.20 22:15	19.5	36.6	41	23.7	40.6	26.1	39	23.4	23.5	42.1
13.6.20 22:30	19.1	37.4	41.4	23.4	40.2	25.1	39	22.4	22.9	42.1
13.6.20 22:45	18.8	38.2	41.4	22.4	40.2	24.4	39.4	21.8	22.3	42.1
13.6.20 23:00	18.5	38.8	41.9	22.1	40.2	24.1	39.4	21.1	21.8	42.1
13.6.20 23:15	18.2	39.8	42.3	22.1	39.7	22.7	39.4	20.8	21.2	41.9
13.6.20 23:30	17.9	40.2	42.3	21.1	39.7	22.7	39.4	20.8	20.8	42.1
13.6.20 23:45	17.7	41.1	42.3	20.5	39.7	21.8	39.4	20.2	20.3	41.9
13.6.21 00:00	17.4	41.7	42.3	20.2	39.7	21.4	39.4	19.5	19.9	41.9
13.6.21 00:15	17.2	42.4	42.3	19.9	39.7	20.8	39.4	19.2	19.5	41.9
13.6.21 00:30	17	43.2	42.3	19.5	39.7	20.2	39.9	18.6	19.1	41.9
13.6.21 00:45	16.8	43.8	42.3	18.9	39.7	20.2	39.9	18.6	18.8	41.6
13.6.21 01:00	16.6	44.5	42.3	18.6	39.3	19.2	39.9	18	18.4	41.6
13.6.21 01:15	16.5	45	42.3	18.3	39.3	18.9	39.9	17.4	18.1	41.6
13.6.21 01:30	16.3	45.6	42.3	18	39.3	18.6	39.9	17.1	17.8	41.9
13.6.21 01:45	16.2	46.3	42.8	18	39.3	18	39.9	17.1	17.6	41.9
13.6.21 02:00	16	46.5	42.8	17.4	39.3	18	39.9	16.8	17.3	41.6
13.6.21 02:15	15.9	47	42.8	17.7	39.3	17.4	39.9	16.5	17.1	41.6
13.6.21 02:30	15.7	47.5	42.8	17.1	39.3	17.4	39.9	16.5	16.8	41.6
13.6.21 02:45	15.6	47.9	42.8	17.1	39.3	17.4	39.9	16.2	16.6	41.6
13.6.21 03:00	15.4	48.8	42.8	16.8	39.3	17.1	39.9	16	16.4	41.4
13.6.21 03:15	15.3	49.3	43.3	16.5	39.3	16.8	39.9	16	16.2	41.4
13.6.21 03:30	15.1	49.7	43.3	16.2	39.3	16.5	39.9	16	16	41.6
13.6.21 03:45	15	50.3	43.3	16.2	39.3	16.2	40.3	15.4	15.8	41.6
13.6.21 04:00	14.9	50.7	43.3	15.7	39.3	16	40.3	15.4	15.6	41.6
13.6.21 04:15	14.7	50.9	43.3	15.7	39.3	15.7	40.3	15.1	15.5	41.6
13.6.21 04:30	14.6	51	43.3	15.7	39.3	15.7	40.3	14.8	15.3	41.6
13.6.21 04:45	14.4	51.5	43.3	15.4	39.3	15.7	40.3	14.5	15.1	41.6
13.6.21 05:00	14.3	51.7	43.3	15.4	39.3	15.4	40.3	14.5	15	41.6
13.6.21 05:15	14.3	52.2	43.3	15.4	39.3	15.1	40.3	14.5	14.8	41.6
13.6.21 05:30	14.3	52.3	43.3	15.1	39.3	14.8	40.3	14.2	14.7	41.6

Table 26 continued:

	Exterior		DC01		DC02		DC04		DC12	
Sample			LPN-METU-4-A		LPN-METU-3-A		LPN-KERK-6-A		LPN-KERK-3-A	
DATE	T. (°C)	RH (%)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)
13.6.21 05:45	14.4	52.1	43.3	14.8	39.3	15.1	40.3	14	14.6	41.6
13.6.21 06:00	14.7	52	43.3	14.8	39.3	14.8	40.3	14	14.5	41.4
13.6.21 06:15	15	51.8	43.3	14.8	39.3	14.8	40.3	14	14.5	41.4
13.6.21 06:30	15.4	50.8	43.3	14.8	39.3	14.5	40.3	14.2	14.5	41.6
13.6.21 06:45	16	50.4	43.7	15.1	39.7	15.1	40.3	14.2	14.6	42.1
13.6.21 07:00	16.8	49.6	43.7	15.1	39.7	15.1	40.8	14.5	14.8	42.3
13.6.21 07:15	17.8	48.3	44.2	15.4	40.6	15.4	40.8	14.5	15.1	42.8
13.6.21 07:30	19.1	46.3	44.6	15.7	40.6	15.7	41.3	15.4	15.6	43.2
13.6.21 07:45	20.8	44.4	44.2	16	41	16	41.7	16	16.3	43.9
13.6.21 08:00	23.3	40.6	44.6	16.2	41	16.8	41.7	16.8	17.2	44.2
13.6.21 08:15	25.9	36.8	45.1	17.4	41	17.7	42.2	18	18.2	44.6
13.6.21 08:30	28.8	32.8	45.6	18.3	41.5	18.3	42.6	19.5	19.4	45.3
13.6.21 08:45	31.3	28.9	45.6	19.2	41.5	19.5	42.6	21.4	20.7	45.3
13.6.21 09:00	32.4	26.4	45.6	20.5	41.5	20.5	42.2	22.7	21.8	45.1
13.6.21 09:15	35	22.8	45.6	21.4	41.5	21.8	41.7	23.7	22.8	45.1
13.6.21 09:30	37.3	21	46.1	22.4	41.5	23.4	41.7	25.1	23.9	45.3
13.6.21 09:45	36.9	21.3	46.5	23.4	41.9	24.4	41.7	26.9	25.3	45.3
13.6.21 10:00	37.6	20.3	46.1	25.1	41.5	25.8	41.3	28.3	26.8	45.3
13.6.21 10:15	37.6	19.6	45.6	26.5	41	27.2	40.3	29.8	27.9	45.1
13.6.21 10:30	38.9	18.9	45.6	27.2	41	27.9	40.3	30.2	28.8	45.1
13.6.21 10:45	42.7	15.6	45.6	28.3	41.5	29.1	39.9	31	30	45.3
13.6.21 11:00	45	13.8	45.6	29.8	41.5	30.2	39.4	33	31.3	45.3
13.6.21 11:15	46.9	12.9	45.1	31.4	41.5	32.2	39.9	33.9	32.5	45.1
13.6.21 11:30	47.5	12.4	44.6	33	41.5	33.5	39.9	34.8	33.8	45.1
13.6.21 11:45	47.9	11.8	44.2	33.9	41.5	34.8	39.4	35.7	35	45.1
13.6.21 12:00	48.1	12	44.2	35.2	41.5	36.1	39.4	36.1	36.2	45.1
13.6.21 12:15	48.6	11.9	43.3	36.1	41.5	38.5	39	38	37.3	45.1
13.6.21 12:30	48.4	11.4	42.3	38	41.5	38.9	38.5	38	38.3	44.9
13.6.21 12:45	48.4	11.8	41.9	39.4	41.5	39.9	39	38.9	39.3	44.9
13.6.21 13:00	48.7	11.6	42.3	40.4	41.5	40.4	39	40.4	40.1	44.9
13.6.21 13:15	49.6	11.1	42.3	42	41	42.6	38.5	39.9	40.9	44.9
13.6.21 13:30	51.1	10.3	41.9	42.6	41.5	42.6	37.6	41.5	41.6	44.9
13.6.21 13:45	52.5	9.1	41.9	43.7	41.5	42	36.7	42	42	44.6
13.6.21 14:00	53.8	8.5	41.9	44.8	41.5	43.1	37.1	42	42.4	44.2
13.6.21 14:15	54.9	8.4	41.9	44.2	41.5	44.2	38	42	42.7	43.7
13.6.21 14:30	55.1	8.3	40.5	44.8	41.5	44.8	37.1	43.7	43	43.5
13.6.21 14:45	55	8.7	40	45.4	40.6	44.8	37.1	42.6	43.2	43.9
13.6.21 15:00	55.9	8.5	39.1	45.4	40.2	46	36.2	43.7	43.4	43.5
13.6.21 15:15	54.5	8.7	37.8	45.4	39.3	47.2	34.8	43.1	43.4	42.8
13.6.21 15:30	50.8	10	37.8	44.8	39.3	46	34.8	43.7	43.3	42.3
13.6.21 15:45	49.2	10.9	37.3	45.4	39.3	46.6	34.4	43.1	43.1	42.1
13.6.21 16:00	50	10.7	36.4	44.8	39.3	46.6	34.4	42	42.9	41.4
13.6.21 16:15	50.1	10.5	36	43.7	38.9	46.6	33.5	42	42.7	40.5
13.6.21 16:30	46.9	11.7	35.5	43.1	38.4	47.9	32.6	41.5	42.2	39.8
13.6.21 16:45	44.9	12.3	34.6	43.7	38	47.9	32.6	41.5	41.7	39.1
13.6.21 17:00	42.9	13.9	35.1	42	37.1	46.6	32.6	39.9	41	39.1
13.6.21 17:15	41.6	14.7	35.5	42	36.7	45.4	32.6	39.4	40.2	38.9

Table 26 continued:

	Exterior		DC01		DC02		DC04		DC12	
Sample			LPN-METU-4-A		LPN-METU-3-A		LPN-KERK-6-A		LPN-KERK-3-A	
DATE	T. (°C)	RH (%)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)
13.6.21 17:30	40.1	15.8	36	41	36.3	47.2	32.6	38.5	39.4	38.7
13.6.21 17:45	38.5	17.1	36.4	41	36.7	46.6	32.6	38.5	38.5	38.7
13.6.21 18:00	37	18.2	36	39.9	36.7	45.4	32.6	37	37.7	38.4
13.6.21 18:15	35.5	19.1	35.5	39.4	36.3	44.2	32.6	37	36.9	38.4
13.6.21 18:30	34.1	20.2	36	38	36.3	44.8	32.6	36.1	36	38.2
13.6.21 18:45	32.7	21.4	35.5	38	35.9	43.7	32.6	34.8	35.2	38
13.6.21 19:00	31.4	22.4	35.5	36.6	35.4	42.6	33	33.9	34.3	37.7
13.6.21 19:15	30.3	23.3	35.5	35.7	35	42	33	33	33.4	37.5
13.6.21 19:30	28.9	24	35.1	34.8	35	41.5	32.6	32.2	32.6	37.5
13.6.21 19:45	27.3	25	34.2	34.3	35	38.9	32.6	31.4	31.7	37
13.6.21 20:00	25.7	25.8	33.8	32.6	34.6	37	32.6	30.2	30.7	36.8
13.6.21 20:15	24.4	26.8	33.8	31.8	34.6	35.2	32.6	29.1	29.8	36.8
13.6.21 20:30	23.3	28.2	33.8	30.2	34.6	34.3	33	28.3	28.9	36.6
13.6.21 20:45	22.4	29.9	34.2	29.8	34.6	32.6	32.6	27.6	28	36.6
13.6.21 21:00	21.6	31.8	34.2	27.9	34.6	31.4	32.6	26.9	27.1	36.1
13.6.21 21:15	21	33.4	34.6	27.6	34.6	30.2	32.6	25.8	26.2	36.1
13.6.21 21:30	20.4	34.7	35.1	26.1	34.6	29.1	33	24.7	25.4	36.1
13.6.21 21:45	19.9	35.7	35.1	25.4	34.6	28.3	33	24.1	24.7	35.9
13.6.21 22:00	19.5	36.5	35.5	24.7	34.6	26.5	33	23.7	24	35.9
13.6.21 22:15	19	37.5	35.5	24.1	34.6	25.8	33.5	23.1	23.3	35.9
13.6.21 22:30	18.6	38.2	36	23.4	34.6	25.1	33.5	22.4	22.7	35.9
13.6.21 22:45	18.3	39.1	35.5	22.4	34.6	24.1	33.5	21.8	22.1	35.7
13.6.21 23:00	18	40	35.5	22.1	34.6	23.4	33.5	21.1	21.5	35.7
13.6.21 23:15	17.7	40.5	35.5	21.4	34.6	22.7	33.5	20.5	21	35.7
13.6.21 23:30	17.5	41.3	36	21.1	34.6	21.8	33.5	20.2	20.5	35.4
13.6.21 23:45	17.2	42.3	36	20.5	34.6	21.8	33.9	19.5	20	35.4
13.6.22 00:00	17	42.8	36	20.2	34.6	21.1	33.9	19.2	19.6	35.4
13.6.22 00:15	16.8	43.5	36	19.5	34.6	20.5	33.9	18.9	19.2	35.4
13.6.22 00:30	16.6	43.9	36	19.2	34.2	20.2	33.9	18.3	18.9	35.4
13.6.22 00:45	16.4	44.4	36.4	18.9	34.2	19.5	33.9	18.3	18.5	35.2
13.6.22 01:00	16.2	45.1	36.4	18.6	34.2	18.9	33.9	17.7	18.2	35.2
13.6.22 01:15	16.1	45.4	36.4	18	34.2	18.6	33.9	17.7	17.9	35.4
13.6.22 01:30	15.9	45.7	36.4	17.7	34.2	18.3	33.9	17.1	17.6	35.2
13.6.22 01:45	15.7	46.2	36.4	17.7	34.2	18	33.9	17.1	17.3	35.2
13.6.22 02:00	15.6	46.5	36.4	17.1	34.2	17.4	33.9	16.8	17	35.2
13.6.22 02:15	15.4	46.9	36.4	17.1	34.2	17.4	33.9	16.5	16.8	35.2
13.6.22 02:30	15.3	47.3	36.4	17.1	34.2	17.1	33.9	16.2	16.6	35.2
13.6.22 02:45	15.1	47.6	36.4	16.5	33.7	16.8	33.9	16.2	16.3	35
13.6.22 03:00	14.9	47.9	36.9	16.2	33.7	16.5	33.9	16	16.1	35.2
13.6.22 03:15	14.7	48.4	36.9	16.2	33.7	16.2	33.9	15.7	15.9	35.2
13.6.22 03:30	14.6	49	36.9	16	33.7	16	33.9	15.4	15.7	35.2
13.6.22 03:45	14.4	49.4	36.9	15.7	33.7	15.7	33.9	15.1	15.5	35.2
13.6.22 04:00	14.2	49.9	36.9	15.4	33.7	15.7	33.9	14.8	15.3	35
13.6.22 04:15	14.1	50.3	36.9	15.4	33.7	15.4	33.9	14.8	15.1	35
13.6.22 04:30	14	50.5	36.9	15.4	33.7	15.1	33.9	14.5	14.9	35
13.6.22 04:45	13.9	50.8	36.9	15.4	33.7	15.1	34.4	14.2	14.7	35
13.6.22 05:00	13.8	51.1	36.9	14.8	33.7	14.8	34.4	14	14.5	35

Table 27: Raw Data of the Vapor Resistivity Test for LPN-METU-1-A, LPN-KERK-2-C, STRAW-KERK-2, AAC and SPN-KERK-2-B

	DC13		DC14		DC16		DC17		DC18	
Sample	LPN-METU-1-A		LPN-KERK-2-C		STRAW-KERK-2		AAC		SPN-KERK-2-B	
DATE	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)
13.06.2018 13:00	20.1	54.4	20.4	57	20.4	60.5	19.9	88.9	20.4	55.5
13.06.2018 13:15	20.1	54.4	20.4	56.7	20.3	60	19.9	88.4	20.4	55
13.06.2018 13:30	20.1	54.7	20.3	56.7	20.2	60.2	19.8	89.2	20.3	55
13.06.2018 13:45	20	54.4	20.2	57	20	60.5	19.7	90	20.2	55.3
13.06.2018 14:00	20	54.7	20.1	57.4	19.9	60.5	19.6	91.1	20.1	55.5
13.06.2018 14:15	20	54.7	20	57.4	19.8	60.7	19.6	91.8	20.1	55.5
13.06.2018 14:30	19.9	54.7	20	57.7	19.7	61	19.5	92.6	20	55.5
13.06.2018 14:45	19.9	54.7	19.9	57.7	19.6	61.2	19.5	93.4	20	55.5
13.06.2018 15:00	19.9	54.9	19.9	57.7	19.6	61.2	19.5	94.2	20	55.5
13.06.2018 15:15	19.9	54.7	19.8	57.9	19.5	61.5	19.5	94.7	20	55.3
13.06.2018 15:30	19.8	54.4	19.8	57.9	19.4	61.8	19.4	95	20	55.3
13.06.2018 15:45	19.8	54.4	19.7	57.7	19.4	61.8	19.4	95	19.9	55
13.06.2018 16:00	19.7	54.2	19.7	57.9	19.3	61.8	19.3	95.3	19.8	55
13.06.2018 16:15	19.7	54.4	19.6	57.9	19.2	61.8	19.3	95.5	19.8	55
13.06.2018 16:30	19.7	54.7	19.6	57.9	19.2	62	19.2	96.6	19.8	55.3
13.06.2018 16:45	19.7	54.4	19.5	58.2	19.2	62.3	19.2	97.1	19.8	55.5
13.06.2018 17:00	19.7	54.4	19.6	58.4	19.2	62.5	19.3	97.9	19.8	55.3
13.06.2018 17:15	19.7	54.7	19.6	58.4	19.2	62.8	19.3	98.2	19.9	55.5
13.06.2018 17:30	19.7	54.4	19.6	58.4	19.2	62.8	19.3	98.2	20	55.5
13.06.2018 17:45	19.7	54.4	19.6	58.4	19.2	63	19.4	98.7	20	55.3
13.06.2018 18:00	19.8	54.2	19.6	58.4	19.2	63.3	19.4	98.7	20.1	55.5
13.06.2018 18:15	19.8	54.4	19.6	58.7	19.2	63	19.4	98.7	20.1	55.3
13.06.2018 18:30	19.8	54.4	19.6	58.4	19.2	63	19.4	98.7	20.1	54.8
13.06.2018 18:45	19.7	54.4	19.6	58.4	19.1	63	19.4	98.7	20	54.8
13.06.2018 19:00	19.7	54.2	19.6	58.4	19.1	63	19.3	99.2	20	54.8
13.06.2018 19:15	19.6	54.2	19.5	58.4	19.1	63.3	19.3	99.5	19.9	55
13.06.2018 19:30	19.6	54.2	19.5	58.4	19	63.3	19.3	99.8	19.9	55
13.06.2018 19:45	19.6	54.4	19.5	58.4	19	63.3	19.2	99.8	19.9	55
13.06.2018 20:00	19.6	54.4	19.4	58.4	19	63.5	19.2	100	19.8	55
13.06.2018 20:15	19.5	54.4	19.4	58.7	18.9	63.5	19.2	100	19.8	55.3
13.06.2018 20:30	19.5	54.4	19.4	58.7	18.9	63.5	19.2	100	19.7	55.3
13.06.2018 20:45	19.4	54.7	19.3	58.7	18.9	63.8	19.1	100	19.7	55.5
13.06.2018 21:00	19.4	54.7	19.3	58.7	18.8	63.8	19.1	100	19.7	55.5
13.06.2018 21:15	19.4	54.4	19.3	58.9	18.8	64	19.1	100	19.6	55.5
13.06.2018 21:30	19.4	54.4	19.2	58.9	18.8	63.8	19	100	19.6	55.5
13.06.2018 21:45	19.3	54.4	19.2	59.2	18.7	64	19	100	19.6	55.8
13.06.2018 22:00	19.3	54.4	19.2	59.2	18.7	64	19	100	19.5	55.5
13.06.2018 22:15	19.3	54.4	19.2	58.9	18.7	64.3	19	100	19.5	55.5
13.06.2018 22:30	19.2	54.4	19.1	58.9	18.7	64.3	18.9	100	19.5	55.8
13.06.2018 22:45	19.2	54.4	19.1	59.2	18.6	64.3	18.9	100	19.4	55.8
13.06.2018 23:00	19.2	54.4	19.1	59.2	18.6	64.5	18.9	100	19.4	55.8

Table 27 continued:

	DC13		DC14		DC16		DC17		DC18	
Sample	LPN-METU-1-A		LPN-KERK-2-C		STRAW-KERK-2		AAC		SPN-KERK-2-B	
DATE	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)
13.06.2018 23:15	19.2	54.4	19	59.4	18.6	64.5	18.8	100	19.4	55.8
13.06.2018 23:30	19.1	54.4	19	59.2	18.6	64.5	18.8	100	19.3	56
13.06.2018 23:45	19.1	54.2	19	59.2	18.5	64.8	18.8	100	19.3	56
13.06.2019 00:00	19.1	54.2	18.9	59.4	18.5	64.8	18.8	100	19.3	55.8
13.06.2019 00:15	19	54.2	18.9	59.4	18.5	64.8	18.7	100	19.2	55.8
13.06.2019 00:30	19	54.2	18.9	59.4	18.4	64.8	18.7	100	19.2	56
13.06.2019 00:45	19	54.2	18.9	59.4	18.4	64.8	18.7	100	19.2	56
13.06.2019 01:00	19	54.4	18.8	59.4	18.4	64.8	18.6	100	19.1	56
13.06.2019 01:15	18.9	54.4	18.8	59.4	18.3	65	18.6	100	19.1	56
13.06.2019 01:30	18.9	54.4	18.8	59.7	18.3	65	18.6	100	19.1	56
13.06.2019 01:45	18.9	54.4	18.7	59.7	18.3	65	18.6	100	19	56
13.06.2019 02:00	18.9	54.4	18.7	59.4	18.3	65	18.5	100	19	56
13.06.2019 02:15	18.8	54.4	18.7	59.4	18.2	65.3	18.5	100	19	56
13.06.2019 02:30	18.8	54.2	18.6	59.7	18.2	65.3	18.5	100	18.9	56
13.06.2019 02:45	18.7	54.2	18.6	59.7	18.2	65.3	18.4	100	18.9	56.2
13.06.2019 03:00	18.7	54.2	18.6	59.7	18.1	65.5	18.4	100	18.9	56.2
13.06.2019 03:15	18.7	54.2	18.5	59.7	18.1	65.3	18.4	100	18.8	56.2
13.06.2019 03:30	18.6	54.2	18.5	59.9	18.1	65.3	18.3	100	18.8	56.2
13.06.2019 03:45	18.6	54.2	18.5	59.7	18	65.5	18.3	100	18.7	56
13.06.2019 04:00	18.6	54.2	18.4	59.7	18	65.5	18.3	100	18.7	56
13.06.2019 04:15	18.5	54.2	18.4	59.9	18	65.5	18.2	100	18.7	56.2
13.06.2019 04:30	18.5	54.2	18.3	59.9	17.9	65.5	18.2	100	18.6	56.2
13.06.2019 04:45	18.5	53.9	18.3	59.9	17.9	65.8	18.2	100	18.6	56.2
13.06.2019 05:00	18.4	54.2	18.3	59.9	17.8	65.8	18.1	100	18.5	56.2
13.06.2019 05:15	18.4	54.2	18.2	59.9	17.8	65.8	18.1	100	18.5	56.2
13.06.2019 05:30	18.3	54.2	18.2	59.9	17.8	65.8	18	100	18.5	56.5
13.06.2019 05:45	18.3	53.9	18.1	59.9	17.7	65.8	18	100	18.4	56.2
13.06.2019 06:00	18.3	53.9	18.1	60.2	17.7	65.8	18	100	18.4	56.5
13.06.2019 06:15	18.2	54.2	18.1	60.2	17.7	66	17.9	100	18.3	56.5
13.06.2019 06:30	18.2	54.2	18.1	59.9	17.6	66	17.9	100	18.3	56.5
13.06.2019 06:45	18.2	54.2	18	60.2	17.6	66.3	17.9	100	18.3	56.5
13.06.2019 07:00	18.2	54.2	18	60.2	17.6	66	17.8	100	18.3	56.5
13.06.2019 07:15	18.1	54.2	18	60.2	17.6	66.3	17.8	100	18.2	56.7
13.06.2019 07:30	18.1	54.4	18	60.4	17.6	66.6	17.8	100	18.2	56.7
13.06.2019 07:45	18.1	54.4	18	60.2	17.6	66.6	17.8	100	18.2	56.5
13.06.2019 08:00	18.1	54.2	18	60.4	17.5	66.8	17.8	100	18.2	56.7
13.06.2019 08:15	18.1	54.4	18	60.4	17.5	66.8	17.8	100	18.2	56.7
13.06.2019 08:30	18.1	54.4	17.9	60.7	17.5	66.8	17.8	100	18.2	56.7
13.06.2019 08:45	18.1	54.4	18	60.4	17.6	66.8	17.8	100	18.2	57
13.06.2019 09:00	18.1	54.7	18	60.7	17.6	66.8	17.8	100	18.2	57
13.06.2019 09:15	18.1	54.4	18	60.7	17.6	67.1	17.8	100	18.3	57
13.06.2019 09:30	18.1	54.4	18	60.7	17.6	67.1	17.8	100	18.3	57
13.06.2019 09:45	18.1	54.4	18	60.7	17.6	67.3	17.8	100	18.3	57.2
13.06.2019 10:00	18.1	54.4	18	60.9	17.6	67.3	17.8	100	18.3	57.2
13.06.2019 10:15	18.1	54.4	18	60.7	17.6	67.3	17.8	100	18.3	57.5
13.06.2019 10:30	18.1	54.4	18	60.7	17.6	67.3	17.8	100	18.4	57.5

Table 27 continued:

	DC13		DC14		DC16		DC17		DC18	
Sample	LPN-METU-1-A		LPN-KERK-2-C		STRAW-KERK-2		AAC		SPN-KERK-2-B	
DATE	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)
13.06.2019 10:45	18.1	54.4	18	60.9	17.7	67.6	17.8	100	18.4	57.2
13.06.2019 11:00	18.2	54.4	18.1	60.9	17.7	67.6	17.8	100	18.4	57.5
13.06.2019 11:15	18.2	54.4	18.1	60.9	17.7	67.6	17.9	100	18.4	57.5
13.06.2019 11:30	18.2	54.2	18.1	60.9	17.7	67.6	17.9	100	18.4	57.5
13.06.2019 11:45	18.2	54.4	18.1	60.9	17.7	67.8	17.9	100	18.5	57.5
13.06.2019 12:00	18.2	54.2	18.1	60.9	17.7	67.6	17.9	100	18.5	57.2
13.06.2019 12:15	18.2	54.2	18.1	60.9	17.7	67.8	17.9	100	18.5	57.2
13.06.2019 12:30	18.2	54.2	18.2	60.9	17.8	67.8	18	100	18.6	57.2
13.06.2019 12:45	18.3	54.2	18.2	60.9	17.8	67.8	18	100	18.6	57.2
13.06.2019 13:00	18.3	54.2	18.2	61.2	17.8	67.8	18	100	18.6	57.2
13.06.2019 13:15	18.3	53.9	18.2	61.2	17.8	67.8	18	100	18.6	57.2
13.06.2019 13:30	18.3	53.9	18.3	60.9	17.8	67.8	18.1	100	18.7	57.5
13.06.2019 13:45	18.3	53.9	18.3	60.9	17.8	67.8	18.1	100	18.7	57.5
13.06.2019 14:00	18.4	53.9	18.3	60.9	17.9	68.1	18.1	100	18.7	57.5
13.06.2019 14:15	18.4	53.9	18.3	60.9	17.9	67.8	18.1	100	18.8	57.5
13.06.2019 14:30	18.4	53.7	18.4	60.9	17.9	68.1	18.2	100	18.8	57.5
13.06.2019 14:45	18.5	53.9	18.4	60.9	18	68.1	18.2	100	18.9	57.5
13.06.2019 15:00	18.5	53.7	18.5	60.9	18	68.1	18.3	100	19	57.2
13.06.2019 15:15	18.6	53.7	18.5	60.9	18	68.3	18.4	100	19.1	57.2
13.06.2019 15:30	18.7	53.7	18.6	60.9	18.1	68.3	18.5	100	19.2	57.2
13.06.2019 15:45	18.8	53.7	18.7	60.9	18.2	68.1	18.6	100	19.3	57.2
13.06.2019 16:00	18.8	53.4	18.7	61.2	18.2	68.3	18.6	100	19.4	57
13.06.2019 16:15	18.9	53.4	18.8	60.9	18.3	68.1	18.7	100	19.5	57
13.06.2019 16:30	19	53.4	18.9	60.9	18.3	68.1	18.8	100	19.6	57.2
13.06.2019 16:45	19	53.4	18.9	60.9	18.4	68.1	18.9	100	19.7	57.2
13.06.2019 17:00	19.1	53.2	19	61.2	18.5	68.1	19	100	19.8	57.2
13.06.2019 17:15	19.2	53.2	19.1	61.2	18.5	68.3	19	100	19.9	57.2
13.06.2019 17:30	19.2	53.4	19.2	60.9	18.6	68.3	19.1	100	20	57.2
13.06.2019 17:45	19.3	53.2	19.2	60.9	18.7	68.3	19.2	100	20	57.2
13.06.2019 18:00	19.4	53.2	19.3	60.9	18.7	68.1	19.3	100	20.1	57.2
13.06.2019 18:15	19.4	53.2	19.3	60.7	18.7	68.3	19.3	100	20.2	57.2
13.06.2019 18:30	19.5	53.4	19.4	60.9	18.8	68.3	19.4	100	20.2	57
13.06.2019 18:45	19.5	53.4	19.4	60.9	18.8	68.3	19.4	100	20.2	57.2
13.06.2019 19:00	19.5	53.4	19.5	60.9	18.9	68.3	19.5	100	20.3	57.2
13.06.2019 19:15	19.6	53.2	19.5	60.9	18.9	68.3	19.5	100	20.3	57.2
13.06.2019 19:30	19.6	53.2	19.5	60.9	18.9	68.3	19.5	100	20.3	57.5
13.06.2019 19:45	19.6	53.4	19.5	61.2	18.9	68.3	19.5	100	20.3	57.5
13.06.2019 20:00	19.6	53.4	19.5	61.2	18.9	68.6	19.5	100	20.3	57.7
13.06.2019 20:15	19.6	53.7	19.5	61.2	18.9	68.6	19.5	100	20.3	57.7
13.06.2019 20:30	19.6	53.7	19.5	61.2	18.9	68.6	19.5	100	20.3	57.9
13.06.2019 20:45	19.6	53.7	19.5	61.4	18.9	68.6	19.5	100	20.2	57.7
13.06.2019 21:00	19.6	53.9	19.5	61.4	18.9	68.8	19.5	100	20.2	57.9
13.06.2019 21:15	19.7	53.9	19.5	61.2	18.9	68.6	19.5	100	20.2	57.9
13.06.2019 21:30	19.7	53.7	19.5	61.4	18.9	68.6	19.5	100	20.2	58.2
13.06.2019 21:45	19.6	53.9	19.5	61.4	18.9	68.8	19.5	100	20.1	58.2
13.06.2019 22:00	19.6	53.9	19.5	61.4	18.9	68.8	19.5	100	20.1	58.4

Table 27 continued:

	DC13		DC14		DC16		DC17		DC18	
Sample	LPN-METU-1-A		LPN-KERK-2-C		STRAW-KERK-2		AAC		SPN-KERK-2-B	
DATE	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)
13.06.2019 22:15	19.6	53.9	19.5	61.7	18.9	68.8	19.5	0	20.1	58.2
13.06.2019 22:30	19.6	54.2	19.5	61.7	18.9	68.8	19.5	0	20.1	58.2
13.06.2019 22:45	19.6	53.9	19.5	61.7	18.9	68.8	19.4	0	20.1	58.4
13.06.2019 23:00	19.6	53.9	19.5	61.7	18.9	68.8	19.4	0	20	58.4
13.06.2019 23:15	19.6	53.9	19.5	61.4	18.9	69.1	19.4	0	20	58.4
13.06.2019 23:30	19.6	53.9	19.5	61.7	18.9	69.1	19.4	0	20	58.4
13.06.2019 23:45	19.6	54.2	19.4	61.7	18.9	69.1	19.4	0	20	58.7
13.06.2020 00:00	19.6	54.2	19.4	61.7	18.8	68.8	19.4	0	20	58.7
13.06.2020 00:15	19.6	54.2	19.4	61.9	18.8	69.1	19.4	0	19.9	58.7
13.06.2020 00:30	19.6	53.9	19.4	61.9	18.8	69.1	19.3	0	19.9	58.7
13.06.2020 00:45	19.6	54.2	19.4	61.9	18.8	69.1	19.3	0	19.9	58.7
13.06.2020 01:00	19.5	54.2	19.4	61.9	18.8	69.1	19.3	0	19.9	58.7
13.06.2020 01:15	19.5	54.2	19.4	61.7	18.8	69.1	19.3	0	19.8	58.9
13.06.2020 01:30	19.5	54.2	19.3	61.9	18.8	69.1	19.3	0	19.8	58.9
13.06.2020 01:45	19.5	54.2	19.3	61.9	18.7	69.1	19.2	0	19.8	58.9
13.06.2020 02:00	19.5	54.2	19.3	61.9	18.7	69.1	19.2	0	19.7	58.7
13.06.2020 02:15	19.4	54.2	19.3	61.9	18.7	69.1	19.2	0	19.7	58.9
13.06.2020 02:30	19.4	54.2	19.2	61.9	18.7	69.1	19.2	0	19.7	58.9
13.06.2020 02:45	19.4	54.2	19.2	62.2	18.7	69.1	19.1	0	19.7	58.9
13.06.2020 03:00	19.4	54.2	19.2	62.2	18.6	69.3	19.1	0	19.6	59.2
13.06.2020 03:15	19.4	54.2	19.2	61.9	18.6	69.3	19.1	0	19.6	58.9
13.06.2020 03:30	19.3	54.2	19.1	61.9	18.6	69.3	19.1	0	19.6	58.9
13.06.2020 03:45	19.3	54.2	19.1	61.9	18.5	69.3	19	0	19.5	58.9
13.06.2020 04:00	19.3	54.2	19.1	61.9	18.5	69.1	19	0	19.5	58.9
13.06.2020 04:15	19.2	54.2	19	61.9	18.5	69.1	19	0	19.4	58.9
13.06.2020 04:30	19.2	54.2	19	61.9	18.4	69.1	18.9	0	19.4	58.9
13.06.2020 04:45	19.1	54.2	19	61.9	18.4	69.1	18.9	0	19.3	59.2
13.06.2020 05:00	19.1	54.2	18.9	62.2	18.4	69.1	18.8	0	19.3	58.9
13.06.2020 05:15	19.1	54.2	18.9	62.2	18.3	69.1	18.8	0	19.2	58.9
13.06.2020 05:30	19	54.2	18.8	62.2	18.3	69.1	18.8	0	19.2	58.9
13.06.2020 05:45	19	54.2	18.8	61.9	18.2	69.1	18.7	0	19.1	58.9
13.06.2020 06:00	18.9	54.2	18.7	61.9	18.2	69.1	18.7	0	19.1	58.9
13.06.2020 06:15	18.9	54.2	18.7	61.9	18.2	69.1	18.6	0	19	58.9
13.06.2020 06:30	18.9	54.2	18.6	61.9	18.1	68.8	18.6	0	19	58.9
13.06.2020 06:45	18.8	53.9	18.6	61.9	18.1	69.1	18.5	0	18.9	58.9
13.06.2020 07:00	18.8	53.9	18.5	61.7	18	69.1	18.5	0	18.9	58.7
13.06.2020 07:15	18.7	53.9	18.5	61.9	18	69.1	18.4	0	18.8	58.9
13.06.2020 07:30	18.7	53.9	18.5	61.9	17.9	69.1	18.4	0	18.8	58.9
13.06.2020 07:45	18.7	53.9	18.4	62.2	17.9	68.6	18.4	0	18.8	59.2
13.06.2020 08:00	19	53.7	18.8	62.7	18.6	70.6	18.8	0	19.2	59.2
13.06.2020 08:15	19.3	53.2	19.5	62.7	19.7	70.9	19.3	0	19.7	59.4
13.06.2020 08:30	19.7	53	20.2	62.7	20.9	71.1	20.2	0	20.4	59.4
13.06.2020 08:45	20.2	53	21	62.4	22.2	71.1	21.1	0	21.2	59.6
13.06.2020 09:00	20.8	52.7	22	62.7	23.6	70.9	22.2	0	22.1	59.4
13.06.2020 09:15	21.4	53	23.1	62.7	25.1	70.3	23.2	0	23	59.2
13.06.2020 09:30	22.2	53	24.3	62.4	26.6	69.8	24.2	0	24	59.2

Table 27 continued:

	DC13		DC14		DC16		DC17		DC18	
Sample	LPN-METU-1-A		LPN-KERK-2-C		STRAW-KERK-2		AAC		SPN-KERK-2-B	
DATE	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)
13.06.2020 09:45	23.1	53	25.4	62.4	28.1	68.8	25.3	0	25	59.2
13.06.2020 10:00	24	53.2	26.4	62.2	29.5	67.8	26.3	0	26.1	59.2
13.06.2020 10:15	25.1	53.4	27.5	61.7	30.6	67.1	27.3	0	27.2	59.2
13.06.2020 10:30	26.2	53.2	28.7	61.4	31.8	66.8	28.3	0	28.3	59.2
13.06.2020 10:45	27.4	53.2	30.1	61.2	32.9	66.3	29.2	0	29.6	59.2
13.06.2020 11:00	28.5	53	31.5	60.9	34	66	30.1	0	30.9	58.9
13.06.2020 11:15	29.8	53.2	32.9	60.4	35.1	65.5	31	0	32.3	58.7
13.06.2020 11:30	31.1	53	34.3	59.7	36.2	65	31.8	100	33.6	58.2
13.06.2020 11:45	32.3	53	35.6	59.4	37.2	64.5	32.7	100	34.9	57.7
13.06.2020 12:00	33.7	52.7	37	59.2	38.3	63.8	33.7	100	36.1	57.2
13.06.2020 12:15	35.1	52.7	38.2	58.4	39.3	63	34.8	100	37.3	57.2
13.06.2020 12:30	36.4	52.7	39.3	57.9	40.1	62.5	35.9	100	38.4	57
13.06.2020 12:45	37.7	52.5	40.4	57.2	40.9	62	37.1	100	39.5	56.7
13.06.2020 13:00	38.9	52.5	41.3	56.2	41.7	61.8	38.3	100	40.6	56.2
13.06.2020 13:15	39.8	52.7	42.1	55.5	42.3	61.5	39.3	100	41.6	55.8
13.06.2020 13:30	40.6	52.7	42.8	55.3	42.9	60	40.3	100	42.4	55.5
13.06.2020 13:45	41.2	52.7	43.5	54.1	43.4	58.2	41.1	100	43.1	54.8
13.06.2020 14:00	41.7	52.7	44.1	53.1	43.9	57.2	41.7	100	43.7	54.3
13.06.2020 14:15	42.2	52.7	44.7	52.6	44.4	56.5	42.3	97.1	44.2	53.8
13.06.2020 14:30	42.6	52.7	45	52.2	44.6	56	42.6	94.7	44.5	53.6
13.06.2020 14:45	43	52.7	45.2	51.5	44.8	55.5	42.9	94.5	44.7	52.8
13.06.2020 15:00	43.3	52.7	45.3	50.3	44.8	54.8	43.1	89.2	44.8	52.1
13.06.2020 15:15	43.5	52.5	45.2	49.1	44.7	53.6	43.3	85.8	44.7	51.4
13.06.2020 15:30	43.7	51.7	45	48.3	44.6	52.6	43.4	85.8	44.5	50.9
13.06.2020 15:45	43.7	51.5	44.7	47.9	44.4	52.1	43.4	86.1	44.4	50.9
13.06.2020 16:00	43.7	50.8	44.4	47.4	44.2	51.2	43.3	84.8	44.1	50.4
13.06.2020 16:15	43.6	50.5	44.2	47.1	43.9	50.7	43.1	84	43.8	50.2
13.06.2020 16:30	43.4	50.3	44.1	46.9	43.5	50	42.7	81.7	43.5	49.7
13.06.2020 16:45	43.2	49.5	43.8	45	42.9	48.5	42.3	78.3	43	49
13.06.2020 17:00	42.8	49.5	43.6	44.3	42.2	47.8	41.7	77.1	42.4	49
13.06.2020 17:15	42.4	49.3	43.4	42.9	41.4	47	41.2	76	41.8	48.5
13.06.2020 17:30	41.8	49.3	42.7	40.9	40.3	46.6	40.5	74.2	41	48
13.06.2020 17:45	41.2	49.3	42.1	40.9	39.2	46.6	39.7	74.2	40.2	48
13.06.2020 18:00	40.5	49.3	41.5	41.1	38.2	46.6	39	74	39.4	47.7
13.06.2020 18:15	39.9	49.5	40.8	40.9	37.2	46.3	38.3	73.5	38.6	47.5
13.06.2020 18:30	39.3	49.3	40	41.1	36.2	46.3	37.6	73.2	37.8	47.3
13.06.2020 18:45	38.6	48.8	39.1	40.9	35.2	45.8	36.8	72.2	37	46.8
13.06.2020 19:00	37.8	48.8	38.1	40.4	34.2	45.8	36.1	71.7	36.2	46.3
13.06.2020 19:15	37.1	48.8	37.1	40.2	33.2	45.8	35.3	71.2	35.4	46.1
13.06.2020 19:30	36.3	48.6	36.1	39.5	32.2	45.6	34.5	70.7	34.5	45.8
13.06.2020 19:45	35.4	48.3	35	39.2	31.1	45.4	33.6	70.5	33.5	45.4
13.06.2020 20:00	34.5	48.3	33.8	39	30.1	45.4	32.7	70	32.5	45.1
13.06.2020 20:15	33.6	48.1	32.7	38.8	29.1	45.4	31.8	69.5	31.5	44.4
13.06.2020 20:30	32.6	47.8	31.5	38.8	28.1	45.4	30.8	69.2	30.5	44.2
13.06.2020 20:45	31.7	47.6	30.4	39.2	27.2	45.4	29.9	69	29.5	43.9
13.06.2020 21:00	30.8	47.6	29.3	39.2	26.2	45.4	29	69.2	28.6	43.5

Table 27 continued:

	DC13		DC14		DC16		DC17		DC18	
Sample	LPN-METU-1-A		LPN-KERK-2-C		STRAW-KERK-2		AAC		SPN-KERK-2-B	
DATE	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)
13.06.2020 21:15	29.9	47.6	28.3	39.2	25.4	45.4	28.2	69.2	27.7	43.2
13.06.2020 21:30	29	47.4	27.4	39.2	24.6	45.6	27.4	69.5	26.8	43
13.06.2020 21:45	28.2	47.1	26.5	39.5	23.8	45.6	26.6	69.7	26	43
13.06.2020 22:00	27.4	47.1	25.7	39.7	23.1	45.6	25.8	69.7	25.2	42.8
13.06.2020 22:15	26.7	47.1	24.9	39.7	22.4	45.6	25.1	70	24.5	42.5
13.06.2020 22:30	26	46.9	24.2	39.7	21.8	45.6	24.5	70.5	23.8	42.3
13.06.2020 22:45	25.3	46.9	23.6	39.9	21.2	45.8	23.8	70.5	23.2	42
13.06.2020 23:00	24.7	46.9	22.9	39.9	20.7	46.1	23.2	70.7	22.6	42
13.06.2020 23:15	24.1	46.6	22.4	40.2	20.2	45.8	22.7	71	22.1	42
13.06.2020 23:30	23.5	46.6	21.9	40.2	19.8	46.1	22.2	71.2	21.5	41.6
13.06.2020 23:45	23	46.4	21.4	40.2	19.4	46.1	21.7	71.4	21.1	41.6
13.06.2021 00:00	22.5	46.4	20.9	40.4	19	46.1	21.2	71.7	20.6	41.6
13.06.2021 00:15	22	46.1	20.5	40.4	18.6	46.1	20.8	71.9	20.2	41.6
13.06.2021 00:30	21.5	46.1	20	40.4	18.3	46.3	20.4	72.2	19.8	41.3
13.06.2021 00:45	21.1	46.1	19.7	40.4	17.9	46.1	20	72.5	19.5	41.3
13.06.2021 01:00	20.7	45.9	19.3	40.6	17.6	46.3	19.6	73	19.1	41.3
13.06.2021 01:15	20.3	46.1	19	40.4	17.3	46.3	19.3	73	18.8	41.1
13.06.2021 01:30	19.9	45.9	18.7	40.6	17.1	46.3	18.9	73.2	18.5	41.1
13.06.2021 01:45	19.6	45.9	18.4	40.6	16.9	46.6	18.6	73.5	18.3	41.1
13.06.2021 02:00	19.3	45.9	18.1	40.9	16.6	46.6	18.3	73.7	18	41.1
13.06.2021 02:15	19	45.6	17.8	40.6	16.4	46.6	18.1	74	17.8	41.1
13.06.2021 02:30	18.7	45.9	17.6	40.6	16.2	46.6	17.8	74.2	17.5	41.1
13.06.2021 02:45	18.4	45.6	17.3	40.6	16	46.6	17.6	74.5	17.3	40.9
13.06.2021 03:00	18.1	45.6	17.1	40.9	15.8	46.8	17.3	74.5	17.1	40.9
13.06.2021 03:15	17.8	45.4	16.9	40.9	15.6	46.6	17.1	75	16.9	40.9
13.06.2021 03:30	17.6	45.4	16.7	40.9	15.4	46.8	16.9	75.3	16.7	40.6
13.06.2021 03:45	17.3	45.6	16.5	40.9	15.3	46.8	16.7	75.3	16.5	40.9
13.06.2021 04:00	17.1	45.6	16.3	40.9	15.1	47	16.5	75.8	16.3	40.9
13.06.2021 04:15	16.9	45.4	16.1	40.9	14.9	46.8	16.3	76	16.2	40.9
13.06.2021 04:30	16.7	45.4	15.9	40.9	14.8	47	16.1	76	16	40.9
13.06.2021 04:45	16.5	45.4	15.7	40.9	14.6	47	15.9	76.3	15.8	40.6
13.06.2021 05:00	16.3	45.4	15.6	41.1	14.5	47	15.7	76.6	15.7	40.6
13.06.2021 05:15	16.1	45.2	15.4	41.1	14.3	47	15.5	76.8	15.5	40.6
13.06.2021 05:30	15.9	45.2	15.3	41.1	14.2	47.3	15.4	77.3	15.4	40.6
13.06.2021 05:45	15.8	45.2	15.1	41.1	14.1	47.3	15.3	77.8	15.3	40.6
13.06.2021 06:00	15.6	45.4	15.1	41.1	14.1	47.5	15.2	78.9	15.2	40.4
13.06.2021 06:15	15.6	45.4	15.1	41.5	14.1	47.5	15.1	80.4	15.2	40.4
13.06.2021 06:30	15.6	45.4	15.1	42	14.2	48	15.1	80.9	15.2	40.6
13.06.2021 06:45	15.6	45.4	15.2	42.2	14.3	48	15.1	81.2	15.3	40.9
13.06.2021 07:00	15.7	45.6	15.3	42.5	14.5	48.5	15.2	81.4	15.5	41.1
13.06.2021 07:15	15.8	45.6	15.5	42.7	14.9	49.2	15.4	82.2	15.7	41.3
13.06.2021 07:30	16	45.6	15.9	43.2	15.4	49.5	15.6	83	16	41.8
13.06.2021 07:45	16.3	45.6	16.3	43.6	16.3	49.7	16	83.5	16.5	42.3
13.06.2021 08:00	16.6	45.9	16.9	44.1	17.5	50.2	16.4	85	17.1	42.8
13.06.2021 08:15	17.1	46.1	17.8	44.3	18.7	50.7	17.1	87.4	17.8	43
13.06.2021 08:30	17.7	46.1	18.8	44.8	20.1	51.6	18.2	89.5	18.8	43.5

Table 27 continued:

	DC13		DC14		DC16		DC17		DC18	
Sample	LPN-METU-1-A		LPN-KERK-2-C		STRAW-KERK-2		AAC		SPN-KERK-2-B	
DATE	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)
13.06.2021 08:45	18.5	46.1	19.9	45	21.5	52.1	19.3	90.3	19.9	43.9
13.06.2021 09:00	19.2	46.4	21	44.8	22.8	51.9	20.3	89.5	21	43.9
13.06.2021 09:15	20	46.4	22	45	24	51.9	21.3	89.7	22	43.9
13.06.2021 09:30	20.8	46.9	23.2	45.2	25.3	52.1	22.3	90	23	44.4
13.06.2021 09:45	21.8	47.4	24.5	45.5	27	52.1	23.5	91.1	24.2	44.4
13.06.2021 10:00	22.9	47.6	25.8	45.2	28.5	51.6	24.8	91.3	25.5	44.7
13.06.2021 10:15	24	47.6	26.9	45	29.6	50.9	25.7	89.7	26.5	44.4
13.06.2021 10:30	24.9	47.6	27.8	45	30.4	50.7	26.5	89.2	27.4	44.4
13.06.2021 10:45	26	47.8	29.2	45.2	31.4	51.2	27.5	90	28.7	44.9
13.06.2021 11:00	27.3	47.8	30.7	45.2	32.7	51.2	28.6	89.5	30.1	44.9
13.06.2021 11:15	28.6	48.1	32.3	45.2	34	51.4	29.6	89.5	31.6	44.9
13.06.2021 11:30	30	48.1	33.9	45	35.3	50.9	30.6	89.2	33.1	44.9
13.06.2021 11:45	31.5	48.1	35.5	44.8	36.6	50.4	31.7	88.2	34.6	44.9
13.06.2021 12:00	32.9	48.1	36.9	44.8	37.7	50	32.8	87.6	35.8	44.4
13.06.2021 12:15	34.3	48.1	38.2	44.5	38.8	49.5	33.9	87.4	37	44.2
13.06.2021 12:30	35.7	47.8	39.3	43.8	39.6	48.7	35.1	86.8	38.1	44.2
13.06.2021 12:45	36.9	47.8	40.3	43.4	40.3	48.7	36.3	86.3	39.1	43.9
13.06.2021 13:00	38.1	47.8	41.1	43.2	40.9	48.7	37.4	85.3	40.1	44.2
13.06.2021 13:15	39	47.8	41.9	42.9	41.6	48.7	38.5	84	41	44.2
13.06.2021 13:30	39.8	48.3	42.7	42.5	42.2	47.5	39.4	82.7	41.8	43.9
13.06.2021 13:45	40.4	48.1	43.4	42.5	42.7	46.3	40.2	81.7	42.5	43.7
13.06.2021 14:00	40.8	48.1	44	41.5	43.2	45.8	40.9	80.7	43.1	43.5
13.06.2021 14:15	41.2	48.1	44.5	41.5	43.6	45.4	41.4	78.6	43.6	43.2
13.06.2021 14:30	41.6	48.1	44.9	41.3	43.9	44.9	41.7	77.1	43.9	43.2
13.06.2021 14:45	41.9	48.3	45.1	40.4	44	44.6	42	73.7	44	42.8
13.06.2021 15:00	42.2	47.8	45.1	39	44	44	42.1	71.9	44.1	42.3
13.06.2021 15:15	42.3	47.4	44.9	37.9	43.8	43.3	42.3	71.4	43.9	41.6
13.06.2021 15:30	42.4	46.6	44.6	37.6	43.6	42.3	42.3	71	43.6	41.3
13.06.2021 15:45	42.4	46.4	44.3	37.6	43.4	41.9	42.2	70.5	43.4	41.1
13.06.2021 16:00	42.4	46.1	44	37.6	43.2	41.6	42.1	70.2	43.1	40.6
13.06.2021 16:15	42.3	45.9	43.8	37.6	42.9	41.2	41.9	69	42.9	40.4
13.06.2021 16:30	42	45.4	43.5	36.5	42.4	40	41.5	66	42.4	40.1
13.06.2021 16:45	41.7	44.9	43.2	35.6	41.7	39.6	41	64.5	41.9	39.9
13.06.2021 17:00	41.3	45.2	42.8	35.1	41	39.3	40.4	64.2	41.2	39.7
13.06.2021 17:15	40.8	45.2	42.6	34.4	40.2	39.1	39.8	64	40.6	39.4
13.06.2021 17:30	40.3	45.2	42.2	34.2	39.2	38.9	39.1	64.2	39.9	39.4
13.06.2021 17:45	39.8	45.2	41.9	33.9	38.3	38.9	38.5	64.5	39.2	39.4
13.06.2021 18:00	39.2	45.2	41.5	33.9	37.4	38.6	37.9	64.7	38.5	39.2
13.06.2021 18:15	38.7	44.9	40.8	33.9	36.5	38.6	37.2	64.5	37.8	39.2
13.06.2021 18:30	38.1	44.9	40	33.9	35.5	38.4	36.6	64.5	37.1	39
13.06.2021 18:45	37.5	44.9	39.2	33.9	34.6	38.2	35.9	64.2	36.4	38.5
13.06.2021 19:00	36.8	44.9	38.3	33.5	33.7	37.9	35.2	64	35.6	38.5
13.06.2021 19:15	36.2	44.9	37.3	33.3	32.8	37.9	34.5	64	34.9	38
13.06.2021 19:30	35.5	44.5	36.4	33	31.8	37.9	33.7	63.5	34.1	37.8
13.06.2021 19:45	34.7	44.2	35.3	32.6	30.9	37.7	32.9	63.2	33.2	37.3
13.06.2021 20:00	33.8	44	34.2	31.9	29.9	37.5	32.1	63	32.2	36.8

Table 27 continued:

	DC13		DC14		DC16		DC17		DC18	
Sample	LPN-METU-1-A		LPN-KERK-2-C		STRAW-KERK-2		AAC		SPN-KERK-2-B	
DATE	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)
13.06.2021 20:15	32.9	43.8	33	31.9	28.9	37.2	31.2	62.7	31.3	36.6
13.06.2021 20:30	32	43.8	31.8	31.7	27.9	37.2	30.3	62.7	30.3	36.4
13.06.2021 20:45	31.1	43.5	30.7	31.7	27	37	29.4	62.7	29.3	36.1
13.06.2021 21:00	30.2	43.5	29.6	31.9	26.1	36.8	28.5	62.7	28.3	35.6
13.06.2021 21:15	29.3	43.3	28.6	31.9	25.2	37	27.7	63	27.4	35.4
13.06.2021 21:30	28.5	43.3	27.6	31.9	24.4	37	26.9	63.2	26.5	35.2
13.06.2021 21:45	27.7	43.3	26.7	32.2	23.6	37	26.1	63.2	25.7	34.9
13.06.2021 22:00	26.9	43.1	25.8	32.2	22.9	37	25.3	63.5	25	34.9
13.06.2021 22:15	26.2	42.8	25	32.2	22.3	36.8	24.7	64	24.2	34.7
13.06.2021 22:30	25.5	42.8	24.3	32.2	21.6	36.8	24	64.2	23.6	34.5
13.06.2021 22:45	24.8	42.8	23.6	32.2	21.1	36.8	23.4	64.7	22.9	34.5
13.06.2021 23:00	24.2	42.6	23	32.4	20.5	37	22.8	65	22.3	34.5
13.06.2021 23:15	23.6	42.6	22.4	32.4	20	37	22.2	65	21.8	34.2
13.06.2021 23:30	23.1	42.4	21.8	32.4	19.6	37	21.7	65.2	21.3	34
13.06.2021 23:45	22.5	42.4	21.3	32.2	19.1	37	21.2	65.7	20.8	34.2
13.06.2022 00:00	22	42.1	20.8	32.2	18.7	37	20.8	66	20.3	34
13.06.2022 00:15	21.6	42.1	20.4	32.4	18.4	37.2	20.3	66.2	19.9	33.8
13.06.2022 00:30	21.1	42.1	19.9	32.4	18	37.2	19.9	66.5	19.5	33.8
13.06.2022 00:45	20.7	42.1	19.6	32.4	17.7	37.2	19.6	67	19.2	33.8
13.06.2022 01:00	20.3	41.9	19.2	32.4	17.4	37.2	19.2	67.2	18.8	33.8
13.06.2022 01:15	19.9	41.9	18.8	32.4	17.1	37	18.9	67.5	18.5	33.8
13.06.2022 01:30	19.5	41.9	18.5	32.4	16.9	37	18.5	67.7	18.2	33.8
13.06.2022 01:45	19.2	41.9	18.2	32.4	16.6	37.2	18.2	68.2	17.9	33.6
13.06.2022 02:00	18.8	41.7	17.9	32.4	16.4	37.2	17.9	68.2	17.7	33.6
13.06.2022 02:15	18.5	41.4	17.6	32.4	16.2	37.2	17.7	68.5	17.4	33.8
13.06.2022 02:30	18.2	41.7	17.3	32.4	16	37.2	17.4	69	17.2	33.6
13.06.2022 02:45	17.9	41.4	17.1	32.4	15.7	37.5	17.1	69	17	33.6
13.06.2022 03:00	17.6	41.7	16.9	32.4	15.5	37.5	16.9	69.2	16.7	33.6
13.06.2022 03:15	17.4	41.4	16.6	32.4	15.3	37.2	16.6	69.5	16.5	33.3
13.06.2022 03:30	17.1	41.4	16.4	32.4	15.1	37.2	16.4	69.7	16.3	33.3
13.06.2022 03:45	16.8	41.2	16.1	32.4	15	37.2	16.2	69.7	16.1	33.6
13.06.2022 04:00	16.6	41.4	15.9	32.4	14.8	37.2	16	70.2	15.9	33.6
13.06.2022 04:15	16.4	41.4	15.7	32.4	14.6	37.2	15.8	70.5	15.7	33.6
13.06.2022 04:30	16.1	41.2	15.5	32.4	14.4	37.5	15.6	70.5	15.5	33.6
13.06.2022 04:45	15.9	41.2	15.3	32.4	14.3	37.5	15.4	70.7	15.3	33.6
13.06.2022 05:00	15.7	41.2	15.2	32.4	14.1	37.5	15.2	71.2	15.2	33.6

Table 28: Thermal behavior in boxes during summer time, from 27/06/2013 to 30/06/2013, extracted from a set of data starting on the 06/06/2013 and finishing on the 01/07/2013

			DL03		DL10		DL08		DL12		DL13	
Sample	Exterior		Polystyrene		AAC		LPN-METU-1		LPN-METU-2		LPN-METU-4	
DATE	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)
13.06.27 04:30	20.2	44	20.77	46.52	22.87	92.57	24.77	25.69	24.68	28.45	23.69	31.63
13.06.27 04:45	20	45	20.6	46.69	22.61	92.48	24.61	24.99	24.48	27.72	23.52	30.27
13.06.27 05:00	20.2	44	20.41	47.05	22.37	92.48	24.44	24.76	24.34	27.31	23.28	29.9
13.06.27 05:15	20.1	44	20.22	47.34	22.13	92.61	24.24	26.12	24.12	28.41	23.04	31.29
13.06.27 05:30	19.6	45	20.03	47.57	21.89	92.78	24	26.97	23.91	29.38	22.85	33.09
13.06.27 05:45	19.4	46	19.84	47.83	21.63	92.67	23.81	27.17	23.71	28.84	22.59	31.81
13.06.27 06:00	19.7	45	19.65	48.37	21.41	92.54	23.67	27.23	23.55	29.57	22.32	33.63
13.06.27 06:15	19.9	44	19.58	48.9	21.18	92.67	23.52	26.71	23.42	29.06	22.23	33.1
13.06.27 06:30	19.9	44	19.63	49.31	20.96	92.8	23.4	27.42	23.33	30.75	22.2	33.03
13.06.27 06:45	20.5	42	19.91	49.13	20.77	92.84	23.42	26.49	23.4	32.09	22.18	33.38
13.06.27 07:00	21.3	40	20.41	48.12	20.6	92.87	23.67	28.08	23.91	35.72	22.37	36.7
13.06.27 07:15	21.5	38	21.01	46.39	20.44	92.76	24.44	30.84	24.94	38.76	22.85	40
13.06.27 07:30	21.9	36	21.63	44.39	20.34	92.71	25.43	32.76	25.91	38.97	23.59	43.29
13.06.27 07:45	22.4	36	22.3	42.66	20.27	92.97	26.28	30.82	26.6	36.91	24.32	41.97
13.06.27 08:00	22.9	33	22.99	40.33	20.25	92.98	27.19	31.75	27.16	35.85	25.09	39.7
13.06.27 08:15	23.4	33	23.67	38.37	20.27	93.22	28.12	33.98	27.9	38	25.91	42.49
13.06.27 08:30	24.1	32	24.34	36.46	20.37	93.51	28.77	33.4	28.44	36.88	26.33	37.4
13.06.27 08:45	24.7	30	25.02	34.93	20.48	93.64	29.37	34.09	29.17	36.6	26.97	38.56
13.06.27 09:00	25.2	30	25.67	33.42	20.63	93.86	29.87	30.87	29.59	33.8	27.09	35.32
13.06.27 09:15	25.6	28	26.33	32.03	20.79	93.51	30.22	32.4	29.99	34.22	27.41	35.66
13.06.27 09:30	26.3	27	26.94	31.17	21.03	93.96	30.52	32.46	30.32	33.33	27.85	35.6
13.06.27 09:45	26.7	27	27.58	30.38	21.32	94.4	30.93	31.56	30.8	33.8	28.69	35.99
13.06.27 10:00	26.9	27	28.27	29.48	21.6	94.63	31.05	31.61	31.1	33.82	29.24	34.57
13.06.27 10:15	27.4	27	28.99	28.44	21.89	94.23	31.43	31.75	31.48	32.79	29.54	31.59
13.06.27 10:30	28.3	26	29.62	28.01	22.25	94.69	31.92	31.36	31.92	32.33	30.34	31.87
13.06.27 10:45	28.4	27	30.27	27.03	22.59	93.93	32.36	30.57	32.15	31.49	30.75	29.86
13.06.27 11:00	29.3	26	30.9	26.45	22.94	93.4	32.77	30.78	32.54	30.69	31.1	29.39
13.06.27 11:15	29.2	25	31.46	26.08	23.35	93.41	33.16	29.4	32.85	29.67	31.84	28.21
13.06.27 11:30	29.4	25	31.92	25.34	23.71	92.12	33.44	27.75	32.92	28.58	32.05	26.62
13.06.27 11:45	29.5	25	32.25	24.81	24.1	92.69	33.55	27.39	32.98	28.22	31.94	26.32
13.06.27 12:00	30.1	21	32.67	23.86	24.56	93.48	33.55	27.17	32.95	28.51	31.94	26.32
13.06.27 12:15	30.1	22	33.08	22.41	24.94	91.64	33.68	26.33	32.95	26.83	32	24.63
13.06.27 12:30	30.8	19	33.6	21.63	25.4	92.52	33.78	25.49	33.03	26.39	32.79	24.38
13.06.27 12:45	31.6	20	34.07	20.35	25.79	92.43	33.78	25.42	33.05	25.66	33.03	22.76

Table 28 continued:

Sample	Exterior		Polystyrene		AAC		LPN-METU-1		LPN-METU-2		LPN-METU-4	
DATE	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)
13.06.27 13:00:00	31.7	21	34.55	20.45	26.23	92.49	33.73	24.97	33.03	25.73	32.85	23.12
13.06.27 13:15:00	31.5	19	34.97	20.05	26.67	92.93	33.78	26.15	33.11	26.55	32.74	23.53
13.06.27 13:30:00	31.8	19	35.29	18.85	27.01	91.19	33.97	24.91	33.26	25.01	32.79	22.67
13.06.27 13:45:00	32.2	18	35.58	18.16	27.38	91.04	34.07	23.99	33.37	24.79	33.37	21.59
13.06.27 14:00:00	32.4	18	35.88	18.03	27.78	90.6	34.12	23.95	33.42	24.06	33.52	21.33
13.06.27 14:15:00	32.9	18	36.01	17.46	28.05	88.46	34.15	23.58	33.5	23.61	33.47	20.5
13.06.27 14:30:00	32.7	18	36.17	17.4	28.44	90.32	34.2	23.88	33.52	23.84	33.44	20.99
13.06.27 14:45:00	32.7	18	36.36	17.41	28.79	90.55	34.31	23.22	33.68	23.33	33.68	20.63
13.06.27 15:00:00	32.2	19	36.58	17.28	29.14	90.49	34.44	22.7	33.81	23.34	33.91	20.41
13.06.27 15:15:00	33.1	19	36.8	17.07	29.57	91.13	34.57	23.05	33.99	23.12	34.47	20.45
13.06.27 15:30:00	32.2	19	36.8	17.21	29.72	86.83	34.73	21.56	34.12	22.53	34.73	19.48
13.06.27 15:45:00	32.7	19	36.82	17.36	30.02	88.62	34.78	22.05	34.2	22.43	35.05	19.27
13.06.27 16:00:00	32.9	19	36.96	17.44	30.39	90.37	34.92	22.81	34.28	22.84	35.08	20.03
13.06.27 16:15:00	33.3	19	37.1	17.3	30.75	88.79	35.08	21.62	34.47	22.22	35.24	19.24
13.06.27 16:30:00	34	19	37.18	17.52	31	89.79	35.26	22.76	34.62	23.05	35.34	19.66
13.06.27 16:45:00	33.6	19	37.32	17.53	31.36	91.91	35.58	23.6	34.86	24.11	35.4	21.18
13.06.27 17:00:00	32.9	19	37.4	17.86	31.64	92.23	35.77	21.96	35.18	21.92	35.82	19.46
13.06.27 17:15:00	32.7	21	37.37	18.04	31.82	91.63	35.82	20.34	35.29	21.55	36.07	18.71
13.06.27 17:30:00	32.5	20	37.23	18.24	32.05	90.23	35.85	20.23	35.32	21.4	36.25	18.88
13.06.27 17:45:00	32.4	21	37.15	18.46	32.15	90.94	35.9	20.08	35.42	21.18	36.28	18.57
13.06.27 18:00:00	32.5	21	36.93	18.66	32.2	88.34	35.9	19.7	35.45	21.26	36.23	18.57
13.06.27 18:15:00	31.9	21	36.63	18.86	32.23	86.23	35.82	19.81	35.4	21.71	36.09	18.6
13.06.27 18:30:00	31.8	21	36.15	19.19	32.23	86.6	35.69	19.27	35.21	20.87	35.66	18.39
13.06.27 18:45:00	31.7	20	35.45	19.58	32.25	86.86	35.42	18.76	34.94	20.48	35.29	18.29
13.06.27 19:00:00	31.4	19	34.76	19.29	32.07	83.7	35.02	18.47	34.49	20.15	34.78	18.19
13.06.27 19:15:00	30.9	19	34.1	18.65	31.79	80.14	34.49	17.86	33.89	19.81	34.05	17.8
13.06.27 19:30:00	30.8	19	33.34	18.68	31.46	79.45	33.78	17.48	33.11	19.46	33.13	17.72
13.06.27 19:45:00	30.6	18	32.61	18.92	31.26	79.98	33.16	17.41	32.46	19.35	32.41	17.9
13.06.27 20:00:00	30.1	18	32	19.66	31.26	85.29	32.74	17.66	32.02	19.62	32	18.19
13.06.27 20:15:00	29.7	18	31.38	19.2	31.03	79.96	32.33	17.29	31.56	19.22	31.59	17.94
13.06.27 20:30:00	29.3	17	30.72	18.96	30.57	80.24	31.69	17.03	30.87	19.03	30.82	17.82
13.06.27 20:45:00	29.1	17	30.14	19.45	30.39	82.09	31.2	17	30.39	19.08	30.24	17.86
13.06.27 21:00:00	28.7	17	29.57	19.45	30.17	82.63	30.7	16.9	29.89	19.05	29.64	17.79
13.06.27 21:15:00	28.3	17	29.07	19.28	29.94	81.91	30.22	16.61	29.44	18.72	29.09	17.72
13.06.27 21:30:00	27.9	17	28.57	19.75	29.74	86.34	29.82	16.93	29.02	18.78	28.67	17.78
13.06.27 21:45:00	27.5	18	28.07	20.49	29.57	88.01	29.52	16.76	28.74	18.91	28.3	17.68
13.06.27 22:00:00	27.2	19	27.58	21.57	29.39	89.58	29.27	17.28	28.52	18.97	28	17.82

Table 28 continued:

Sample	Exterior		Polystyrene		AAC		LPN-METU-1		LPN-METU-2		LPN-METU-4	
DATE	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)
13.06.27 22:15:00	26.4	20	27.09	22.38	29.19	89.21	29.09	16.67	28.39	18.74	27.83	17.62
13.06.27 22:30:00	25.9	21	26.6	23.11	28.89	90.18	28.77	17.03	28.1	18.87	27.48	17.79
13.06.27 22:45:00	25.8	22	26.16	23.9	28.64	91	28.57	17.32	27.92	18.79	27.26	17.78
13.06.27 23:00:00	25.5	24	25.72	24.77	28.39	91.31	28.44	17.12	27.8	18.71	27.11	17.62
13.06.27 23:15:00	25.4	27	25.23	25.69	28.1	91.51	28.25	17.08	27.63	18.77	26.92	17.83
13.06.27 23:30:00	25.1	27	24.85	26.83	27.8	91.63	28	17.14	27.41	18.83	26.72	17.93
13.06.27 23:45:00	24.6	29	24.51	28.16	27.51	91.65	27.78	16.98	27.21	19.42	26.52	18.63
13.06.28 00:00:00	24.4	31	24.29	30.11	27.16	91.54	27.48	17.71	27.01	20.9	26.6	20.72
13.06.28 00:15:00	24.2	33	24.17	31.44	26.87	91.78	27.38	18.31	27.04	21.27	26.82	21.11
13.06.28 00:30:00	24	33	24.05	32.44	26.57	91.98	27.28	18.23	27.04	21.56	26.94	21.48
13.06.28 00:45:00	23.3	33	23.93	33.16	26.3	92.13	27.19	18.07	26.99	20.49	26.99	20.67
13.06.28 01:00:00	23.1	34	23.71	34.01	26.01	92.01	27.04	18.06	26.84	19.77	26.82	19.32
13.06.28 01:15:00	23.1	35	23.42	34.91	25.74	91.89	26.89	18.24	26.67	20.21	26.57	19.9
13.06.28 01:30:00	22.8	37	23.06	35.94	25.5	91.88	26.72	18.01	26.48	20.05	26.35	19.97
13.06.28 01:45:00	22.6	38	22.75	36.73	25.23	91.88	26.52	17.81	26.28	20.18	26.13	20.36
13.06.28 02:00:00	22.4	39	22.51	37.53	24.97	91.98	26.28	17.8	26.06	19.95	25.94	19.72
13.06.28 02:15:00	22.3	40	22.3	38.89	24.7	92.08	26.09	18.09	25.84	20.23	25.7	20.08
13.06.28 02:30:00	21.8	43	22.08	39.97	24.44	92.14	25.87	18.45	25.72	20.78	25.62	22.58
13.06.28 02:45:00	21.4	45	21.82	41.5	24.17	91.88	25.74	19.19	25.6	21.55	25.67	21.04
13.06.28 03:00:00	21.6	44	21.58	42.71	23.91	92.1	25.74	19.56	25.6	23.31	25.82	23.91
13.06.28 03:15:00	20.9	47	21.41	44.07	23.67	92.18	25.72	19.56	25.6	22.72	25.84	23.33
13.06.28 03:30:00	21.3	46	21.29	45.02	23.4	92.3	25.65	20.3	25.55	24.11	25.79	25.36
13.06.28 03:45:00	21.3	46	21.18	46.06	23.16	92.4	25.65	20.81	25.67	25.21	25.94	25.59
13.06.28 04:00:00	21	47	21.08	46.75	22.92	92.37	25.57	19.85	25.67	24.56	25.87	25.95
13.06.28 04:15:00	21.1	47	20.98	47.34	22.68	92.49	25.45	20.14	25.6	24.92	25.79	25.73
13.06.28 04:30:00	20.7	48	20.84	47.92	22.47	92.49	25.31	19.98	25.5	25.27	25.62	26.73
13.06.28 04:45:00	20.6	48	20.7	48.35	22.25	92.59	25.14	20.19	25.31	25.55	25.45	26.71
13.06.28 05:00:00	20.5	48	20.51	48.83	22.03	92.66	24.94	20.1	25.16	24.45	25.33	26.16
13.06.28 05:15:00	20.3	49	20.29	49.65	21.82	92.69	24.77	20.09	24.97	24.29	25.09	26.58
13.06.28 05:30:00	20.5	48	20.1	50.41	21.6	92.73	24.58	19.79	24.77	23.33	24.82	25.66
13.06.28 05:45:00	20.6	49	19.91	51.2	21.41	92.68	24.44	20.59	24.56	24.84	24.58	26.79
13.06.28 06:00:00	20.3	50	19.79	51.75	21.22	92.77	24.29	20.29	24.39	23.74	24.48	27.93
13.06.28 06:15:00	20.7	50	19.72	51.86	21.03	92.91	24.12	20.17	24.27	24.64	24.46	28
13.06.28 06:30:00	21.5	48	19.82	52.22	20.84	93	24	21.23	24.2	24.93	24.41	28.64
13.06.28 06:45:00	22.4	46	20.1	52.57	20.67	93	24	20.64	24.2	25.11	24.36	28.14
13.06.28 07:00:00	22.9	45	20.6	52.36	20.53	93.15	23.98	20.42	24.24	25.33	24.32	28.42
13.06.28 07:15:00	23.1	43	21.32	51.08	20.41	92.93	24.36	24.18	24.73	29.88	24.58	33.66

Table 28 continued:

			DL03		DL10		DL08		DL12		DL13	
Sample	Exterior		Polystyrene		AAC		LPN-METU-1		LPN-METU-2		LPN-METU-4	
DATE	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)
13.06.28 07:30:00	23.3	41	22.11	49.16	20.32	92.77	25.65	26.22	26.3	33.47	25.74	37.99
13.06.28 07:45:00	24	40	22.92	47.17	20.29	92.99	27.26	27.25	27.73	33.21	26.92	36.38
13.06.28 08:00:00	24.7	39	23.64	45.4	20.32	93.32	28.42	27.95	28.89	33.77	28.07	37.64
13.06.28 08:15:00	25.2	37	24.32	43.86	20.39	93.48	29.37	27.4	29.97	33.58	29.14	36.18
13.06.28 08:30:00	26.4	34	25.04	41.77	20.51	93.6	30.27	29.32	30.82	31.81	29.67	34.47
13.06.28 08:45:00	27.4	33	25.7	40.39	20.67	94.07	31.13	28.7	31.71	31.85	30.14	35.47
13.06.28 09:00:00	28	32	26.35	39.15	20.89	94.42	31.41	27.16	32.2	30.99	30.44	32.91
13.06.28 09:15:00	27.7	33	27.01	38.12	21.15	94.72	31.31	26.86	32.23	30.49	30.34	33.4
13.06.28 09:30:00	28.6	31	27.78	36.8	21.44	94.84	31.2	25.31	32.02	28.15	30.27	30.54
13.06.28 09:45:00	29.6	29	28.47	35.12	21.7	94.91	31.05	25.52	31.56	27.79	30.09	29.95
13.06.28 10:00:00	29.7	27	29.17	33.97	22.06	95.23	31.18	25.38	31.64	28.78	30.09	30.89
13.06.28 10:15:00	29.8	27	29.87	32.58	22.42	95.32	31.43	25.84	31.87	28.65	30.27	31.12
13.06.28 10:30:00	30.3	27	30.55	31.51	22.8	95.51	31.74	25.68	32.07	28.59	30.52	30.56
13.06.28 10:45:00	31.1	24	31.13	30.13	23.18	95.52	31.97	25.66	32.28	28.39	30.7	30.07
13.06.28 11:00:00	31.4	23	31.69	27.76	23.52	94.74	32.25	25.35	32.46	27.31	30.7	28.48
13.06.28 11:15:00	31.9	21	32.18	26.82	23.95	94.99	32.59	24.96	32.74	27.33	30.7	28.77
13.06.28 11:30:00	32.3	20	32.72	25.51	24.39	95.24	32.9	25.39	33.05	28.3	30.85	29
13.06.28 11:45:00	31.4	18	33.16	23.19	24.77	94.42	33.13	24.7	33.21	26.63	30.87	27.04
13.06.28 12:00:00	31.7	17	33.57	21.6	25.14	93.54	33.29	23.53	33.21	25.41	30.8	25.72
13.06.28 12:15:00	31.5	19	33.99	20.17	25.6	94.26	33.39	23.87	33.37	25.68	30.8	25.9
13.06.28 12:30:00	31.7	19	34.47	19.17	26.09	94.43	33.68	24.3	33.7	26.59	30.95	26.61
13.06.28 12:45:00	32.3	19	34.94	18.34	26.48	93.4	34.1	24.62	34.12	26.51	31.15	26.92
13.06.28 13:00:00	33.2	18	35.37	18.07	26.87	93.08	34.52	23.2	34.23	25.15	31.41	26.42
13.06.28 13:15:00	33.8	19	35.77	17.95	27.28	92.99	34.73	23.17	34.23	24.56	31.89	25.72
13.06.28 13:30:00	34.1	19	36.09	18.11	27.73	93.91	34.86	23.55	34.18	25	32.25	25.31
13.06.28 13:45:00	34.4	18	36.61	17.74	28.17	93.88	35	23.79	34.36	25.75	32.51	25.47
13.06.28 14:00:00	34.3	17	37.15	17.81	28.49	90.77	35.26	23.21	34.73	25.04	33.11	24.55
13.06.28 14:15:00	33.9	17	37.45	17.61	28.87	92.04	35.58	23.23	35.08	24.91	33.81	23.86
13.06.28 14:30:00	34.7	17	37.59	17.04	29.19	89.31	35.88	22.8	35.45	23.78	34.39	21.5
13.06.28 14:45:00	34.4	17	37.56	16.89	29.49	89.78	36.09	22.73	35.64	23.46	35.02	20.63
13.06.28 15:00:00	34.3	17	37.73	16.47	29.84	90.36	36.31	23.12	35.88	23.96	35.61	20.21
13.06.28 15:15:00	34.7	16	37.95	16.26	30.27	91.57	36.53	22.76	36.15	23.94	35.8	20.68
13.06.28 15:30:00	34.2	17	38.06	15.91	30.6	90.84	36.77	22.7	36.34	23.46	35.56	19.83
13.06.28 15:45:00	34.2	17	38.03	15.51	30.8	89.99	36.8	22.25	36.17	22.51	34.84	19.56
13.06.28 16:00:00	35.1	16	38.03	15.47	31.08	89.48	36.77	21.19	35.93	21.82	34.57	20.26
13.06.28 16:15:00	34.6	17	38.09	15.76	31.38	90.58	36.74	21.27	35.8	21.96	34.7	20.23

Table 28 continued:

			DL03		DL10		DL08		DL12		DL13	
Sample	Exterior		Polystyrene		AAC		LPN-METU-1		LPN-METU-2		LPN-METU-4	
DATE	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)
13.06.28 16:30:00	33.9	17	38.31	15.63	31.69	90.2	36.96	20.78	36.07	22.13	35.1	20.48
13.06.28 16:45:00	34.6	17	38.56	15.42	31.89	88.83	37.29	22.28	36.36	23.65	35.61	20.4
13.06.28 17:00:00	34.3	17	38.7	15.72	32.25	91.48	37.51	21.77	36.74	22.7	36.17	20.02
13.06.28 17:15:00	33.8	17	38.5	15.78	32.61	91.37	37.65	21.77	36.88	22.63	36.31	19.72
13.06.28 17:30:00	33.4	18	38.48	15.67	32.77	90.56	37.73	20.34	36.96	21.35	36.15	18.87
13.06.28 17:45:00	33.1	19	38.42	15.92	32.92	89.07	37.62	19.8	36.77	20.89	35.96	18.63
13.06.28 18:00:00	32.5	19	38.14	16.16	33.13	90.16	37.65	19.19	36.69	20.88	35.85	18.32
13.06.28 18:15:00	32	19	37.65	16.46	33.11	89.06	37.21	17.63	36.31	19.45	35.82	17.94
13.06.28 18:30:00	31.5	19	37.1	16.65	33	84.14	36.8	16.68	35.9	18.86	35.72	17.39
13.06.28 18:45:00	31.2	19	36.2	16.75	32.56	79.95	36.15	16.26	35.18	18.59	35.24	16.91
13.06.28 19:00:00	30.8	19	35.34	17.43	32.2	79.6	35.45	16.15	34.44	18.85	34.57	17.1
13.06.28 19:15:00	30.6	20	34.55	17.81	32.12	80.08	34.92	16.28	33.97	18.71	34.02	17.08
13.06.28 19:30:00	30.1	21	33.65	18.12	32.05	80.03	34.44	16.1	33.5	18.57	33.44	17.16
13.06.28 19:45:00	29.8	23	32.79	18.79	31.87	80.46	33.89	15.99	32.95	18.47	32.82	17.32
13.06.28 20:00:00	29.4	24	32.07	19.67	31.66	80.01	33.44	16.2	32.51	18.63	32.28	17.82
13.06.28 20:15:00	28.9	27	31.51	21.12	31.46	79.48	33.05	16.8	32.2	19.03	31.97	18.71
13.06.28 20:30:00	26.4	31	31.03	22.63	31.2	81.51	32.85	17.32	32.05	19.93	31.87	19.69
13.06.28 20:45:00	25.7	33	30.72	23.73	31.2	87.76	32.79	17.47	32.07	20.08	31.87	20.03
13.06.28 21:00:00	25.4	33	30.37	25.69	30.77	77.16	32.9	18.31	32.3	20.7	32.15	21.29
13.06.28 21:15:00	25.3	33	29.54	29.24	29.84	75.61	32.79	19.29	32.38	21.6	30.9	24.29
13.06.28 21:30:00	25.1	33	28.49	29.98	29.37	78.26	32.43	19.5	31.87	22.09	29.19	26.99
13.06.28 21:45:00	25.4	32	27.92	30.99	29.24	82.72	32.23	19.26	31.61	22.04	28.52	27.67
13.06.28 22:00:00	25.1	33	27.63	31.74	29.29	87.92	32.15	19.22	31.71	21.03	28.77	25.58
13.06.28 22:15:00	25	33	27.28	32.56	29.24	89.17	32.05	18.72	31.61	20.77	28.99	24.75
13.06.28 22:30:00	25.1	33	26.99	33.3	29.09	89.83	31.87	18.82	31.48	20.38	29.09	24.06
13.06.28 22:45:00	25.3	33	26.72	33.95	28.89	90.23	31.66	18.55	31.26	20.41	29.04	23.5
13.06.28 23:00:00	25.6	33	26.5	34.6	28.67	90.42	31.43	18.68	31.03	20.09	28.92	23.46
13.06.28 23:15:00	25.6	33	26.3	35.22	28.44	90.64	31.18	18.67	30.8	20.04	28.79	23.19
13.06.28 23:30:00	25.4	33	26.11	35.5	28.2	90.77	30.93	18.51	30.55	20.03	28.59	22.55
13.06.28 23:45:00	25.2	33	25.91	35.62	27.95	90.84	30.67	18.42	30.29	20.54	28.42	22.54
13.06.29 00:00:00	24.5	34	25.72	35.66	27.7	91	30.37	18.29	30.04	21.42	28.39	23.83
13.06.29 00:15:00	24.2	35	25.5	36.11	27.46	91.06	30.12	18.54	29.84	20.85	28.37	22.98

Table 28 continued:

			DL03		DL10		DL08		DL12		DL13	
Sample	Exterior		Polystyrene		AAC		LPN-METU-1		LPN-METU-2		LPN-METU-4	
DATE	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)
13.06.29 00:30:00	23.9	36	25.21	36.91	27.21	91.14	29.87	18.48	29.64	20.53	28.22	23.56
13.06.29 00:45:00	23.6	37	24.85	37.6	26.94	91.08	29.59	18.39	29.39	20.07	27.9	22.58
13.06.29 01:00:00	23.2	38	24.46	38.42	26.7	91.16	29.34	18.34	29.12	20.02	27.65	22.79
13.06.29 01:15:00	23	38	24.12	39.21	26.43	91.24	29.04	18.29	28.84	19.89	27.41	22.84
13.06.29 01:30:00	23.2	38	23.79	39.93	26.18	91.25	28.74	18.16	28.54	19.65	27.14	22.16
13.06.29 01:45:00	23	37	23.47	40.71	25.91	91.21	28.44	18.14	28.22	19.85	26.77	22.65
13.06.29 02:00:00	22.6	38	23.26	41.24	25.65	91.29	28.12	18.05	27.9	19.68	26.52	22.42
13.06.29 02:15:00	22.4	39	23.04	41.64	25.36	91.29	27.8	18.03	27.63	19.67	26.28	22.48
13.06.29 02:30:00	21.7	42	22.94	42.15	25.11	91.35	27.51	17.94	27.33	19.5	26.01	22.24
13.06.29 02:45:00	22	41	22.97	41.96	24.85	91.19	27.21	18.37	27.04	20.97	25.79	23.03
13.06.29 03:00:00	22	41	22.94	41.86	24.58	91.41	27.06	18.52	26.87	20.07	25.84	23.98
13.06.29 03:15:00	22.7	39	22.9	41.98	24.34	91.16	26.84	18.39	26.62	19.91	25.74	24.05
13.06.29 03:30:00	22.8	39	22.8	42.26	24.1	91.32	26.62	18.34	26.43	20.19	25.65	23.75
13.06.29 03:45:00	21.4	43	22.71	42.25	23.91	91.51	26.48	19.68	26.28	21.44	25.55	24.18
13.06.29 04:00:00	21.1	43	22.54	42.23	23.67	91.09	26.48	19.34	26.23	21.7	25.7	25.68
13.06.29 04:15:00	21.1	43	22.39	42.96	23.45	91.7	26.28	18.77	26.13	20.47	25.74	25.43
13.06.29 04:30:00	21	43	22.18	43.29	23.23	91.46	26.04	19.05	25.94	20.39	25.6	25.42
13.06.29 04:45:00	20.9	44	21.89	44.1	23.04	91.74	25.82	18.67	25.74	20	25.4	25.41
13.06.29 05:00:00	21.1	44	21.6	44.64	22.85	91.97	25.6	18.51	25.55	20.07	25.21	25.47
13.06.29 05:15:00	21	44	21.37	45.12	22.66	92.09	25.38	18.5	25.33	20.05	24.97	25.2
13.06.29 05:30:00	21.7	43	21.2	45.62	22.47	92.21	25.16	18.41	25.11	19.89	24.7	25.29
13.06.29 05:45:00	21.7	44	21.08	45.92	22.27	92.34	24.92	18.32	24.9	20.03	24.48	25.09
13.06.29 06:00:00	21.6	46	20.96	46.16	22.08	92.32	24.73	18.98	24.7	20.94	24.24	25.4
13.06.29 06:15:00	21.7	48	20.84	46.59	21.89	92.53	24.53	18.45	24.53	20.23	24.07	25.82
13.06.29 06:30:00	21.5	50	20.98	46.93	21.7	92.62	24.34	18.36	24.34	20.22	23.93	25.88
13.06.29 06:45:00	22.1	51	21.51	46.74	21.51	92.48	24.22	18.8	24.17	20.35	23.98	29.03
13.06.29 07:00:00	22.3	49	22.03	46.1	21.37	92.11	24.32	19.55	24.15	20.87	24.75	31.36
13.06.29 07:15:00	23	49	22.44	46.53	21.2	90.34	24.8	22.67	24.63	25.86	25.48	33.11
13.06.29 07:30:00	23.1	47	22.73	46.76	21.1	90.6	25.31	21.9	25.45	26.64	25.65	34.98
13.06.29 07:45:00	24.1	45	23.16	46.82	21.06	91.08	25.5	21.39	25.67	23.94	25.84	35.07
13.06.29 08:00:00	24.8	42	23.67	46.14	21.06	91.66	25.65	20.67	25.7	23.54	26.04	32.88
13.06.29 08:15:00	24.9	41	24.07	46.06	21.08	92.09	25.72	20.52	25.82	24.42	26.23	32.69
13.06.29 08:30:00	25.3	40	24.61	45.55	21.13	92.38	25.94	20.98	26.18	25.17	26.79	34.67
13.06.29 08:45:00	26.8	38	25.28	44.56	21.25	92.69	26.23	22.8	26.6	27.99	27.28	38.35
13.06.29 09:00:00	27.3	37	26.06	42.24	21.37	92.69	28	29.71	28.72	34.18	29.22	38.85
13.06.29 09:15:00	27.8	35	26.89	40.42	21.51	92.8	30.02	28.14	30.75	31.76	30.44	35.35

Table 28 continued:

			DL03		DL10		DL08		DL12		DL13	
Sample	Exterior		Polystyrene		AAC		LPN-METU-1		LPN-METU-2		LPN-METU-4	
DATE	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)
13.06.29 09:30:00	28.1	34	27.58	39.11	21.7	93.17	31.13	28.01	31.82	31.68	31.1	35.73
13.06.29 09:45:00	29.2	31	28.32	37.85	21.96	93.54	32.05	28.73	32.64	30.99	31.79	34.81
13.06.29 10:00:00	30	29	29.07	36.59	22.25	93.59	32.85	29.38	33.44	30.77	32.46	33.66
13.06.29 10:15:00	30.3	28	29.84	35.25	22.59	93.9	33.31	29.78	33.91	32.21	32.82	35.57
13.06.29 10:30:00	30.6	27	30.7	33.2	22.94	93.81	34.02	30.34	34.26	31.12	33.29	33.31
13.06.29 10:45:00	31	27	31.43	31.59	23.3	93.54	34.55	29.51	34.73	29.96	33.47	31.09
13.06.29 11:00:00	31.1	27	32.02	29.96	23.69	93.12	34.81	28.07	35	28.96	33.11	29.54
13.06.29 11:15:00	31.3	27	32.46	28.79	24.05	93.45	34.44	26.2	34.7	28.13	32.28	29.99
13.06.29 11:30:00	31.3	27	32.87	28.12	24.51	93.54	34.44	26.53	34.84	28.91	32	30.18
13.06.29 11:45:00	32.4	25	33.31	27.43	24.87	92.15	34.33	25.75	34.6	27.5	31.61	30.76
13.06.29 12:00:00	32.2	25	33.76	26.8	25.33	92.93	34.39	27.01	34.6	29.01	31.56	31.08
13.06.29 12:15:00	32.3	24	34.12	26.13	25.74	92.89	35.1	26.51	35.16	27.95	32.1	30.48
13.06.29 12:30:00	32.8	21	34.47	25.52	26.21	92.6	35.53	26.5	35.45	27.16	32.61	29.72
13.06.29 12:45:00	32.3	19	34.89	25.13	26.62	92.73	35.53	25.91	35.42	27.6	32.72	29.95
13.06.29 13:00:00	31.8	21	35.4	24.32	27.09	92.99	35.72	26.18	35.58	27.98	32.95	31.12
13.06.29 13:15:00	32	21	35.66	23.85	27.55	93.63	35.93	26.31	35.8	28.14	33.18	30.38
13.06.29 13:30:00	32.3	21	35.56	22.92	27.97	93.45	36.12	25.76	36.01	27.72	33.44	29.13
13.06.29 13:45:00	31.7	22	35.99	21.1	28.39	93.6	36.34	25.97	36.31	27.11	33.68	30.02
13.06.29 14:00:00	31.4	22	36.77	19.94	28.79	93.7	36.66	25.88	36.61	26.36	34.2	28.35
13.06.29 14:15:00	32.6	20	37.1	19.03	29.19	93.8	36.91	25.48	36.85	25.78	34.47	26.79
13.06.29 14:30:00	32.5	20	37.37	18.76	29.54	93.32	37.1	23.7	36.99	24.74	34.52	26.87
13.06.29 14:45:00	32.4	20	37.67	18.92	29.84	92.01	37.15	22.27	36.8	22.4	34.86	23.52
13.06.29 15:00:00	33.2	19	37.45	19.08	30.14	92.98	37.07	22.68	36.5	23.25	35.02	23.6
13.06.29 15:15:00	33.2	19	36.82	19.51	30.52	93.66	37.02	23.62	36.53	25.01	35.02	24.24
13.06.29 15:30:00	33.1	19	36.58	19.5	30.8	93.07	37.15	23.93	36.63	25.32	34.92	23.97
13.06.29 15:45:00	33.4	18	36.31	19.81	31.1	93.37	37.23	23.71	36.74	22.85	34.89	23.26
13.06.29 16:00:00	32.8	18	35.99	19.25	31.28	92.09	37.21	21.71	36.58	22.99	34.78	22.8
13.06.29 16:15:00	32.4	18	35.88	19.46	31.46	92.67	37.12	24	36.34	23.95	34.39	22.63
13.06.29 16:30:00	32.5	18	35.66	20.09	31.66	93.02	37.21	24.01	36.44	24.93	34.33	23.89
13.06.29 16:45:00	32.7	19	35.4	20.64	31.84	92.94	37.26	24.24	36.55	25.16	34.52	24.87
13.06.29 17:00:00	33	18	35.18	20.42	31.94	92.69	37.4	23.8	36.8	24.73	34.81	24.37
13.06.29 17:15:00	32.8	19	34.89	20.97	32.07	93.31	37.45	24.1	36.91	24.89	34.97	24.16
13.06.29 17:30:00	33.4	19	34.49	21.58	32.18	93.53	37.45	24.03	36.91	24.59	35	23.34
13.06.29 17:45:00	33.3	17	34.07	22.4	32.23	93.64	37.48	23.88	36.91	24.66	35.02	23.68
13.06.29 18:00:00	33.7	18	33.76	22.74	32.25	93.72	37.43	23.57	36.8	24.43	34.94	22.51
13.06.29 18:15:00	33.9	18	33.6	23.15	32.25	93.75	37.34	23.57	36.72	24.65	34.89	22.7

Table 28 continued:

			DL03		DL10		DL08		DL12		DL13	
Sample	Exterior		Polystyrene		AAC		LPN-METU-1		LPN-METU-2		LPN-METU-4	
DATE	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)
13.06.29 18:30:00	32.9	19	33.39	23.28	32.23	93.72	37.26	23.71	36.63	24.87	34.81	22.91
13.06.29 18:45:00	32.2	19	33.55	22.16	32.12	93.06	37.02	22.11	36.39	22.38	34.47	21.28
13.06.29 19:00:00	31.7	19	33.89	22.32	32.07	93.61	36.8	23.08	36.04	23.63	34.12	22.95
13.06.29 19:15:00	31.1	20	34.05	22.54	32.05	93.8	36.82	23.2	36.15	23.49	34.41	22.51
13.06.29 19:30:00	30.1	23	33.89	22.96	32.05	93.84	36.82	23.42	36.15	24.13	34.52	22.86
13.06.29 19:45:00	29.6	24	33.44	23.49	32.05	93.89	36.8	23.23	36.12	23.86	34.49	22.07
13.06.29 20:00:00	28.6	27	32.79	24.39	32.05	93.94	36.8	23.31	36.09	23.94	34.44	22.4
13.06.29 20:15:00	27.8	30	32.02	25.42	32	93.98	36.77	22.93	36.04	23.63	34.33	21.65
13.06.29 20:30:00	27.4	29	31.15	25.43	31.94	93.92	36.47	21.59	35.66	21.5	33.99	19.97
13.06.29 20:45:00	27.2	29	30.29	26.48	31.79	93.78	36.2	21.91	35.37	22.24	33.63	20.02
13.06.29 21:00:00	27.4	27	29.52	27.73	31.64	93.64	35.99	22.01	35.1	22.3	33.31	19.62
13.06.29 21:15:00	27.3	27	28.84	29.08	31.43	93.52	35.64	21.42	34.76	21.82	32.87	18.92
13.06.29 21:30:00	26.8	27	28.22	30.43	31.18	93.38	35.1	21.17	34.33	21.87	32.43	18.82
13.06.29 21:45:00	26.3	27	27.68	31.61	30.9	93.29	34.44	19.92	33.81	20.79	32.02	18.49
13.06.29 22:00:00	26.2	27	27.26	32.25	30.6	92.9	33.7	19.65	33	20.44	31.64	19.64
13.06.29 22:15:00	26.1	27	26.92	32.96	30.29	93.16	33.31	19.93	32.54	20.48	31.36	19.1
13.06.29 22:30:00	25.9	27	26.57	33.54	29.99	93.16	32.92	19.37	32.12	19.86	31.03	19.04
13.06.29 22:45:00	26.2	27	26.18	33.67	29.67	93.15	32.54	19.43	31.77	19.91	30.7	18.79
13.06.29 23:00:00	26.3	27	25.84	34.21	29.34	93.12	32.2	19.26	31.43	20.15	30.29	18.85
13.06.29 23:15:00	26.2	27	25.6	34.99	29.04	93.09	31.87	19.46	31.1	20.17	29.94	18.98
13.06.29 23:30:00	26.1	27	25.43	35.3	28.72	93.01	31.54	19.07	30.82	19.93	29.57	18.73
13.06.29 23:45:00	26.1	26	25.31	35.23	28.39	92.93	31.1	18.89	30.42	19.83	29.22	18.94
13.06.30 00:00:00	25.9	25	25.21	34.85	28.07	92.9	30.62	18.03	29.97	19.96	28.94	19.9
13.06.30 00:15:00	24.9	27	25.14	33.87	27.75	92.29	30.04	18.23	29.46	20.3	28.72	20.85
13.06.30 00:30:00	24.9	27	25.09	32.93	27.38	90.75	29.54	18.5	29.04	20.42	28.37	21.05
13.06.30 00:45:00	24.8	27	25.04	32.32	26.94	90.3	29.12	19.08	28.59	21.07	27.95	22.07
13.06.30 01:00:00	24.7	27	24.97	32.22	26.7	91.4	28.79	19.36	28.3	21.35	27.65	22.49
13.06.30 01:15:00	24.4	27	24.82	31.63	26.48	91.81	28.54	19.5	28.1	21.41	27.41	22.4
13.06.30 01:30:00	24	28	24.61	31.28	26.23	91.87	28.42	19.6	27.97	21.03	27.16	21.42
13.06.30 01:45:00	24.2	27	24.36	31.86	26.01	92.2	28.22	19.44	27.83	21.1	26.97	22.15
13.06.30 02:00:00	24.4	27	24.2	32.48	25.79	92.47	28	19.54	27.6	21.08	26.72	22.1
13.06.30 02:15:00	24.2	27	24.03	33.14	25.55	92.27	27.83	19.46	27.46	20.96	26.57	21.83
13.06.30 02:30:00	24.5	27	23.76	33.81	25.36	92.48	27.6	19.37	27.28	20.84	26.4	21.45
13.06.30 02:45:00	24.4	28	23.42	34.48	25.11	92.45	27.38	19.28	27.06	20.71	26.16	20.96
13.06.30 03:00:00	24.6	28	23.09	34.75	24.87	92.39	27.14	19.27	26.82	20.7	25.79	21.04
13.06.30 03:15:00	24.7	28	22.82	35.22	24.65	92.33	26.89	19.25	26.55	20.57	25.5	20.77

Table 28 continued:

			DL03		DL10		DL08		DL12		DL13	
Sample	Exterior		Polystyrene		AAC		LPN-METU-1		LPN-METU-2		LPN-METU-4	
DATE	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)
13.06.30 03:30:00	24.4	28	22.68	35.64	24.44	92.63	26.62	19.24	26.3	20.71	25.26	21.08
13.06.30 03:45:00	23	32	22.51	36.18	24.2	92.78	26.33	19.15	26.04	20.8	24.97	21.29
13.06.30 04:00:00	22.6	33	22.37	36.7	23.98	92.87	26.06	18.98	25.77	20.86	24.8	21.87
13.06.30 04:15:00	23	32	22.25	37.05	23.74	93.04	25.79	19.04	25.53	21.76	24.63	22.59
13.06.30 04:30:00	23.1	32	22.18	37.37	23.52	93.13	25.55	19.32	25.33	21.16	24.51	21.77
13.06.30 04:45:00	22.4	32	22.18	37.76	23.3	92.98	25.36	19.24	25.14	20.78	24.41	21.84
13.06.30 05:00:00	23	32	22.23	37.83	23.09	93.06	25.16	19.15	24.94	20.77	24.34	21.84
13.06.30 05:15:00	23.7	32	22.18	38.09	22.92	93.21	24.97	19.1	24.77	20.76	24.22	21.9
13.06.30 05:30:00	23.9	31	22.03	38.37	22.73	93.3	24.8	19.06	24.58	20.97	24.12	22.26
13.06.30 05:45:00	24.4	32	21.8	38.87	22.56	93.35	24.61	19.05	24.44	20.52	24.03	22.04
13.06.30 06:00:00	24.7	32	21.58	39.07	22.39	93.3	24.46	19.19	24.27	21.32	23.91	22.58
13.06.30 06:15:00	25.1	33	21.44	39.38	22.23	93.35	24.29	19.03	24.12	21.16	23.79	22.53
13.06.30 06:30:00	24.9	33	21.46	39.84	22.06	93.4	24.15	19.06	24	21.01	23.71	23.11
13.06.30 06:45:00	25.8	33	21.68	40.22	21.89	93.45	24.03	19.01	23.88	20.78	23.69	22.75
13.06.30 07:00:00	25.9	31	22.11	40.11	21.77	93.47	23.95	19.01	23.81	20.88	23.69	22.75
13.06.30 07:15:00	26.6	33	22.68	39.84	21.65	93.25	24	19.23	23.86	21.73	23.69	23.84
13.06.30 07:30:00	27	33	23.35	39.26	21.58	93.14	24.15	19.69	24.03	21.74	23.86	23.34
13.06.30 07:45:00	27.4	33	24.1	38.48	21.56	93.36	24.44	20.15	24.24	22.38	24.07	24.01
13.06.30 08:00:00	26.9	44	24.87	37.44	21.58	93.42	24.9	21.14	24.65	22.74	24.63	25.86
13.06.30 08:15:00	26.6	46	25.6	35.72	21.63	93.18	25.72	23.25	25.21	24.38	26.06	28.49
13.06.30 08:30:00	26.6	47	26.21	34.81	21.75	93.55	26.65	23.89	25.94	25.81	27.04	27.27
13.06.30 08:45:00	26.9	47	26.89	36.55	21.89	93.77	27.36	23.17	26.55	25.38	27.68	28.61
13.06.30 09:00:00	27.3	44	27.65	34.95	22.13	94.34	28	23.99	27.53	27.84	28.57	31.3
13.06.30 09:15:00	28.2	40	28.44	37	22.35	93.34	28.87	25.58	28.42	29.6	29.59	32.66
13.06.30 09:30:00	28.9	38	28.92	40.58	22.59	91.44	30.27	28.96	30.37	32.59	30.7	35.02
13.06.30 09:45:00	28.1	39	29.19	40.47	22.9	92.66	31.48	28.33	31.74	31.67	30.7	35.69
13.06.30 10:00:00	28.8	40	29.52	40.81	23.21	92.39	32.3	28.75	32.41	31.73	30.72	37.03
13.06.30 10:15:00	29.1	38	29.74	40.6	23.52	91.77	32.98	28.88	32.82	31.26	30.37	37.86
13.06.30 10:30:00	29.1	38	30.14	39.37	23.83	92.08	33.55	28.85	33.08	31.46	30.34	38.17
13.06.30 10:45:00	29.4	37	30.44	37.16	24.1	90.5	33.78	28.14	33.03	30.99	29.92	37.51
13.06.30 11:00:00	29.6	33	30.8	36.25	24.44	91.42	33.94	28.15	33.11	30.99	29.84	37.98
13.06.30 11:15:00	29.3	33	31.13	35.91	24.7	90.75	34.02	28.38	33.08	31.57	29.97	38.38
13.06.30 11:30:00	29.6	33	31.41	36.21	25.02	89.15	34.2	29.3	33.24	32.44	30.37	38.31
13.06.30 11:45:00	30.2	32	31.61	35.28	25.31	90.34	34.44	28.96	33.39	31.95	30.6	37.57
13.06.30 12:00:00	30.1	33	31.82	34.73	25.62	90.37	34.49	28.7	33.42	31.88	30.62	37.02
13.06.30 12:15:00	30.3	33	31.92	33.89	25.89	90.14	34.55	28.53	33.37	31.88	30.62	36.25

Table 28 continued:

			DL03		DL10		DL08		DL12		DL13	
Sample	Exterior		Polystyrene		AAC		LPN-METU-1		LPN-METU-2		LPN-METU-4	
DATE	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)
13.06.30 12:30:00	30.7	30	32.12	31.92	26.13	87.79	34.57	28.05	33.31	31.01	30.62	34.84
13.06.30 12:45:00	30.5	31	32.38	31.53	26.38	89.43	34.57	28.2	33.29	31.33	30.77	35.21
13.06.30 13:00:00	30.7	27	32.85	30.61	26.62	88.99	34.73	28.36	33.47	31.67	31.26	34.79
13.06.30 13:15:00	31.2	24	33.47	29.66	26.89	89.06	34.92	28.26	33.78	31.48	31.56	34.18
13.06.30 13:30:00	30.7	27	34.02	29.46	27.16	88.13	35.08	28.2	34.07	31.03	32.02	33.02
13.06.30 13:45:00	30.2	27	34.02	28.91	27.36	85.96	35.08	28.09	33.89	30.98	32.18	32.42
13.06.30 14:00:00	31.3	27	34.12	28.05	27.58	86.79	35.13	27.8	33.94	30.41	32.2	31.42
13.06.30 14:15:00	31.2	26	34.26	27.85	27.8	87.2	35.13	27.58	33.97	30.41	32.3	31.57
13.06.30 14:30:00	31.4	25	34.33	25.51	27.97	85.79	35.02	26.72	33.84	29.42	32.41	29.27
13.06.30 14:45:00	30.9	26	34.52	23.98	28.07	82.89	34.76	25.82	33.63	27.91	32.51	27.38
13.06.30 15:00:00	31.2	27	34.65	24.2	28.22	83.47	34.65	25.77	33.76	28.5	32.95	27.34
13.06.30 15:15:00	31.4	27	34.73	24.7	28.42	84.47	34.65	25.99	34.05	28.08	33.34	26.56
13.06.30 15:30:00	31.7	26	34.44	24.19	28.54	81.48	34.62	25.62	34.05	27.61	33.5	25.99
13.06.30 15:45:00	30.8	27	34.49	23.77	28.64	80.84	34.68	25.51	34.31	27.22	33.86	25.2
13.06.30 16:00:00	31	26	34.7	23.78	28.77	82.85	34.76	25.41	34.65	27.54	34.33	25.31
13.06.30 16:15:00	30.1	27	35	23.52	28.92	85.28	34.86	25.64	35.1	27.61	34.84	24.37
13.06.30 16:30:00	30.3	27	35	23.38	29.04	81.88	35.08	25.65	35.42	26.57	35.13	23.72
13.06.30 16:45:00	31.3	26	35.08	23.53	29.17	82.12	35.29	25.15	35.72	26.26	35.48	23.52
13.06.30 17:00:00	31.1	27	35.08	23.46	29.24	80.77	35.56	24.72	36.01	25.27	35.72	22.71
13.06.30 17:15:00	30.7	27	34.92	23.66	29.32	83.13	35.58	24.72	36.12	24.76	35.5	22.85
13.06.30 17:30:00	29.8	27	34.73	23.79	29.49	83.38	35.69	24.66	36.17	24.69	35.5	22.32
13.06.30 17:45:00	29.4	27	34.2	24.03	29.57	81.59	35.69	23.83	36.07	23.33	34.97	22.29
13.06.30 18:00:00	29.2	27	33.57	24.76	29.59	83	35.45	23.67	35.66	23.46	34.39	23.52
13.06.30 18:15:00	28.8	27	33.39	25.31	29.79	87.28	35.26	24.1	35.56	24.27	34.36	24.9
13.06.30 18:30:00	28.3	28	33.7	24.56	29.72	80.82	35.37	24.19	35.9	24.22	34.97	22.81
13.06.30 18:45:00	27.8	29	33.84	24.64	29.69	85.15	35.4	24.19	36.09	24.31	35.21	23.58
13.06.30 19:00:00	27.4	30	33.6	24.06	29.59	82.37	35.5	23.3	36.15	22.51	35.1	20.86
13.06.30 19:15:00	27.1	30	32.95	24.37	29.57	82.02	35.29	22.76	35.58	21.95	34.1	22.08
13.06.30 19:30:00	26.6	32	32.25	24.95	29.49	81.92	34.97	22.36	35.13	22.03	33.34	22.75
13.06.30 19:45:00	26.1	33	31.64	25.81	29.46	83	34.65	22.42	34.84	21.9	32.87	22.9
13.06.30 20:00:00	25.9	33	30.98	26.8	29.46	84.91	34.36	22.4	34.52	21.81	32.38	23.17
13.06.30 20:15:00	25.4	34	30.27	27.82	29.41	87.16	34.15	22.46	34.2	21.86	32.02	23.29
13.06.30 20:30:00	24.4	42	29.62	29.04	29.39	88.85	33.94	22.82	33.97	22.45	31.77	23.05
13.06.30 20:45:00	24.1	47	28.92	30.35	29.32	89.78	33.76	22.96	33.76	22.73	31.66	22.6
13.06.30 21:00:00	23.7	51	28.17	31.72	29.19	90.23	33.55	22.95	33.52	22.5	31.41	22.21
13.06.30 21:15:00	23.3	54	27.51	33.05	29.02	90.5	33.26	22.78	33.21	22.25	31.13	22.16

Table 28 continued:

			DL03		DL10		DL08		DL12		DL13	
Sample	Exterior		Polystyrene		AAC		LPN-METU-1		LPN-METU-2		LPN-METU-4	
DATE	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)
13.06.30 21:30:00	22.9	55	26.99	34.25	28.82	90.65	32.92	22.61	32.85	22.12	30.85	21.99
13.06.30 21:45:00	22.7	55	26.5	35.04	28.59	90.53	32.54	21.83	32.43	21.45	30.5	22.41
13.06.30 22:00:00	22.3	57	26.06	36.73	28.22	87.93	32	21.43	31.77	21.6	29.99	25.59
13.06.30 22:15:00	22	58	25.79	39.98	27.85	87.26	31.48	21.99	31.26	22.72	29.89	27.81
13.06.30 22:30:00			25.62	42.52	27.55	86.81	31.08	22.34	31.13	24.2	29.87	30.65
13.06.30 22:45:00			25.43	45.03	27.21	85.51	30.82	23.29	31.18	25.82	29.54	33.4
13.06.30 23:00:00			25.21	46.55	26.89	85.52	30.65	23.68	31.26	26.67	28.72	36.03
13.06.30 23:15:00			24.94	47.87	26.57	85.73	30.57	24.27	31.18	26.48	28.07	37.43
13.06.30 23:30:00			24.68	48.7	26.3	85.97	30.42	24.26	30.98	27.85	27.38	39.25
13.06.30 23:45:00			24.41	49.53	26.06	86.57	30.27	24.36	30.8	26.96	26.92	39.92
13.07.01 00:00:00			24.17	50.1	25.84	87.32	30.07	23.87	30.62	26.29	26.79	39.87

Table 29: Thermal behavior in boxes during winter time, from 03/02/2014 to 07/02/2014, extracted from a set of data starting on the 23/01/2014 and finishing on the 26/03/2014

	Weather Station		DC17		DC18		DC19	
Sample	Exterior		LPN-METU-1		LPN-METU-2		LPN-METU-4	
DATE	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)
03/02/2014 00:00	-1.556	68.1	-3.0	82.2	-1.5	74.8	-1.1	74.9
03/02/2014 00:15	-1.584	67.9	-3.0	82.2	-1.6	73.8	-1.1	74.1
03/02/2014 00:30	-1.958	68.5	-3.0	82.7	-1.7	74.1	-1.2	73.9
03/02/2014 00:45	-1.727	67.4	-3.2	83.3	-1.8	73.3	-1.3	75.4
03/02/2014 01:00	-1.756	67.3	-3.0	83.3	-1.9	72.5	-1.4	74.1
03/02/2014 01:15	-1.929	67.9	-3.2	83.3	-2.0	73.8	-1.5	73.6
03/02/2014 01:30	-2.015	68.4	-3.0	83.8	-2.1	74.3	-1.6	74.1
03/02/2014 01:45	-2.334	69.7	-3.0	83.8	-2.1	75.1	-1.6	71.6
03/02/2014 02:00	-2.363	70.4	-3.0	84.3	-2.1	74.8	-1.6	72.3
03/02/2014 02:15	-2.16	69.9	-3.2	84.9	-2.1	74.3	-1.7	75.4
03/02/2014 02:30	-2.247	69.9	-3.5	85.4	-2.2	74.8	-1.7	73.1
03/02/2014 02:45	-2.16	69.5	-3.2	86.0	-2.2	73.8	-1.8	74.6
03/02/2014 03:00	-2.392	69.1	-3.5	85.4	-2.3	75.1	-1.8	78.0
03/02/2014 03:15	-2.888	71.7	-3.5	85.4	-2.4	76.6	-1.8	77.4
03/02/2014 03:30	-3.33	72.7	-3.5	86.0	-2.5	77.1	-1.8	79.0
03/02/2014 03:45	-3.807	74.4	-3.5	86.0	-2.4	77.6	-1.7	79.0
03/02/2014 04:00	-3.598	72.9	-4.0	86.0	-2.5	76.6	-1.7	81.3
03/02/2014 04:15	-3.866	73.6	-3.7	87.1	-2.5	77.9	-1.6	82.0
03/02/2014 04:30	-4.046	74.7	-4.2	87.6	-2.5	79.7	-1.6	82.6
03/02/2014 04:45	-4.287	75.4	-4.2	88.7	-2.5	79.7	-1.6	82.8
03/02/2014 05:00	-4.439	75.4	-4.2	88.7	-2.5	79.7	-1.6	83.3
03/02/2014 05:15	-4.682	76.1	-4.5	89.8	-2.5	80.4	-1.6	83.3
03/02/2014 05:30	-3.747	74	-4.5	90.4	-2.6	77.1	-1.7	83.8
03/02/2014 05:45	-3.717	73.2	-4.5	91.5	-2.7	77.1	-1.7	84.3
03/02/2014 06:00	-4.348	74.4	-4.5	91.5	-2.8	79.2	-1.7	84.3
03/02/2014 06:15	-4.621	76.2	-4.2	92.0	-2.8	79.7	-1.8	84.6
03/02/2014 06:30	-4.408	75.5	-4.5	92.6	-2.8	79.2	-1.8	85.1
03/02/2014 06:45	-4.106	73.6	-4.5	92.6	-2.9	78.1	-1.9	80.5
03/02/2014 07:00	-4.257	74.3	-4.5	93.1	-3.0	79.2	-1.9	84.9
03/02/2014 07:15	-4.53	74.9	-4.5	93.7	-3.1	80.2	-1.9	85.1
03/02/2014 07:30	-4.318	74.9	-4.5	94.2	-3.1	80.4	-2.0	85.1
03/02/2014 07:45	-4.046	75.1	-4.2	94.2	-3.1	79.7	-2.0	85.1
03/02/2014 08:00	-3.153	72	-4.2	95.9	-3.2	81.2	-2.0	84.9
03/02/2014 08:15	-2.305	71.3	-4.2	97.0	-3.3	80.7	-2.1	83.8
03/02/2014 08:30	1.751	60.8	-3.5	99.2	-3.3	80.4	-2.1	84.9

Table 29 continued:

	Weather Station		DC17		DC18		DC19	
Sample	Exterior		LPN-METU-1		LPN-METU-2		LPN-METU-4	
DATE	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)
03/02/2014 08:45	0.989	59.2	-2.7	100.0	-2.6	98.0	-1.6	96.4
03/02/2014 09:00	-0.032	59.9	-1.4	95.9	-1.1	94.1	-0.3	87.5
03/02/2014 09:15	0.024	60.9	-0.7	84.9	-0.6	85.3	0.0	84.1
03/02/2014 09:30	1.751	55.8	-0.2	81.2	-0.2	90.2	0.2	87.5
03/02/2014 09:45	1.615	55.7	0.3	75.4	0.7	88.6	0.7	88.5
03/02/2014 10:00	2.396	52.5	1.3	71.1	1.3	89.1	1.4	88.3
03/02/2014 10:15	1.94	52.2	1.8	66.1	2.2	100.0	2.2	87.0
03/02/2014 10:30	2.61	51.3	3.1	62.0	2.8	87.6	2.6	82.8
03/02/2014 10:45	3.301	49.1	3.6	59.5	3.3	88.6	2.8	82.0
03/02/2014 11:00	3.854	48.4	4.4	55.5	3.6	77.6	2.9	81.3
03/02/2014 11:15	4.063	48.3	4.6	53.1	3.6	82.5	3.0	80.0
03/02/2014 11:30	4.194	47	5.1	51.2	3.8	85.0	3.2	79.0
03/02/2014 11:45	4.558	46.2	5.4	50.2	4.2	75.3	3.1	75.1
03/02/2014 12:00	3.564	47.3	6.2	47.8	3.9	69.6	3.0	77.2
03/02/2014 12:15	4.74	45.3	6.4	46.4	3.7	84.5	2.9	79.7
03/02/2014 12:30	4.168	44.6	6.7	46.4	4.0	75.3	3.0	77.2
03/02/2014 12:45	5.385	43.4	7.2	45.9	4.2	73.3	2.9	80.0
03/02/2014 13:00	6.153	42.8	7.7	45.4	4.4	74.8	2.9	81.3
03/02/2014 13:15	5.205	42.7	8.0	43.6	4.4	80.4	2.9	80.5
03/02/2014 13:30	5.745	41.9	8.3	41.7	4.3	68.3	3.0	80.5
03/02/2014 13:45	5.514	41.5	8.3	41.3	4.2	67.6	3.2	79.5
03/02/2014 14:00	5.693	39.8	8.8	40.3	4.4	76.1	3.4	82.8
03/02/2014 14:15	6.204	39.8	8.8	39.9	5.0	64.1	3.5	76.4
03/02/2014 14:30	5.745	40	8.8	39.4	5.1	76.4	3.7	75.9
03/02/2014 14:45	5.924	40	8.8	39.4	5.2	67.1	3.9	76.4
03/02/2014 15:00	5.179	40.1	8.8	37.1	5.0	63.9	3.9	71.6
03/02/2014 15:15	5.488	40	8.3	35.3	4.3	60.9	3.8	72.1
03/02/2014 15:30	5.024	39.7	8.3	35.3	3.6	65.1	3.6	72.6
03/02/2014 15:45	4.792	40.3	7.7	34.8	3.0	65.1	3.4	70.8
03/02/2014 16:00	4.115	38.7	7.2	34.8	2.6	66.3	3.3	73.1
03/02/2014 16:15	3.827	39.4	6.4	34.8	2.2	65.8	3.0	70.1
03/02/2014 16:30	3.749	38.8	5.7	35.3	1.9	65.3	2.7	70.6
03/02/2014 16:45	3.142	42.6	4.9	38.0	1.6	66.3	2.6	75.9
03/02/2014 17:00	2.477	44.5	3.9	41.7	1.4	67.3	2.6	70.1
03/02/2014 17:15	1.94	45.6	3.1	44.5	1.4	69.6	2.6	63.4
03/02/2014 17:30	1.697	45.7	2.3	47.8	1.3	62.6	2.6	61.9
03/02/2014 17:45	1.453	45.5	1.3	49.8	1.2	61.9	2.5	64.1

Table 29 continued:

	Weather Station		DC17		DC18		DC19	
Sample	Exterior		LPN-METU-1		LPN-METU-2		LPN-METU-4	
DATE	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)
03/02/2014 18:00	1.18	46	1.1	52.6	1.1	61.1	2.4	59.2
03/02/2014 18:15	1.071	46.3	0.6	54.1	0.8	60.9	2.3	56.5
03/02/2014 18:30	0.989	47.6	0.1	56.5	0.6	62.6	1.9	57.5
03/02/2014 18:45	0.632	49.1	-0.2	58.5	0.3	66.1	1.8	61.7
03/02/2014 19:00	0.495	50.7	-0.4	59.0	0.2	62.9	1.8	67.4
03/02/2014 19:15	0.024	52.4	-0.9	60.5	0.0	60.6	1.7	71.8
03/02/2014 19:30	-0.199	53.8	-1.2	61.5	-0.2	62.9	1.6	64.6
03/02/2014 19:45	-0.311	54.8	-1.4	63.5	-0.3	58.2	1.5	69.3
03/02/2014 20:00	-0.088	54.3	-1.7	64.5	-0.4	62.1	1.4	75.7
03/02/2014 20:15	-0.479	53.4	-1.7	65.5	-0.5	64.3	1.4	77.2
03/02/2014 20:30	-0.958	56.2	-1.9	66.6	-0.6	69.6	1.4	78.7
03/02/2014 20:45	-1.157	56.8	-1.9	68.1	-0.6	70.6	1.4	80.5
03/02/2014 21:00	-1.327	57.8	-2.2	69.1	-0.6	70.8	1.3	80.5
03/02/2014 21:15	-1.727	59.9	-2.5	70.6	-0.6	66.8	1.2	75.7
03/02/2014 21:30	-1.384	59.5	-2.7	71.1	-0.8	58.9	0.9	66.4
03/02/2014 21:45	-1.498	60	-2.7	72.7	-0.9	61.6	0.7	75.7
03/02/2014 22:00	-2.421	62.8	-2.7	73.8	-0.9	68.8	0.7	77.2
03/02/2014 22:15	-2.16	62.8	-3.0	75.4	-0.9	69.6	0.6	76.2
03/02/2014 22:30	-2.566	63.6	-3.0	75.9	-0.9	69.6	0.5	79.0
03/02/2014 22:45	-2.859	65.4	-3.2	77.5	-1.0	62.6	0.3	69.1
03/02/2014 23:00	-3.035	67.2	-3.5	78.5	-1.1	65.1	0.0	74.4
03/02/2014 23:15	-3.33	68.6	-3.5	79.6	-1.2	67.6	0.0	78.2
03/02/2014 23:30	-2.771	68.1	-3.5	81.2	-1.3	65.8	-0.1	76.2
03/02/2014 23:45	-2.596	67.1	-3.5	81.2	-1.4	64.1	-0.2	77.4
04/02/2014 00:00	-2.508	67.5	-3.5	82.2	-1.6	61.4	-0.4	73.9
04/02/2014 00:15	-3.065	68.8	-3.7	82.2	-1.9	61.9	-0.5	76.2
04/02/2014 00:30	-3.065	70.3	-3.5	83.8	-2.1	61.1	-0.7	76.7
04/02/2014 00:45	-3.836	72.1	-3.7	83.8	-2.2	61.9	-0.8	76.7
04/02/2014 01:00	-3.926	73.3	-3.7	84.9	-2.1	67.8	-0.8	80.0
04/02/2014 01:15	-3.866	73.8	-3.7	86.0	-2.1	65.6	-0.8	78.7
04/02/2014 01:30	-3.896	73.2	-3.7	86.0	-2.3	63.6	-0.9	78.2
04/02/2014 01:45	-4.016	74.7	-3.7	87.1	-2.3	64.3	-1.0	79.0
04/02/2014 02:00	-4.016	75	-4.0	87.6	-2.4	63.6	-1.1	78.7
04/02/2014 02:15	-4.227	75.3	-4.0	88.7	-2.4	67.8	-1.1	82.0
04/02/2014 02:30	-4.257	75.3	-4.0	89.3	-2.4	67.8	-1.1	80.8
04/02/2014 02:45	-4.439	75.3	-4.0	89.8	-2.4	70.3	-1.2	79.5

Table 29 continued:

	Weather Station		DC17		DC18		DC19	
Sample	Exterior		LPN-METU-1		LPN-METU-2		LPN-METU-4	
DATE	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)
04/02/2014 03:00	-4.287	75.4	-4.0	90.9	-2.4	66.3	-1.3	74.1
04/02/2014 03:15	-4.469	76.1	-4.2	91.5	-2.5	66.3	-1.4	70.6
04/02/2014 03:30	-4.834	74.6	-4.2	91.5	-2.6	69.1	-1.5	77.2
04/02/2014 03:45	-5.698	78.1	-4.2	92.0	-2.6	72.3	-1.5	76.2
04/02/2014 04:00	-4.621	76.5	-4.5	92.0	-2.7	65.1	-1.7	73.9
04/02/2014 04:15	-5.418	78.8	-4.5	93.1	-2.8	69.8	-1.7	78.7
04/02/2014 04:30	-5.079	79.9	-4.5	93.7	-2.8	70.3	-1.7	81.0
04/02/2014 04:45	-6.579	81.5	-4.5	93.7	-2.8	72.1	-1.7	82.0
04/02/2014 05:00	-6.168	81.8	-4.5	94.2	-2.8	72.3	-1.7	82.3
04/02/2014 05:15	-5.791	81.7	-4.7	94.8	-2.8	72.3	-1.7	83.1
04/02/2014 05:30	-5.388	79.9	-5.0	95.3	-2.9	70.8	-1.7	80.3
04/02/2014 05:45	-5.357	78.7	-5.0	96.4	-3.0	65.3	-1.9	77.2
04/02/2014 06:00	-5.979	79.5	-5.2	96.4	-3.1	68.8	-1.9	81.0
04/02/2014 06:15	-6.325	81.9	-5.0	97.0	-3.2	69.8	-2.0	80.3
04/02/2014 06:30	-6.547	81.6	-5.0	97.0	-3.2	70.1	-2.0	82.3
04/02/2014 06:45	-7.284	83.3	-5.2	97.5	-3.3	73.3	-2.0	82.6
04/02/2014 07:00	-6.674	82.7	-5.0	98.1	-3.4	68.6	-2.1	78.0
04/02/2014 07:15	-6.136	80.6	-5.2	98.7	-3.6	66.8	-2.3	78.7
04/02/2014 07:30	-5.574	81	-5.5	99.2	-3.7	71.8	-2.3	81.0
04/02/2014 07:45	-6.042	81.6	-5.2	99.2	-3.8	71.6	-2.4	81.5
04/02/2014 08:00	-1.929	73.1	-5.2	100.0	-3.9	70.3	-2.4	81.3
04/02/2014 08:15	-1.929	72.5	-4.7	100.0	-3.9	69.3	-2.5	77.4
04/02/2014 08:30	-1.9	71.8	-4.0	100.0	-3.9	74.1	-2.5	82.8
04/02/2014 08:45	-0.451	71.7	-3.5	100.0	-3.7	77.9	-2.4	83.3
04/02/2014 09:00	0.218	65.5	-2.5	100.0	-3.5	79.9	-2.3	86.2
04/02/2014 09:15	-0.06	66.8	-1.9	100.0	-2.9	89.4	-2.0	86.7
04/02/2014 09:30	0.412	64.7	-0.9	100.0	-2.3	85.5	-1.8	85.9
04/02/2014 09:45	0.934	62.2	-0.2	100.0	-1.5	100.0	-1.2	93.8
04/02/2014 10:00	1.344	59.7	0.3	100.0	-0.2	100.0	-0.4	98.8
04/02/2014 10:15	1.425	60.7	1.3	100.0	1.6	100.0	1.1	99.6
04/02/2014 10:30	3.142	57	2.1	99.2	2.9	96.7	1.7	90.7
04/02/2014 10:45	3.406	54.4	2.6	94.8	3.3	86.3	1.8	89.9
04/02/2014 11:00	3.564	53.3	3.4	90.9	3.4	82.2	1.8	83.6
04/02/2014 11:15	2.69	53.5	4.1	87.1	3.1	75.8	1.5	82.0
04/02/2014 11:30	4.246	49.2	4.4	83.3	3.1	80.9	1.4	84.9
04/02/2014 11:45	4.272	49.8	4.9	76.9	3.2	79.7	1.4	84.1

Table 29 continued:

	Weather Station		DC17		DC18		DC19	
Sample	Exterior		LPN-METU-1		LPN-METU-2		LPN-METU-4	
DATE	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)
04/02/2014 12:00	4.766	47	5.7	76.4	3.3	83.7	1.5	87.8
04/02/2014 12:15	4.506	46.2	5.9	70.1	4.2	81.4	1.9	88.8
04/02/2014 12:30	5.179	42.9	6.4	62.0	4.0	78.9	2.1	87.2
04/02/2014 12:45	6.357	41.6	6.9	61.0	4.5	91.0	2.4	90.9
04/02/2014 13:00	5.308	43.3	7.5	61.5	4.7	79.4	2.6	90.7
04/02/2014 13:15	5.05	42.2	7.7	58.0	4.9	78.4	2.7	89.6
04/02/2014 13:30	5.076	43.7	8.0	57.5	4.6	72.1	3.0	89.3
04/02/2014 13:45	5.205	41.9	8.3	56.5	4.2	73.6	3.2	86.4
04/02/2014 14:00	6.255	38.8	8.8	56.0	4.1	75.6	3.5	92.8
04/02/2014 14:15	5.385	37.8	8.5	50.7	4.3	74.6	3.7	84.3
04/02/2014 14:30	6.204	38.1	8.5	49.8	4.1	75.3	4.0	88.8
04/02/2014 14:45	6.051	37	8.5	47.8	4.9	86.3	4.5	84.3
04/02/2014 15:00	6.306	36.9	8.8	48.3	5.9	80.4	5.0	91.4
04/02/2014 15:15	5.77	37.3	8.8	47.8	5.9	77.6	5.2	79.7
04/02/2014 15:30	5.924	37.2	8.5	48.3	6.0	72.1	5.5	82.3
04/02/2014 15:45	6.077	37.5	8.8	49.3	6.0	74.1	5.8	92.0
04/02/2014 16:00	5.308	39	8.3	48.8	6.0	70.6	6.0	83.8
04/02/2014 16:15	5.719	38.4	8.0	50.7	5.8	75.3	6.2	93.3
04/02/2014 16:30	4.973	39.2	7.2	51.2	5.7	72.3	6.4	93.0
04/02/2014 16:45	4.428	39.7	6.7	53.1	6.0	77.4	6.8	91.2
04/02/2014 17:00	3.67	41.8	5.9	55.5	6.1	77.9	7.0	95.1
04/02/2014 17:15	2.209	46.3	4.9	58.5	6.0	76.1	7.4	96.4
04/02/2014 17:30	1.751	47.1	3.9	61.0	6.1	79.7	7.6	95.9
04/02/2014 17:45	1.153	48.3	3.1	63.5	6.1	80.7	7.7	95.6
04/02/2014 18:00	0.88	49.2	2.3	66.1	5.9	79.4	7.7	94.3
04/02/2014 18:15	0.77	49.2	1.8	68.6	5.7	79.2	7.6	94.1
04/02/2014 18:30	0.77	49.2	1.1	71.1	5.5	78.6	7.6	94.1
04/02/2014 18:45	0.797	49.6	0.8	73.2	5.2	72.1	7.3	90.1
04/02/2014 19:00	-0.227	52.3	0.6	74.8	4.7	72.5	7.1	90.7
04/02/2014 19:15	0.135	51.6	0.3	76.4	4.3	66.8	6.7	82.6
04/02/2014 19:30	-0.227	52.7	0.1	78.5	3.8	71.6	6.4	88.0
04/02/2014 19:45	-0.06	52.8	-0.2	79.6	3.4	69.3	6.0	87.2
04/02/2014 20:00	-0.311	53.5	-0.7	81.2	3.0	69.8	5.7	87.5
04/02/2014 20:15	-0.76	54.8	-0.7	81.7	2.7	70.1	5.4	87.0
04/02/2014 20:30	-1.699	57.7	-0.9	83.3	2.5	73.6	5.1	89.6
04/02/2014 20:45	-1.9	59.4	-1.2	83.8	2.3	75.1	4.9	90.1

Table 29 continued:

	Weather Station		DC17		DC18		DC19	
Sample	Exterior		LPN-METU-1		LPN-METU-2		LPN-METU-4	
DATE	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)
04/02/2014 21:00	-1.47	58.4	-1.2	84.9	2.0	72.1	4.6	88.3
04/02/2014 21:15	-2.189	60.4	-1.4	86.0	1.8	74.3	4.4	90.1
04/02/2014 21:30	-1.785	58.5	-1.7	87.1	1.6	75.3	4.2	90.1
04/02/2014 21:45	-1.958	60.2	-1.9	88.2	1.3	74.8	3.9	89.1
04/02/2014 22:00	-1.1	57.4	-1.9	88.7	0.8	62.1	3.1	67.1
04/02/2014 22:15	-1.356	58.8	-1.9	88.7	0.1	62.6	2.3	71.6
04/02/2014 22:30	-2.421	61.4	-1.9	89.8	-0.3	68.3	2.1	83.6
04/02/2014 22:45	-2.742	63.4	-1.9	90.4	-0.4	70.8	2.0	86.4
04/02/2014 23:00	-2.683	63.7	-2.2	91.5	-0.4	75.6	2.0	87.8
04/02/2014 23:15	-2.247	60.9	-2.2	91.5	-0.5	74.3	1.9	83.8
04/02/2014 23:30	-2.712	62.2	-2.5	92.0	-0.6	77.6	1.8	87.8
04/02/2014 23:45	-2.334	61	-2.7	92.6	-0.6	74.6	1.6	86.2
05/02/2014 00:00	-2.771	62.1	-3.0	93.7	-0.7	76.4	1.5	87.8
05/02/2014 00:15	-2.712	62.8	-3.0	94.2	-0.7	75.1	1.3	86.2
05/02/2014 00:30	-3.508	64.8	-3.0	94.2	-0.8	75.1	1.1	87.2
05/02/2014 00:45	-3.598	65.9	-3.2	95.3	-0.9	76.9	1.0	88.0
05/02/2014 01:00	-3.926	67.7	-3.0	95.9	-0.9	75.8	0.8	85.4
05/02/2014 01:15	-3.836	66.4	-3.2	96.4	-1.1	74.6	0.6	84.6
05/02/2014 01:30	-3.687	65	-3.2	96.4	-1.2	74.3	0.4	86.4
05/02/2014 01:45	-3.986	65.3	-3.7	97.0	-1.3	76.4	0.3	87.2
05/02/2014 02:00	-4.318	66.7	-3.5	97.0	-1.3	76.1	0.2	88.3
05/02/2014 02:15	-4.227	67	-3.5	97.5	-1.4	74.6	0.0	88.5
05/02/2014 02:30	-4.318	66.8	-3.5	98.7	-1.4	76.4	-0.1	88.8
05/02/2014 02:45	-4.712	69	-3.7	99.2	-1.5	75.1	-0.2	87.0
05/02/2014 03:00	-5.049	70.2	-3.7	99.2	-1.6	74.6	-0.3	88.3
05/02/2014 03:15	-4.834	69.9	-4.0	99.2	-1.7	72.1	-0.5	85.1
05/02/2014 03:30	-4.804	69	-4.0	99.8	-1.9	74.3	-0.6	86.7
05/02/2014 03:45	-5.326	70.6	-4.0	99.8	-1.9	75.6	-0.7	88.3
05/02/2014 04:00	-5.049	68.9	-4.0	100.0	-2.0	74.6	-0.8	88.5
05/02/2014 04:15	-5.233	70.1	-4.0	100.0	-2.1	73.6	-0.9	87.8
05/02/2014 04:30	-4.926	68.9	-4.2	100.0	-2.2	73.8	-1.0	88.3
05/02/2014 04:45	-4.834	68.8	-4.2	100.0	-2.3	73.6	-1.1	88.0
05/02/2014 05:00	-5.698	71.5	-4.2	100.0	-2.3	73.6	-1.2	88.5
05/02/2014 05:15	-5.885	72.1	-4.2	100.0	-2.4	74.8	-1.2	89.3
05/02/2014 05:30	-5.76	71.3	-4.2	100.0	-2.5	76.1	-1.3	89.6
05/02/2014 05:45	-6.231	73.6	-4.5	100.0	-2.6	77.1	-1.3	89.6

Table 29 continued:

	Weather Station		DC17		DC18		DC19	
Sample	Exterior		LPN-METU-1		LPN-METU-2		LPN-METU-4	
DATE	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)
05/02/2014 06:00	-5.916	73.8	-4.5	100.0	-2.6	75.1	-1.4	89.3
05/02/2014 06:15	-6.073	74.2	-4.7	100.0	-2.8	73.3	-1.5	88.3
05/02/2014 06:30	-6.168	74.5	-4.5	100.0	-2.8	75.3	-1.5	89.1
05/02/2014 06:45	-6.073	74.8	-4.5	100.0	-2.9	75.3	-1.6	89.3
05/02/2014 07:00	-6.515	75.7	-4.7	100.0	-3.0	75.1	-1.7	88.5
05/02/2014 07:15	-6.294	74.9	-4.7	100.0	-3.1	74.8	-1.7	89.1
05/02/2014 07:30	-6.199	75.9	-4.7	100.0	-3.2	74.6	-1.8	88.8
05/02/2014 07:45	-5.326	73.4	-4.7	100.0	-3.3	74.8	-1.9	88.8
05/02/2014 08:00	-2.276	66.5	-4.7	100.0	-3.4	74.6	-1.9	89.1
05/02/2014 08:15	-0.817	61.1	-4.2	100.0	-3.4	76.9	-2.0	89.1
05/02/2014 08:30	-1.584	63	-3.7	100.0	-3.5	80.9	-2.0	88.0
05/02/2014 08:45	-1.27	64.5	-3.0	100.0	-3.6	80.7	-2.1	88.0
05/02/2014 09:00	-0.032	62.4	-2.2	100.0	-3.6	80.7	-2.1	88.3
05/02/2014 09:15	0.273	61.2	-1.7	100.0	-3.4	82.5	-2.1	87.2
05/02/2014 09:30	0.218	60.6	-0.4	0.0	-3.1	88.9	-2.0	87.5
05/02/2014 09:45	1.208	58.7	0.1	0.0	-2.7	89.4	-2.0	88.3
05/02/2014 10:00	2.128	55	0.8	0.0	-2.2	89.7	-1.8	89.1
05/02/2014 10:15	3.195	52.3	1.6	0.0	-1.7	87.6	-1.6	91.4
05/02/2014 10:30	3.775	50.9	2.3	0.0	-1.2	88.6	-1.4	92.2
05/02/2014 10:45	3.38	50.1	3.4	0.0	-0.7	90.2	-1.2	92.8
05/02/2014 11:00	4.115	46.8	3.9	100.0	-0.3	88.6	-0.9	93.3
05/02/2014 11:15	5.128	45.5	4.6	100.0	0.2	89.1	-0.6	93.8
05/02/2014 11:30	5.796	44	5.1	100.0	0.9	97.5	0.0	98.3
05/02/2014 11:45	5.385	44.8	5.9	95.9	1.3	85.3	0.2	93.0
05/02/2014 12:00	6.331	41.9	6.4	89.3	1.8	87.3	0.5	94.9
05/02/2014 12:15	5.693	42.4	6.7	83.3	2.4	85.3	0.8	94.3
05/02/2014 12:30	7.091	40.1	7.2	78.0	2.8	85.5	1.2	97.0
05/02/2014 12:45	7.192	39.7	8.0	74.8	3.2	80.9	1.6	97.0
05/02/2014 13:00	7.87	38	8.3	71.1	3.5	81.2	2.0	98.6
05/02/2014 13:15	6.864	39.7	8.5	67.6	3.7	79.7	2.4	93.8
05/02/2014 13:30	7.066	38.8	9.0	63.5	3.8	74.1	2.8	94.1
05/02/2014 13:45	6.712	39.4	9.3	59.0	4.1	76.1	3.2	90.9
05/02/2014 14:00	7.444	37.8	9.6	57.5	4.4	76.1	3.6	93.8
05/02/2014 14:15	7.268	37.8	9.6	56.5	4.8	74.1	4.0	88.0
05/02/2014 14:30	8.02	36.9	9.6	55.1	5.2	74.1	4.4	92.2
05/02/2014 14:45	7.645	37.6	9.6	55.5	5.5	76.9	4.7	89.9

Table 29 continued:

	Weather Station		DC17		DC18		DC19	
Sample	Exterior		LPN-METU-1		LPN-METU-2		LPN-METU-4	
DATE	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)
05/02/2014 15:00	8.965	35.7	9.8	56.5	5.9	75.8	5.1	94.6
05/02/2014 15:15	7.444	37.4	9.8	55.5	6.4	73.3	5.5	93.8
05/02/2014 15:30	7.845	36.9	9.8	56.0	6.7	79.4	5.9	93.8
05/02/2014 15:45	7.97	36.6	9.8	56.5	7.2	80.2	6.4	95.6
05/02/2014 16:00	6.712	38.1	9.3	55.1	7.3	71.3	6.7	96.4
05/02/2014 16:15	6.687	37.9	9.0	56.0	7.5	72.5	7.2	97.0
05/02/2014 16:30	6.153	38.4	8.5	57.5	7.1	56.5	7.7	95.4
05/02/2014 16:45	5.719	39	7.7	59.0	6.6	59.4	8.1	94.3
05/02/2014 17:00	4.973	40.2	7.2	61.5	6.4	61.4	8.3	95.6
05/02/2014 17:15	3.512	44.2	6.2	64.0	6.4	72.8	8.5	97.8
05/02/2014 17:30	3.591	44	5.1	66.1	6.4	77.1	8.6	97.5
05/02/2014 17:45	3.089	45.8	4.4	68.6	6.5	70.6	8.6	94.9
05/02/2014 18:00	2.209	48.2	3.4	71.1	6.3	69.3	8.5	95.4
05/02/2014 18:15	2.074	48.5	2.8	73.2	6.1	66.8	8.3	90.1
05/02/2014 18:30	1.805	49.1	2.3	75.4	5.7	65.1	8.1	92.8
05/02/2014 18:45	1.67	49.9	2.1	76.4	5.2	63.9	7.7	89.6
05/02/2014 19:00	1.317	51.2	1.6	78.0	4.7	65.1	7.4	89.3
05/02/2014 19:15	0.495	53.2	1.1	78.5	4.3	69.1	7.2	93.3
05/02/2014 19:30	-0.311	57.5	0.8	80.6	4.0	68.3	7.0	92.0
05/02/2014 19:45	0.495	54.7	0.3	81.7	3.7	70.8	6.7	93.3
05/02/2014 20:00	0.88	52.6	0.1	83.3	3.4	72.3	6.5	93.8
05/02/2014 20:15	1.859	49.6	-0.2	83.8	3.1	69.1	6.1	86.7
05/02/2014 20:30	1.398	50.8	-0.2	84.9	2.7	66.3	5.7	89.6
05/02/2014 20:45	-0.704	57.9	-0.2	86.0	2.4	68.8	5.4	81.8
05/02/2014 21:00	-0.032	55.9	-0.2	86.5	1.7	56.5	4.2	70.6
05/02/2014 21:15	0.218	56.8	-0.7	86.5	1.1	63.1	3.7	73.1
05/02/2014 21:30	0.467	56.1	-0.4	86.5	0.9	67.6	3.5	86.4
05/02/2014 21:45	-1.015	61.2	-0.9	87.1	0.8	69.8	3.4	89.1
05/02/2014 22:00	-1.27	61.2	-1.2	88.2	0.7	70.6	3.4	90.1
05/02/2014 22:15	-0.507	58.3	-1.2	88.7	0.5	62.4	2.8	72.3
05/02/2014 22:30	-0.986	59.4	-1.4	88.7	0.2	69.6	2.7	87.5
05/02/2014 22:45	-0.563	58.1	-1.4	89.3	0.1	70.1	2.7	89.3
05/02/2014 23:00	-1.27	60.2	-1.7	89.3	0.0	71.3	2.6	90.1
05/02/2014 23:15	-1.356	60.7	-1.9	90.4	-0.1	72.1	2.5	90.4
05/02/2014 23:30	-1.756	61.9	-1.9	90.9	-0.2	73.1	2.4	90.4
05/02/2014 23:45	-1.756	62.3	-2.2	91.5	-0.3	72.3	2.3	90.4

Table 29 continued:

	Weather Station		DC17		DC18		DC19	
Sample	Exterior		LPN-METU-1		LPN-METU-2		LPN-METU-4	
DATE	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)
06/02/2014 00:00	-1.986	62.9	-2.2	92.0	-0.3	73.1	2.1	90.7
06/02/2014 00:15	-2.334	64.1	-2.2	92.6	-0.4	72.1	2.0	90.1
06/02/2014 00:30	-3.124	66.8	-2.5	93.1	-0.5	71.6	1.8	90.1
06/02/2014 00:45	-3.183	68.1	-2.5	94.2	-0.5	73.1	1.6	90.1
06/02/2014 01:00	-3.212	68	-2.7	94.2	-0.6	73.3	1.5	90.7
06/02/2014 01:15	-3.153	67.8	-2.7	94.8	-0.6	73.8	1.3	90.9
06/02/2014 01:30	-2.918	67.5	-2.7	95.3	-0.7	72.8	1.2	90.7
06/02/2014 01:45	-3.36	69.5	-3.0	96.4	-0.7	72.8	1.0	89.9
06/02/2014 02:00	-2.888	67.2	-3.0	96.4	-0.8	72.5	0.8	90.9
06/02/2014 02:15	-3.687	69.3	-3.0	97.0	-0.9	71.8	0.6	87.5
06/02/2014 02:30	-3.598	69.1	-3.2	97.5	-1.0	72.1	0.5	89.6
06/02/2014 02:45	-2.859	68.1	-3.0	98.1	-1.1	68.8	0.2	81.5
06/02/2014 03:00	-2.918	67.6	-3.2	98.1	-1.4	66.8	-0.1	83.8
06/02/2014 03:15	-4.106	71	-3.2	99.2	-1.5	71.8	-0.2	89.1
06/02/2014 03:30	-3.508	69.8	-3.2	99.2	-1.5	73.3	-0.3	87.5
06/02/2014 03:45	-3.242	68.8	-3.2	99.2	-1.7	72.1	-0.4	86.7
06/02/2014 04:00	-4.621	73.4	-3.5	99.2	-1.8	73.6	-0.5	89.3
06/02/2014 04:15	-3.896	70.1	-3.5	99.8	-1.8	74.3	-0.6	90.1
06/02/2014 04:30	-4.348	72.2	-3.7	99.8	-1.8	74.1	-0.6	90.7
06/02/2014 04:45	-4.895	74.6	-3.7	100.0	-1.8	74.3	-0.6	90.9
06/02/2014 05:00	-4.59	73.9	-3.7	100.0	-1.8	73.3	-0.7	91.2
06/02/2014 05:15	-4.712	74.3	-3.7	100.0	-1.9	73.8	-0.8	91.2
06/02/2014 05:30	-4.773	74.4	-4.0	100.0	-2.0	72.3	-0.8	90.9
06/02/2014 05:45	-4.957	75.2	-4.0	100.0	-2.1	73.1	-0.9	91.2
06/02/2014 06:00	-4.682	75.1	-4.2	100.0	-2.1	72.8	-0.9	90.9
06/02/2014 06:15	-4.987	74.9	-4.0	100.0	-2.2	72.1	-1.0	90.9
06/02/2014 06:30	-5.11	74.5	-4.2	100.0	-2.3	71.6	-1.1	91.2
06/02/2014 06:45	-5.172	76.1	-4.0	100.0	-2.3	72.3	-1.1	90.9
06/02/2014 07:00	-5.388	75.9	-4.2	100.0	-2.4	71.6	-1.2	90.9
06/02/2014 07:15	-5.049	75.6	-4.2	100.0	-2.5	72.1	-1.3	90.9
06/02/2014 07:30	-5.542	77.4	-4.2	100.0	-2.6	71.6	-1.3	90.9
06/02/2014 07:45	-4.957	77.1	-4.2	100.0	-2.7	71.6	-1.4	90.7
06/02/2014 08:00	-2.102	70.3	-4.2	100.0	-2.7	72.5	-1.5	90.9
06/02/2014 08:15	-1.9	68.6	-4.0	100.0	-2.9	71.1	-1.5	89.1
06/02/2014 08:30	-1.785	69	-3.2	100.0	-3.1	66.6	-1.6	86.4
06/02/2014 08:45	-1.071	67.7	-2.7	100.0	-3.1	69.1	-1.7	87.5

Table 29 continued:

	Weather Station		DC17		DC18		DC19	
Sample	Exterior		LPN-METU-1		LPN-METU-2		LPN-METU-4	
DATE	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)
06/02/2014 09:00	-0.116	65.4	-2.2	100.0	-3.1	74.3	-1.7	88.3
06/02/2014 09:15	0.962	64.1	-0.9	0.0	-2.8	77.4	-1.7	90.4
06/02/2014 09:30	3.433	57.9	-0.2	0.0	-2.5	81.7	-1.5	93.5
06/02/2014 09:45	2.85	58.5	0.6	0.0	-2.0	79.9	-1.4	91.7
06/02/2014 10:00	3.643	55.1	1.3	0.0	-1.5	80.4	-1.2	91.4
06/02/2014 10:15	3.643	53.7	2.3	0.0	-0.9	80.7	-1.1	90.7
06/02/2014 10:30	4.714	52.3	3.1	0.0	-0.3	78.9	-0.9	92.0
06/02/2014 10:45	5.231	50.3	3.6	100.0	0.1	77.1	-0.7	93.5
06/02/2014 11:00	5.77	46.3	4.6	100.0	0.5	79.9	-0.4	94.1
06/02/2014 11:15	6.458	44.9	5.4	100.0	1.0	77.1	-0.2	93.5
06/02/2014 11:30	7.116	44	5.9	98.7	1.7	79.7	0.1	94.6
06/02/2014 11:45	7.142	43.6	6.7	91.5	2.3	76.4	0.5	95.4
06/02/2014 12:00	8.145	40.8	6.9	84.3	2.8	77.6	0.9	98.0
06/02/2014 12:15	8.22	39.6	8.0	79.0	3.3	73.8	1.4	96.4
06/02/2014 12:30	8.618	37.3	8.3	72.7	3.9	83.2	1.9	100.0
06/02/2014 12:45	8.965	36.5	8.8	69.6	4.4	70.8	2.4	99.6
06/02/2014 13:00	10.785	33.9	9.6	67.6	4.8	74.1	2.9	100.0
06/02/2014 13:15	9.312	34.3	9.8	64.0	5.2	72.5	3.4	98.8
06/02/2014 13:30	9.361	35.2	10.1	60.5	5.5	65.1	3.9	94.1
06/02/2014 13:45	9.583	34.2	10.4	58.0	5.9	64.3	4.3	93.8
06/02/2014 14:00	9.78	34	10.9	56.5	6.2	69.8	4.7	88.3
06/02/2014 14:15	9.854	34.5	11.2	53.6	6.7	64.6	5.1	89.1
06/02/2014 14:30	9.41	34.5	11.2	53.1	7.0	65.1	5.5	89.9
06/02/2014 14:45	9.262	34.4	11.2	52.2	7.5	63.9	5.9	88.3
06/02/2014 15:00	8.965	34.3	10.9	49.8	7.9	61.6	6.4	88.8
06/02/2014 15:15	9.312	33.3	10.9	49.3	8.2	64.1	6.8	85.1
06/02/2014 15:30	8.394	36.2	10.6	47.8	8.4	55.3	7.2	83.6
06/02/2014 15:45	8.344	37.8	10.4	49.3	8.4	56.7	7.5	82.6
06/02/2014 16:00	7.569	39.4	9.6	49.8	8.4	51.1	7.8	79.2
06/02/2014 16:15	7.444	39.2	9.6	50.2	8.0	46.5	7.9	74.6
06/02/2014 16:30	6.889	40.7	8.5	50.7	7.5	47.5	8.0	75.4
06/02/2014 16:45	6.331	39.9	8.0	51.2	7.2	47.3	8.0	73.4
06/02/2014 17:00	5.642	40.3	7.2	53.1	6.9	47.3	8.1	82.6
06/02/2014 17:15	4.895	42.2	6.4	55.5	6.8	58.4	8.3	89.6
06/02/2014 17:30	3.722	44.8	5.7	58.0	6.7	60.1	8.4	90.9
06/02/2014 17:45	4.011	44.1	4.6	61.0	6.7	62.4	8.4	89.3

Table 29 continued:

	Weather Station		DC17		DC18		DC19	
Sample	Exterior		LPN-METU-1		LPN-METU-2		LPN-METU-4	
DATE	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)
06/02/2014 18:00	3.274	46.5	3.9	63.5	6.5	61.6	8.3	89.3
06/02/2014 18:15	3.433	46.5	3.4	66.1	6.3	57.0	8.1	85.7
06/02/2014 18:30	3.459	46.5	2.8	68.6	5.9	56.7	7.8	84.3
06/02/2014 18:45	3.354	46.5	2.6	70.6	5.4	56.2	7.4	81.8
06/02/2014 19:00	3.221	46.8	2.3	72.2	4.9	57.7	7.0	84.3
06/02/2014 19:15	2.85	47.9	2.1	73.8	4.6	58.2	6.8	85.1
06/02/2014 19:30	1.615	51.6	1.6	74.8	4.3	61.1	6.6	90.1
06/02/2014 19:45	0.934	52.8	1.3	75.9	4.2	62.9	6.4	90.4
06/02/2014 20:00	1.208	52.7	1.3	75.9	4.1	62.9	6.3	88.3
06/02/2014 20:15	1.507	51	0.8	78.0	3.7	57.9	5.7	77.4
06/02/2014 20:30	1.398	51.2	0.6	78.5	3.3	60.6	5.3	81.8
06/02/2014 20:45	1.371	52.7	0.6	79.6	2.9	61.4	5.0	84.6
06/02/2014 21:00	0.66	55.6	0.1	81.2	2.7	63.6	4.8	88.0
06/02/2014 21:15	0.439	56.2	0.1	81.7	2.6	62.9	4.6	88.0
06/02/2014 21:30	-0.088	57	-0.2	83.3	2.4	64.6	4.4	88.8
06/02/2014 21:45	-0.06	56.5	-0.4	83.3	2.2	63.9	4.2	89.1
06/02/2014 22:00	0.051	56.4	-0.7	84.3	2.0	59.9	3.9	82.8
06/02/2014 22:15	-0.535	58.1	-0.7	86.0	1.7	59.2	3.6	76.9
06/02/2014 22:30	-0.088	57.7	-0.9	86.5	1.3	59.9	3.2	79.5
06/02/2014 22:45	-0.507	59.5	-1.2	87.1	1.1	61.6	2.9	83.8
06/02/2014 23:00	0.079	56.6	-0.9	88.2	1.0	64.1	2.8	87.5
06/02/2014 23:15	-0.395	57.7	-1.2	88.7	0.9	66.1	2.7	88.3
06/02/2014 23:30	-1.584	62.7	-1.2	89.3	0.7	63.1	2.5	86.2
06/02/2014 23:45	-1.756	62.5	-1.4	89.8	0.6	65.8	2.3	87.5
07/02/2014 00:00	-1.242	60.9	-1.7	90.9	0.5	64.8	2.2	87.5
07/02/2014 00:15	-1.986	62.9	-1.7	90.9	0.3	67.6	2.0	88.3
07/02/2014 00:30	-1.641	61.2	-1.9	91.5	0.2	65.1	1.9	88.3
07/02/2014 00:45	-1.613	61.4	-1.9	92.6	0.1	65.3	1.8	88.5
07/02/2014 01:00	-1.958	63	-1.9	93.7	0.0	64.8	1.6	88.8
07/02/2014 01:15	-1.785	62.2	-1.9	93.7	-0.1	63.9	1.5	88.5
07/02/2014 01:30	-2.015	63.2	-1.9	94.2	-0.2	65.1	1.3	89.3
07/02/2014 01:45	-2.015	63.2	-2.2	94.8	-0.3	65.1	1.2	89.3
07/02/2014 02:00	-2.392	63.9	-2.2	95.3	-0.4	64.3	1.1	89.3
07/02/2014 02:15	-2.771	66	-2.5	95.9	-0.5	63.6	0.9	89.6
07/02/2014 02:30	-3.538	68.6	-2.5	96.4	-0.5	63.6	0.8	89.6
07/02/2014 02:45	-2.947	67.7	-2.5	97.0	-0.6	64.1	0.6	88.0

Table 29 continued:

	Weather Station		DC17		DC18		DC19	
Sample	Exterior		LPN-METU-1		LPN-METU-2		LPN-METU-4	
DATE	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)	T. (°C)	RH (%)
07/02/2014 03:00	-2.976	66.9	-2.5	97.0	-0.7	64.3	0.5	89.3
07/02/2014 03:15	-3.33	68	-2.5	97.5	-0.8	64.1	0.3	88.8
07/02/2014 03:30	-2.654	67	-2.7	98.1	-0.8	66.3	0.2	89.1
07/02/2014 03:45	-3.065	68.3	-2.7	99.2	-0.9	65.1	0.1	89.1
07/02/2014 04:00	-3.479	69.8	-3.0	99.2	-1.0	64.6	-0.1	87.8
07/02/2014 04:15	-3.36	69.9	-2.7	99.8	-1.1	66.1	-0.2	87.2
07/02/2014 04:30	-3.747	70.2	-2.7	99.8	-1.2	64.1	-0.3	88.5
07/02/2014 04:45	-4.408	72.9	-3.0	99.8	-1.3	64.8	-0.3	89.3
07/02/2014 05:00	-3.568	71.1	-3.0	100.0	-1.3	63.6	-0.4	89.3
07/02/2014 05:15	-4.227	72.4	-3.0	100.0	-1.5	62.4	-0.5	87.8
07/02/2014 05:30	-4.621	74	-3.2	100.0	-1.5	63.6	-0.6	88.5
07/02/2014 05:45	-3.956	72.1	-3.2	100.0	-1.6	62.1	-0.7	84.9
07/02/2014 06:00	-4.348	72.1	-3.2	100.0	-1.8	64.3	-0.8	87.8
07/02/2014 06:15	-4.682	74.5	-3.5	100.0	-1.8	65.3	-0.9	88.8
07/02/2014 06:30	-4.56	74	-3.2	100.0	-1.9	64.8	-0.9	89.3
07/02/2014 06:45	-4.408	74.1	-3.5	100.0	-1.9	64.1	-1.0	89.3
07/02/2014 07:00	-4.197	72.5	-3.5	100.0	-2.0	63.9	-1.0	89.3
07/02/2014 07:15	-4.408	73.9	-3.5	100.0	-2.1	64.3	-1.1	89.1
07/02/2014 07:30	-4.076	72.6	-3.7	100.0	-2.2	63.9	-1.1	89.1
07/02/2014 07:45	-3.508	72.2	-3.7	100.0	-2.2	62.9	-1.2	86.7
07/02/2014 08:00	-2.189	68.9	-3.2	100.0	-2.4	60.9	-1.3	87.0
07/02/2014 08:15	-1.527	67.6	-3.0	100.0	-2.6	53.6	-1.4	83.1
07/02/2014 08:30	-0.06	63.2	-2.7	100.0	-2.6	59.6	-1.5	85.4
07/02/2014 08:45	0.356	64.4	-1.7	100.0	-2.6	60.6	-1.5	85.9
07/02/2014 09:00	1.398	61.6	-0.9	100.0	-2.4	63.9	-1.5	86.4
07/02/2014 09:15	2.503	60.6	-0.2	100.0	-2.1	65.8	-1.4	87.8
07/02/2014 09:30	2.209	60.1	0.8	0.0	-1.7	67.3	-1.3	87.2

Table 30: Thermal behavior in boxes during winter time, from 10/12/2014 to 11/12/2014.

DATE	DC02		DC11		DC13		DC14		DC18	
Sample	Exterior		LPN-KERK-3		Woodchips-LWL		STRAW-KERK-2		STRAW-KERK-1	
Temperature/Humidity	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)
10.12.2014 17:00	8.8	77.8	10.2	38.9	10.6	33.8	10.9	39.5	17.0	43.3
10.12.2014 17:15	8.3	79.3	7.5	43.2	8.0	39.1	8.3	42.2	11.8	52.4
10.12.2014 17:30	8.3	80.4	4.9	44.2	5.1	38.6	5.7	42.0	7.5	50.4
10.12.2014 17:45	8.0	80.9	2.3	47.7	2.4	37.7	3.0	39.2	4.0	49.5
10.12.2014 18:00	7.5	80.9	5.4	59.3	6.8	52.0	6.1	55.5	4.0	58.2
10.12.2014 18:15	7.7	80.9	20.4	31.4	22.7	27.5	20.6	36.0	16.6	49.0
10.12.2014 18:30	7.5	80.4	18.6	27.2	22.3	26.2	19.9	34.4	21.1	49.0
10.12.2014 18:45	6.9	80.9	12.1	31.8	12.8	29.5	12.0	35.8	15.9	50.0
10.12.2014 19:00	6.9	80.4	8.5	34.8	8.8	29.1	8.9	36.0	11.1	50.4
10.12.2014 19:15	6.4	84.6	5.8	37.7	5.9	29.1	6.2	35.8	7.4	49.5
10.12.2014 19:30	6.7	84.6	4.6	38.4	4.4	26.9	4.9	35.8	5.1	51.4
10.12.2014 19:45	6.9	84.1	20.4	42.1	22.9	39.6	18.5	45.9	14.1	54.8
10.12.2014 20:00	6.4	84.6	26.5	31.8	28.3	28.9	25.5	42.0	23.9	48.3
10.12.2014 20:15	6.4	86.3	16.6	30.1	19.2	28.9	19.7	37.6	22.2	54.6
10.12.2014 20:30	6.4	88.4	12.1	32.5	13.2	28.0	13.6	35.8	15.8	52.4
10.12.2014 20:45	6.9	88.4	9.7	36.6	10.0	28.4	10.2	35.6	11.5	51.4
10.12.2014 21:00	6.9	87.3	7.5	36.8	7.5	27.1	7.8	34.2	8.3	50.9
10.12.2014 21:15	7.2	87.9	14.8	42.1	17.2	36.3	13.7	42.5	10.9	57.5
10.12.2014 21:30	6.7	91.2	27.3	24.4	30.0	23.8	25.6	30.8	22.6	48.3
10.12.2014 21:45	6.9	89.0	20.2	25.5	22.3	24.2	21.3	33.3	24.9	49.5
10.12.2014 22:00	6.7	89.5	14.4	29.0	15.3	25.3	15.5	32.4	18.8	50.7
10.12.2014 22:15	6.7	90.1	11.7	28.8	12.0	24.6	11.9	31.5	13.8	50.0
10.12.2014 22:30	6.7	90.6	10.1	33.6	10.1	25.3	9.8	32.2	10.4	50.0
10.12.2014 22:45	6.7	90.6	10.8	40.7	12.2	32.8	11.4	40.6	9.2	54.8
10.12.2014 23:00	6.7	90.6	24.3	30.7	26.4	29.1	23.6	38.3	19.3	49.0
10.12.2014 23:15	6.2	90.6	20.7	27.5	23.6	24.2	24.4	31.7	24.9	42.3
10.12.2014 23:30	5.9	91.7	15.3	34.1	16.6	27.5	18.5	30.4	20.2	44.6
10.12.2014 23:45	6.2	94.0	12.2	43.9	12.9	36.3	13.4	36.7	14.5	46.3
11.12.2014 00:00	5.9	95.6	9.0	47.2	9.1	42.6	9.1	45.7	10.0	47.5
11.12.2014 00:15	5.9	98.5	7.9	48.2	8.0	43.1	8.1	44.8	8.3	48.5
11.12.2014 00:30	6.2	97.3	12.9	48.0	13.4	48.6	12.7	51.7	13.4	52.1
11.12.2014 00:45	6.2	99.1	19.5	42.8	20.4	45.6	21.8	46.7	23.0	45.1

Table 30 continued:

DATE	DC02		DC11		DC13		DC14		DC18	
Sample	Exterior		LPN-KERK-3		Woodchips-LWL		STRAW-KERK-2		STRAW-KERK-1	
Temperature/Humidity	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)
11.12.2014 01:00	6.2	98.5	14.0	35.0	15.0	32.4	15.1	36.5	21.4	38.9
11.12.2014 01:15	6.2	96.8	11.2	43.9	11.3	40.3	11.3	42.9	13.5	43.5
11.12.2014 01:30	6.2	96.2	10.2	48.2	10.4	43.5	10.4	46.9	11.0	48.0
11.12.2014 01:45	5.7	95.6	8.6	47.2	8.8	42.1	9.1	45.0	9.2	47.0
11.12.2014 02:00	5.9	96.2	11.1	64.1	12.8	65.0	10.9	60.2	9.0	54.3
11.12.2014 02:15	5.4	96.2	23.2	35.4	24.6	38.2	22.0	40.9	20.2	47.8
11.12.2014 02:30	5.7	96.2	21.6	26.1	25.3	24.9	21.5	37.6	24.9	46.6
11.12.2014 02:45	5.4	96.2	13.3	32.3	14.4	28.2	12.9	37.6	17.9	44.9
11.12.2014 03:00	5.4	96.8	10.0	34.1	10.4	27.7	10.0	36.9	12.7	44.4
11.12.2014 03:15	5.4	96.2	6.9	35.9	7.1	27.1	7.1	36.0	8.5	42.6
11.12.2014 03:30	5.7	95.1	4.9	37.3	4.9	27.1	5.0	36.0	5.5	43.3
11.12.2014 03:45	5.4	94.5	20.8	29.9	22.7	25.1	20.0	37.6	15.0	44.9
11.12.2014 04:00	4.9	94.0	25.4	23.3	28.3	19.4	24.4	28.6	22.5	38.9
11.12.2014 04:15	4.9	93.4	18.1	24.8	20.5	21.5	18.6	30.8	20.8	46.1
11.12.2014 04:30	5.1	94.0	12.1	27.7	13.3	20.9	12.9	30.8	14.7	44.6
11.12.2014 04:45	5.1	94.0	8.7	32.3	9.1	20.9	9.2	30.6	10.1	43.3
11.12.2014 05:00	4.9	94.0	6.3	39.1	6.5	21.1	6.6	31.1	6.8	43.3
11.12.2014 05:15	4.9	93.4	15.7	36.1	18.0	28.4	15.6	37.4	10.3	49.2
11.12.2014 05:30	4.1	94.0	26.1	24.2	29.3	19.9	25.2	29.5	20.8	41.2
11.12.2014 05:45	3.9	96.8	22.6	20.9	26.2	18.8	23.7	28.0	23.6	46.8
11.12.2014 06:00	3.6	100.0	14.6	22.9	16.4	16.9	16.2	25.8	17.5	43.5
11.12.2014 06:15	3.4	99.6	10.7	25.9	11.2	16.9	11.5	27.3	12.3	42.8
11.12.2014 06:30	3.6	99.1	9.1	29.0	9.2	16.9	9.4	27.5	9.5	43.7
11.12.2014 06:45	3.6	99.1	8.8	33.4	8.8	18.2	8.9	29.1	8.3	45.8
11.12.2014 07:00	3.4	96.2	17.9	28.3	19.8	22.0	16.9	29.5	12.7	44.0
11.12.2014 07:15	3.4	96.2	17.8	28.1	18.4	25.1	18.2	27.3	16.8	38.4
11.12.2014 07:30	3.4	97.9	14.3	28.6	14.7	24.0	15.1	27.8	14.9	42.1
11.12.2014 07:45	3.9	100.0	13.2	30.7	13.6	24.6	13.8	29.1	13.0	43.3

Table 31: Thermal behavior in boxes during winter time, from 27/10/2013 to 06/11/2013, extracted from a set of data starting on the 27/10/2013 and finishing on the 14/12/2013

	DC02		DC11		DC13		DC14		DC16	
Sample	Exterior		STRAW-KERK-1		STRAW-KERK-2		LPN-KERK-3		Woodchips-LWL	
DATE	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)
27/10/2013 18:00	12.0	32.1	10.2	38.9	10.6	33.8	10.9	39.5	17.0	43.3
27/10/2013 18:15	11.7	33.3	10.0	39.8	10.4	33.1	10.6	41.3	16.3	42.8
27/10/2013 18:30	11.2	34.2	9.8	40.7	10.2	35.6	10.3	41.3	15.8	46.8
27/10/2013 18:45	10.6	34.2	9.6	41.2	10.1	36.1	10.1	42.5	15.6	49.7
27/10/2013 19:00	10.1	36.7	9.5	40.3	10.0	36.8	10.1	40.4	15.4	50.4
27/10/2013 19:15	9.8	39.3	9.3	40.3	9.9	38.9	9.9	42.0	15.1	50.9
27/10/2013 19:30	9.6	38.0	9.1	41.2	9.7	39.1	9.8	42.2	14.9	51.4
27/10/2013 19:45	9.8	39.3	9.0	41.2	9.6	39.6	9.7	42.0	14.5	51.6
27/10/2013 20:00	9.3	41.0	8.8	41.2	9.4	39.1	9.6	40.9	14.2	51.9
27/10/2013 20:15	9.0	41.5	8.6	41.6	9.2	39.1	9.4	40.9	13.9	51.6
27/10/2013 20:30	9.0	41.5	8.4	42.3	9.0	39.3	9.2	42.5	13.5	51.9
27/10/2013 20:45	8.3	43.2	8.2	41.6	8.8	39.6	9.1	41.5	13.2	51.6
27/10/2013 21:00	8.0	43.7	8.0	42.6	8.6	39.3	8.9	42.0	12.8	52.1
27/10/2013 21:15	7.7	44.6	7.9	42.6	8.4	39.6	8.7	41.8	12.5	51.9
27/10/2013 21:30	7.5	44.6	7.6	43.2	8.2	39.1	8.5	42.0	12.1	51.9
27/10/2013 21:45	7.5	45.0	7.5	43.2	8.0	39.1	8.3	42.2	11.8	52.4
27/10/2013 22:00	6.9	48.1	7.3	43.2	7.8	38.9	8.2	42.2	11.5	51.6
27/10/2013 22:15	7.2	46.8	7.2	43.5	7.6	39.1	8.0	41.3	11.2	52.1
27/10/2013 22:30	7.2	47.7	7.0	42.8	7.4	38.9	7.8	42.2	10.9	51.6
27/10/2013 22:45	6.4	48.1	6.8	43.7	7.2	38.9	7.6	42.2	10.6	51.6
27/10/2013 23:00	6.4	48.1	6.6	43.7	7.0	39.1	7.5	41.8	10.3	51.4
27/10/2013 23:15	5.9	48.1	6.4	44.6	6.8	38.4	7.3	42.2	9.9	51.6
27/10/2013 23:30	6.2	48.1	6.3	45.1	6.6	38.6	7.1	42.2	9.7	51.4
27/10/2013 23:45	5.9	43.7	6.1	44.6	6.4	38.9	6.9	42.2	9.4	50.9
28/10/2013 00:00	5.9	46.3	5.9	44.4	6.2	38.9	6.7	41.8	9.1	50.7
28/10/2013 00:15	5.4	43.7	5.8	44.6	6.0	39.1	6.6	41.8	8.8	50.7
28/10/2013 00:30	5.4	41.9	5.6	44.2	5.9	39.1	6.4	42.2	8.5	50.2
28/10/2013 00:45	5.4	42.3	5.4	44.2	5.7	38.9	6.2	41.3	8.3	50.4
28/10/2013 01:00	5.7	41.9	5.3	44.2	5.5	38.9	6.0	42.2	8.0	50.4
28/10/2013 01:15	5.7	42.3	5.1	43.9	5.3	38.6	5.9	41.8	7.8	50.9
28/10/2013 01:30	5.4	45.5	4.9	44.2	5.1	38.6	5.7	42.0	7.5	50.4
28/10/2013 01:45	5.1	45.9	4.8	44.2	4.9	38.6	5.5	41.1	7.2	50.4
28/10/2013 02:00	4.9	48.1	4.6	43.9	4.8	38.4	5.3	40.2	7.0	50.4
28/10/2013 02:15	4.6	46.8	4.4	44.2	4.6	38.4	5.1	40.9	6.8	50.2
28/10/2013 02:30	4.1	50.0	4.2	44.2	4.4	38.4	5.0	40.2	6.5	50.7
28/10/2013 02:45	4.4	47.7	4.1	44.4	4.2	38.4	4.8	40.6	6.3	50.0

Table 31 continued:

	DC02		DC11		DC13		DC14		DC16	
Sample	Exterior		STRAW-KERK-1		STRAW-KERK-2		LPN-KERK-3		Woodchips-LWL	
DATE	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)
28/10/2013 03:00	4.1	48.6	3.9	44.4	4.0	38.2	4.6	41.5	6.0	50.2
28/10/2013 03:15	3.9	50.0	3.7	44.2	3.8	38.2	4.4	40.2	5.8	50.2
28/10/2013 03:30	3.9	50.4	3.6	44.6	3.6	38.2	4.3	40.9	5.6	50.2
28/10/2013 03:45	3.9	52.3	3.4	44.2	3.5	37.9	4.1	39.9	5.4	50.4
28/10/2013 04:00	3.6	50.9	3.2	44.6	3.3	38.2	3.9	40.6	5.1	50.0
28/10/2013 04:15	3.6	51.8	3.1	44.2	3.1	37.9	3.7	39.7	4.9	50.0
28/10/2013 04:30	3.4	50.9	2.9	44.4	2.9	38.2	3.6	40.2	4.7	50.2
28/10/2013 04:45	3.1	52.7	2.7	44.4	2.8	37.9	3.4	39.5	4.5	50.0
28/10/2013 05:00	3.1	55.1	2.5	44.6	2.6	37.7	3.2	39.7	4.2	49.5
28/10/2013 05:15	2.8	55.1	2.3	47.7	2.4	37.7	3.0	39.2	4.0	49.5
28/10/2013 05:30	2.8	56.0	2.2	48.2	2.2	37.5	2.9	39.5	3.8	49.7
28/10/2013 05:45	2.8	56.0	2.0	48.2	2.1	37.5	2.7	39.0	3.6	49.7
28/10/2013 06:00	2.6	56.9	1.9	47.7	1.9	37.5	2.5	39.5	3.4	49.7
28/10/2013 06:15	2.3	55.1	1.8	48.9	1.8	37.7	2.4	38.5	3.2	50.2
28/10/2013 06:30	2.6	58.8	1.7	46.3	1.6	37.7	2.3	38.8	3.0	50.2
28/10/2013 06:45	2.8	56.9	1.6	47.2	1.5	37.7	2.1	39.0	2.8	50.2
28/10/2013 07:00	3.4	55.1	1.5	45.8	1.4	36.3	2.0	38.5	2.7	49.7
28/10/2013 07:15	5.1	51.3	1.5	46.0	1.3	37.2	1.9	39.2	2.5	50.2
28/10/2013 07:30	6.9	45.0	1.5	45.6	1.3	34.9	2.0	40.2	2.4	51.9
28/10/2013 07:45	8.8	40.6	1.6	44.9	1.6	37.5	2.2	41.1	2.4	54.6
28/10/2013 08:00	9.3	41.5	2.2	48.2	2.4	42.4	2.7	42.2	2.7	56.2
28/10/2013 08:15	10.6	39.3	2.9	53.2	3.5	48.1	3.4	46.7	2.9	56.7
28/10/2013 08:30	11.7	38.0	4.0	63.3	5.0	52.5	4.6	58.4	3.2	58.0
28/10/2013 08:45	14.0	34.2	4.7	57.1	5.7	46.9	5.3	48.3	3.5	56.2
28/10/2013 09:00	15.1	32.5	5.4	59.3	6.8	52.0	6.1	55.5	4.0	58.2
28/10/2013 09:15	16.2	30.4	6.2	61.3	7.6	52.0	6.8	50.0	4.7	61.0
28/10/2013 09:30	14.8	32.5	8.9	58.1	10.5	52.7	8.9	61.2	5.9	59.0
28/10/2013 09:45	14.8	32.5	11.1	52.3	12.7	46.4	10.8	55.0	7.0	59.0
28/10/2013 10:00	15.1	30.8	12.6	54.7	14.2	46.6	12.2	51.9	8.0	58.0
28/10/2013 10:15	16.0	30.4	13.9	52.0	15.6	44.5	13.3	51.7	9.0	56.0
28/10/2013 10:30	16.0	30.4	15.2	47.0	16.8	37.5	14.7	47.4	10.1	53.3
28/10/2013 10:45	16.2	29.6	15.9	42.8	17.4	36.8	15.6	44.1	10.9	52.9
28/10/2013 11:00	16.8	27.9	16.4	43.2	18.0	37.9	16.3	44.5	11.7	53.6
28/10/2013 11:15	17.7	27.5	16.9	40.3	18.7	38.2	17.0	44.3	12.3	52.6
28/10/2013 11:30	17.7	27.1	17.6	40.7	19.6	35.6	17.8	44.1	13.0	52.9
28/10/2013 11:45	17.7	26.7	18.2	43.0	20.3	34.0	18.4	42.9	13.7	50.4

Table 31 continued:

	DC02		DC11		DC13		DC14		DC16	
Sample	Exterior		STRAW-KERK-1		STRAW-KERK-2		LPN-KERK-3		Woodchips-LWL	
DATE	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)
28/10/2013 12:00	18.0	27.1	19.0	34.1	21.1	31.3	19.1	42.2	14.5	50.0
28/10/2013 12:15	18.0	26.7	19.5	32.3	21.6	30.8	19.7	38.5	15.2	49.2
28/10/2013 12:30	18.0	25.9	20.0	31.0	22.2	27.7	20.1	36.2	15.9	46.3
28/10/2013 12:45	18.0	25.9	20.4	31.4	22.7	27.5	20.6	36.0	16.6	49.0
28/10/2013 13:00	18.0	26.3	20.9	29.2	23.2	25.5	20.9	34.2	17.3	46.8
28/10/2013 13:15	18.6	25.9	20.8	32.7	23.4	27.5	21.2	36.2	17.8	48.7
28/10/2013 13:30	18.9	25.5	21.0	31.6	23.9	26.0	21.5	33.7	18.2	47.3
28/10/2013 13:45	18.9	24.7	21.3	33.6	24.4	25.5	21.8	34.2	18.8	47.5
28/10/2013 14:00	19.2	24.3	21.7	32.1	24.5	24.4	21.8	34.4	19.2	44.9
28/10/2013 14:15	18.9	22.7	22.0	32.1	24.9	23.5	22.0	35.3	19.6	47.5
28/10/2013 14:30	19.2	23.5	22.3	28.3	25.3	22.2	22.1	33.0	20.0	44.9
28/10/2013 14:45	19.5	22.7	22.3	32.3	25.0	26.6	22.0	35.8	20.2	46.8
28/10/2013 15:00	19.5	22.7	22.1	31.4	24.8	27.5	21.9	37.2	20.4	47.5
28/10/2013 15:15	19.9	22.3	21.6	30.3	24.4	28.2	21.6	36.7	20.5	48.5
28/10/2013 15:30	19.5	23.1	21.2	31.6	24.1	26.0	21.5	38.1	20.8	49.2
28/10/2013 15:45	19.2	23.1	20.7	29.6	23.9	28.0	21.3	37.6	20.9	50.0
28/10/2013 16:00	18.3	24.3	20.1	29.9	23.6	28.0	21.1	38.3	21.1	49.7
28/10/2013 16:15	17.7	26.3	19.5	28.3	23.3	28.2	20.6	36.5	21.1	51.2
28/10/2013 16:30	16.5	27.1	18.6	27.2	22.3	26.2	19.9	34.4	21.1	49.0
28/10/2013 16:45	16.0	28.3	17.6	27.7	20.9	25.1	18.7	33.0	20.8	44.6
28/10/2013 17:00	15.4	28.3	16.7	27.9	19.5	25.1	17.4	32.8	20.4	43.7
28/10/2013 17:15	14.5	28.7	16.0	28.1	18.3	26.2	16.3	33.3	19.9	43.3
28/10/2013 17:30	14.5	28.7	15.4	29.0	17.3	26.2	15.4	34.9	19.4	43.3
28/10/2013 17:45	14.2	28.7	15.0	30.7	16.5	27.7	14.6	35.6	18.9	40.2
28/10/2013 18:00	14.2	29.6	14.5	30.7	15.7	28.4	13.8	36.2	18.3	43.7
28/10/2013 18:15	13.7	31.6	14.1	31.4	15.0	28.4	13.4	36.2	17.9	42.6
28/10/2013 18:30	13.4	33.3	13.6	31.4	14.5	29.3	13.1	35.6	17.6	47.0
28/10/2013 18:45	12.8	33.7	13.3	32.5	14.1	30.0	12.8	37.2	17.4	49.0
28/10/2013 19:00	12.6	32.9	13.1	32.5	13.9	30.0	12.7	36.9	17.2	49.0
28/10/2013 19:15	12.8	34.6	12.9	32.9	13.7	30.2	12.6	36.9	17.0	49.7
28/10/2013 19:30	12.3	35.0	12.7	32.7	13.5	30.0	12.5	36.9	16.7	50.4
28/10/2013 19:45	11.7	36.3	12.5	32.7	13.3	30.0	12.3	36.7	16.5	50.7
28/10/2013 20:00	11.2	36.3	12.3	33.2	13.0	30.2	12.2	36.5	16.2	50.7
28/10/2013 20:15	10.9	36.7	12.1	31.8	12.8	29.5	12.0	35.8	15.9	50.0
28/10/2013 20:30	10.6	37.6	11.9	32.7	12.5	30.0	11.9	36.7	15.6	50.7
28/10/2013 20:45	10.1	38.9	11.6	32.9	12.3	29.5	11.7	36.7	15.2	50.4

Table 31 continued:

	DC02		DC11		DC13		DC14		DC16	
Sample	Exterior		STRAW-KERK-1		STRAW-KERK-2		LPN-KERK-3		Woodchips-LWL	
DATE	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)
28/10/2013 21:00	10.1	41.0	11.3	33.2	12.0	29.7	11.5	36.7	14.9	50.7
28/10/2013 21:15	9.8	40.2	11.1	33.2	11.7	29.5	11.3	36.7	14.6	50.9
28/10/2013 21:30	9.6	41.5	10.8	33.2	11.5	29.5	11.1	36.2	14.3	50.7
28/10/2013 21:45	9.0	41.5	10.6	33.4	11.2	29.5	10.9	36.2	13.9	50.7
28/10/2013 22:00	8.5	41.9	10.3	33.6	10.9	29.3	10.7	36.5	13.6	50.7
28/10/2013 22:15	8.5	42.8	10.0	33.8	10.6	29.3	10.4	36.5	13.3	50.7
28/10/2013 22:30	8.3	42.3	9.8	34.1	10.4	29.7	10.2	36.0	13.0	50.7
28/10/2013 22:45	8.5	42.3	9.5	34.3	10.1	29.1	10.0	36.0	12.6	50.9
28/10/2013 23:00	8.3	43.7	9.3	34.5	9.8	29.1	9.8	36.2	12.3	50.7
28/10/2013 23:15	8.0	43.2	9.1	34.5	9.6	29.1	9.5	36.2	12.0	50.7
28/10/2013 23:30	7.5	42.8	8.9	34.5	9.3	29.1	9.3	36.0	11.7	50.9
28/10/2013 23:45	7.7	43.2	8.7	34.3	9.1	29.3	9.1	36.2	11.4	50.7
29/10/2013 00:00	7.7	45.5	8.5	34.8	8.8	29.1	8.9	36.0	11.1	50.4
29/10/2013 00:15	7.2	44.1	8.3	34.5	8.6	29.1	8.7	36.0	10.9	50.7
29/10/2013 00:30	7.5	45.9	8.1	34.5	8.4	28.9	8.5	36.0	10.6	50.2
29/10/2013 00:45	7.2	45.0	7.9	34.8	8.2	28.9	8.3	36.0	10.3	50.4
29/10/2013 01:00	6.9	46.3	7.7	35.4	8.0	29.3	8.1	35.6	10.0	50.0
29/10/2013 01:15	6.7	46.8	7.5	35.9	7.8	29.1	7.9	35.6	9.8	49.7
29/10/2013 01:30	6.4	46.8	7.3	35.2	7.5	29.1	7.7	35.6	9.5	50.0
29/10/2013 01:45	6.4	47.7	7.1	35.9	7.3	28.9	7.5	35.8	9.2	49.5
29/10/2013 02:00	6.7	48.1	6.9	36.4	7.1	28.9	7.4	35.3	9.0	49.5
29/10/2013 02:15	6.2	47.7	6.7	36.6	7.0	29.3	7.2	35.1	8.7	49.7
29/10/2013 02:30	6.2	46.3	6.6	37.3	6.8	28.6	7.0	35.1	8.5	49.7
29/10/2013 02:45	6.2	47.7	6.4	36.8	6.6	28.9	6.8	35.3	8.3	49.5
29/10/2013 03:00	6.2	49.5	6.3	36.1	6.4	28.9	6.7	34.9	8.1	49.7
29/10/2013 03:15	5.9	48.6	6.1	37.0	6.2	29.1	6.5	35.1	7.8	49.7
29/10/2013 03:30	5.9	48.6	5.9	39.3	6.1	29.1	6.4	35.1	7.6	49.5
29/10/2013 03:45	5.7	48.1	5.8	37.7	5.9	29.1	6.2	35.8	7.4	49.5
29/10/2013 04:00	5.7	48.1	5.7	40.3	5.8	29.1	6.1	35.8	7.2	49.2
29/10/2013 04:15	5.7	50.0	5.6	40.3	5.6	29.1	5.9	35.3	7.0	49.2
29/10/2013 04:30	5.7	49.5	5.5	38.2	5.5	28.4	5.8	35.1	6.8	50.0
29/10/2013 04:45	5.4	50.0	5.4	38.0	5.4	28.6	5.7	34.6	6.6	49.7
29/10/2013 05:00	5.7	50.9	5.3	38.4	5.2	29.1	5.6	34.6	6.4	49.5
29/10/2013 05:15	5.4	50.4	5.2	42.1	5.1	28.9	5.5	34.9	6.2	49.7
29/10/2013 05:30	5.4	49.1	5.1	38.9	5.0	28.6	5.3	34.6	6.1	49.7
29/10/2013 05:45	5.1	49.1	5.0	38.7	4.9	28.6	5.2	35.3	5.9	49.7

Table 31 continued:

	DC02		DC11		DC13		DC14		DC16	
Sample	Exterior		STRAW-KERK-1		STRAW-KERK-2		LPN-KERK-3		Woodchips-LWL	
DATE	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)
29/10/2013 06:00	5.7	50.4	4.9	37.5	4.8	28.0	5.1	35.1	5.8	49.5
29/10/2013 06:15	5.1	51.3	4.7	41.0	4.7	28.4	5.0	34.4	5.6	49.7
29/10/2013 06:30	5.1	50.9	4.7	40.5	4.6	29.1	4.9	35.3	5.5	49.7
29/10/2013 06:45	5.4	50.0	4.6	38.9	4.5	28.6	4.8	35.6	5.3	49.7
29/10/2013 07:00	6.4	49.5	4.6	39.1	4.4	29.1	4.7	35.1	5.2	50.0
29/10/2013 07:15	7.5	44.1	4.6	37.3	4.4	28.2	4.7	34.9	5.1	50.4
29/10/2013 07:30	8.8	45.0	4.6	38.4	4.4	26.9	4.9	35.8	5.1	51.4
29/10/2013 07:45	10.9	39.7	4.7	39.1	4.5	26.4	5.0	36.0	5.0	52.4
29/10/2013 08:00	12.6	35.0	5.0	38.9	4.9	28.9	5.3	37.2	5.1	53.8
29/10/2013 08:15	14.0	31.2	5.8	42.8	6.0	34.0	6.0	40.2	5.5	55.0
29/10/2013 08:30	15.1	28.7	6.9	48.4	7.6	37.5	6.8	40.2	5.9	55.5
29/10/2013 08:45	16.0	27.9	8.0	47.0	9.1	40.0	7.8	41.3	6.3	56.0
29/10/2013 09:00	16.8	27.5	9.4	48.0	11.0	44.2	9.0	45.0	7.0	56.7
29/10/2013 09:15	16.8	28.3	11.2	48.4	13.2	41.9	10.4	48.1	7.8	55.8
29/10/2013 09:30	16.5	28.3	12.6	46.5	15.0	40.3	11.6	45.9	8.6	56.2
29/10/2013 09:45	18.0	25.9	13.6	45.6	16.0	38.6	12.6	46.7	9.2	56.5
29/10/2013 10:00	18.6	25.5	14.7	45.8	17.1	39.8	13.5	44.3	10.0	56.5
29/10/2013 10:15	19.9	24.3	15.7	45.6	18.2	40.7	14.4	45.2	10.7	56.7
29/10/2013 10:30	21.4	22.7	16.9	46.3	19.3	41.4	15.3	46.9	11.5	57.0
29/10/2013 10:45	21.8	21.5	18.1	47.0	20.6	43.5	16.4	45.9	12.4	56.2
29/10/2013 11:00	22.7	21.5	19.4	41.6	21.9	41.4	17.4	46.9	13.3	55.5
29/10/2013 11:15	22.7	21.5	20.4	42.1	22.9	39.6	18.5	45.9	14.1	54.8
29/10/2013 11:30	22.4	21.5	21.2	35.7	23.6	37.9	19.4	44.5	14.9	55.3
29/10/2013 11:45	22.7	21.1	22.1	34.8	24.5	34.7	20.4	43.4	15.9	55.3
29/10/2013 12:00	23.1	20.3	22.7	30.5	24.9	33.3	21.0	42.2	16.6	52.4
29/10/2013 12:15	23.1	19.9	23.4	31.6	25.5	32.8	21.6	43.2	17.4	52.6
29/10/2013 12:30	23.7	18.3	23.8	36.4	25.8	33.5	22.1	43.8	18.1	54.8
29/10/2013 12:45	24.4	18.7	24.0	30.5	26.1	34.2	22.4	44.1	18.7	51.2
29/10/2013 13:00	24.1	18.7	25.1	31.0	27.0	31.1	23.2	40.2	19.6	52.1
29/10/2013 13:15	23.7	18.7	25.5	28.3	27.5	30.6	23.8	43.6	20.3	49.2
29/10/2013 13:30	24.1	19.5	25.5	27.5	27.5	31.1	24.1	34.9	20.9	51.9
29/10/2013 13:45	25.1	18.0	25.5	27.9	27.4	30.6	24.2	38.5	21.3	50.2
29/10/2013 14:00	24.1	19.5	25.9	28.3	27.8	30.0	24.4	36.5	22.0	49.2
29/10/2013 14:15	23.7	20.7	26.6	28.1	28.4	30.4	24.9	37.4	22.6	49.7
29/10/2013 14:30	23.4	21.1	26.6	26.6	28.3	28.0	25.1	37.6	23.1	48.7
29/10/2013 14:45	23.1	20.7	26.6	31.4	28.3	30.2	25.3	40.9	23.6	51.9

Table 31 continued:

	DC02		DC11		DC13		DC14		DC16	
Sample	Exterior		STRAW-KERK-1		STRAW-KERK-2		LPN-KERK-3		Woodchips-LWL	
DATE	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)
29/10/2013 15:00	23.7	22.3	26.5	31.8	28.3	28.9	25.5	42.0	23.9	48.3
29/10/2013 15:15	23.4	21.1	26.3	29.6	28.3	30.8	25.5	39.5	24.2	47.8
29/10/2013 15:30	22.4	21.1	26.0	29.4	28.3	29.5	25.7	39.7	24.5	43.7
29/10/2013 15:45	22.1	23.1	25.7	29.2	28.2	32.0	25.9	40.9	24.7	49.5
29/10/2013 16:00	21.4	25.9	25.0	28.3	28.0	31.7	25.8	41.1	24.9	54.3
29/10/2013 16:15	19.9	27.9	23.9	27.7	27.4	31.7	25.5	39.7	24.9	53.8
29/10/2013 16:30	18.6	28.7	22.7	27.5	26.6	30.6	25.1	40.2	24.9	55.5
29/10/2013 16:45	17.4	30.0	21.3	27.9	25.5	29.7	24.4	37.4	24.8	55.5
29/10/2013 17:00	16.5	30.8	20.2	27.7	24.5	28.4	23.6	36.7	24.6	55.5
29/10/2013 17:15	16.0	32.5	19.0	28.1	23.0	26.6	22.7	35.6	24.3	53.8
29/10/2013 17:30	15.1	32.5	18.2	29.4	22.0	28.6	22.0	37.4	24.0	54.8
29/10/2013 17:45	15.1	32.1	17.9	29.6	21.3	29.3	21.6	38.3	23.8	55.3
29/10/2013 18:00	14.8	32.9	17.6	30.3	20.8	29.5	21.2	38.5	23.4	55.5
29/10/2013 18:15	14.2	35.4	17.3	29.6	20.3	28.4	20.7	37.9	23.0	54.6
29/10/2013 18:30	14.2	36.3	16.9	29.6	19.7	28.9	20.2	37.4	22.6	54.3
29/10/2013 18:45	13.4	35.9	16.6	30.1	19.2	28.9	19.7	37.6	22.2	54.6
29/10/2013 19:00	13.1	36.7	16.3	30.1	18.7	28.9	19.2	37.4	21.7	54.3
29/10/2013 19:15	13.1	37.1	16.0	30.1	18.2	28.6	18.8	37.2	21.3	53.8
29/10/2013 19:30	13.1	37.6	15.7	30.1	17.8	28.6	18.3	37.2	20.8	53.8
29/10/2013 19:45	12.8	39.3	15.4	29.9	17.3	27.7	17.8	36.2	20.4	52.9
29/10/2013 20:00	12.6	39.3	15.1	29.9	16.8	28.0	17.4	36.9	19.9	53.1
29/10/2013 20:15	12.3	39.7	14.7	30.1	16.4	28.0	16.9	36.5	19.4	53.1
29/10/2013 20:30	11.7	39.3	14.4	30.3	16.0	28.0	16.5	36.5	19.0	53.3
29/10/2013 20:45	11.5	39.3	14.1	30.3	15.6	27.7	16.1	36.5	18.6	53.1
29/10/2013 21:00	11.5	39.7	13.8	30.7	15.2	28.0	15.7	36.0	18.1	53.1
29/10/2013 21:15	10.9	41.0	13.4	31.0	14.8	28.0	15.3	36.0	17.7	52.6
29/10/2013 21:30	11.2	41.9	13.1	31.4	14.5	28.0	14.9	36.2	17.3	52.6
29/10/2013 21:45	11.2	42.8	12.9	31.6	14.1	28.0	14.6	36.2	16.9	52.4
29/10/2013 22:00	11.2	41.9	12.6	31.8	13.8	27.7	14.3	35.8	16.5	52.6
29/10/2013 22:15	10.6	41.5	12.4	32.1	13.5	28.0	13.9	36.0	16.2	52.4
29/10/2013 22:30	10.9	42.3	12.1	32.5	13.2	28.0	13.6	35.8	15.8	52.4
29/10/2013 22:45	10.9	43.7	12.0	32.3	12.9	27.7	13.3	36.0	15.5	52.1
29/10/2013 23:00	10.9	43.7	11.7	31.6	12.6	27.7	13.0	35.8	15.1	52.1
29/10/2013 23:15	10.1	44.1	11.5	32.9	12.4	28.0	12.8	35.6	14.8	52.6
29/10/2013 23:30	10.1	45.9	11.3	33.4	12.1	28.2	12.5	35.8	14.5	51.9
29/10/2013 23:45	10.1	45.5	11.2	33.2	11.9	28.2	12.2	35.8	14.2	52.1

Table 31 continued:

	DC02		DC11		DC13		DC14		DC16	
Sample	Exterior		STRAW-KERK-1		STRAW-KERK-2		LPN-KERK-3		Woodchips-LWL	
DATE	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)
30/10/2013 00:00	9.8	47.2	11.0	33.6	11.7	28.0	12.0	35.3	13.9	51.9
30/10/2013 00:15	10.1	46.3	10.8	33.2	11.4	28.2	11.8	35.8	13.6	52.1
30/10/2013 00:30	9.8	47.7	10.7	34.8	11.2	28.2	11.6	35.8	13.3	51.9
30/10/2013 00:45	9.6	48.6	10.5	35.4	11.0	28.2	11.3	35.8	13.0	51.9
30/10/2013 01:00	9.8	47.7	10.4	34.5	10.9	28.4	11.1	35.6	12.7	51.9
30/10/2013 01:15	9.6	47.7	10.2	36.4	10.7	28.4	10.9	35.3	12.5	51.6
30/10/2013 01:30	9.0	48.1	10.1	37.5	10.5	28.6	10.8	35.8	12.2	51.4
30/10/2013 01:45	9.0	49.5	10.0	35.4	10.4	28.4	10.6	35.3	12.0	51.9
30/10/2013 02:00	9.3	47.7	9.8	34.8	10.2	28.0	10.4	35.6	11.7	51.9
30/10/2013 02:15	9.0	48.6	9.7	36.6	10.0	28.4	10.2	35.6	11.5	51.4
30/10/2013 02:30	9.3	48.1	9.6	34.1	9.8	27.1	10.0	34.4	11.2	51.6
30/10/2013 02:45	9.0	48.6	9.4	34.3	9.6	27.1	9.9	35.6	11.0	51.4
30/10/2013 03:00	8.8	50.0	9.2	36.6	9.5	28.2	9.7	35.6	10.8	51.4
30/10/2013 03:15	8.3	50.4	9.1	38.0	9.3	28.4	9.5	35.6	10.6	51.6
30/10/2013 03:30	8.3	50.0	8.9	37.7	9.2	28.4	9.4	35.8	10.3	51.4
30/10/2013 03:45	7.7	50.0	8.8	38.2	9.0	28.2	9.2	35.6	10.1	51.2
30/10/2013 04:00	7.7	49.5	8.7	37.0	8.9	27.7	9.1	35.8	9.9	51.4
30/10/2013 04:15	7.7	50.4	8.6	36.1	8.7	27.5	8.9	35.6	9.7	51.6
30/10/2013 04:30	7.5	50.0	8.4	37.0	8.6	27.7	8.8	35.3	9.5	51.2
30/10/2013 04:45	7.2	50.9	8.3	38.2	8.4	28.0	8.6	35.1	9.3	51.4
30/10/2013 05:00	7.2	52.3	8.1	36.4	8.2	27.5	8.4	35.1	9.1	51.2
30/10/2013 05:15	7.2	52.3	8.0	36.1	8.0	27.3	8.3	34.9	8.9	51.2
30/10/2013 05:30	6.9	53.7	7.8	35.9	7.9	27.1	8.1	35.1	8.7	51.2
30/10/2013 05:45	6.9	53.7	7.6	35.9	7.7	26.9	7.9	34.2	8.5	50.9
30/10/2013 06:00	7.2	52.7	7.5	36.8	7.5	27.1	7.8	34.2	8.3	50.9
30/10/2013 06:15	7.2	54.1	7.3	33.8	7.3	26.9	7.6	33.0	8.2	50.2
30/10/2013 06:30	7.2	52.7	7.1	35.0	7.2	26.6	7.5	34.4	8.0	50.7
30/10/2013 06:45	7.2	52.3	7.0	35.2	7.0	27.1	7.4	33.9	7.8	50.9
30/10/2013 07:00	7.2	53.2	6.9	36.6	6.9	27.3	7.2	34.4	7.6	50.7
30/10/2013 07:15	8.5	48.6	6.8	35.4	6.9	27.3	7.1	33.5	7.5	51.2
30/10/2013 07:30	9.8	45.5	6.7	35.2	6.8	26.0	7.1	34.2	7.4	52.1
30/10/2013 07:45	11.2	41.5	6.9	34.3	7.0	25.7	7.3	34.2	7.4	53.3
30/10/2013 08:00	12.6	39.7	7.2	35.0	7.5	27.7	7.6	36.0	7.5	54.1
30/10/2013 08:15	13.4	37.1	7.8	37.5	8.4	31.1	8.2	35.8	7.7	55.3
30/10/2013 08:30	15.1	34.6	8.6	37.0	9.5	34.0	8.9	38.8	8.0	56.0
30/10/2013 08:45	16.2	31.6	9.5	42.6	10.8	33.1	9.6	40.4	8.4	56.5

Table 31 continued:

	DC02		DC11		DC13		DC14		DC16	
Sample	Exterior		STRAW-KERK-1		STRAW-KERK-2		LPN-KERK-3		Woodchips-LWL	
DATE	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)
30/10/2013 09:00	17.4	30.8	10.8	44.9	12.4	35.9	10.5	43.2	8.9	56.2
30/10/2013 09:15	18.3	29.6	12.2	42.8	14.2	38.4	11.6	44.5	9.6	57.2
30/10/2013 09:30	19.2	28.7	13.7	44.9	16.0	41.0	12.8	41.1	10.3	57.0
30/10/2013 09:45	20.2	26.7	14.8	42.1	17.2	36.3	13.7	42.5	10.9	57.5
30/10/2013 10:00	21.4	24.3	16.0	47.0	18.5	40.5	14.7	46.2	11.7	57.2
30/10/2013 10:15	21.1	24.3	17.7	43.5	20.3	40.3	16.2	45.7	12.6	57.2
30/10/2013 10:30	21.4	25.1	19.2	42.1	21.9	36.8	17.7	45.7	13.6	55.3
30/10/2013 10:45	21.1	24.3	20.5	38.7	23.1	34.9	18.7	44.8	14.5	56.5
30/10/2013 11:00	22.7	23.9	21.6	36.8	24.3	34.5	19.7	44.1	15.4	56.0
30/10/2013 11:15	23.1	22.7	22.4	33.4	25.0	33.1	20.7	43.2	16.2	54.6
30/10/2013 11:30	23.1	21.5	23.1	39.8	25.7	32.8	21.5	42.9	16.9	52.6
30/10/2013 11:45	24.4	19.9	23.7	32.5	26.3	32.2	22.1	41.8	17.6	54.1
30/10/2013 12:00	25.4	18.3	24.3	34.3	26.7	33.1	22.5	41.3	18.2	54.3
30/10/2013 12:15	25.8	17.2	24.6	34.1	27.0	33.8	22.8	43.4	18.8	54.3
30/10/2013 12:30	25.1	17.2	25.5	29.2	28.2	30.0	23.7	41.5	19.7	50.2
30/10/2013 12:45	25.1	17.2	26.3	31.6	28.9	29.3	24.5	42.7	20.5	51.9
30/10/2013 13:00	25.8	17.6	26.5	33.2	29.0	30.2	25.0	42.7	21.0	53.6
30/10/2013 13:15	25.4	18.0	26.8	29.2	29.4	27.3	25.4	34.2	21.8	47.0
30/10/2013 13:30	24.1	18.0	27.3	24.4	30.0	23.8	25.6	30.8	22.6	48.3
30/10/2013 13:45	24.1	18.3	27.6	24.0	30.2	23.3	25.9	32.6	23.2	45.6
30/10/2013 14:00	24.4	17.2	27.8	23.5	30.3	22.9	26.1	35.1	23.7	46.6
30/10/2013 14:15	24.7	17.6	28.1	24.8	30.6	24.4	26.5	35.6	24.2	45.4
30/10/2013 14:30	24.7	18.3	28.1	28.1	30.5	26.4	26.7	38.5	24.6	49.2
30/10/2013 14:45	25.1	18.0	28.1	28.3	30.3	25.7	26.8	38.8	25.0	50.2
30/10/2013 15:00	24.4	18.0	28.1	27.7	30.2	27.3	27.0	38.5	25.3	51.4
30/10/2013 15:15	24.4	18.7	28.0	29.0	30.1	27.3	27.0	38.8	25.6	51.9
30/10/2013 15:30	24.1	20.7	27.8	29.6	30.1	29.7	27.1	39.9	25.8	50.7
30/10/2013 15:45	23.7	21.9	27.4	28.8	30.0	28.9	27.2	40.2	26.1	50.7
30/10/2013 16:00	22.7	23.9	26.8	27.0	29.8	29.3	27.3	39.9	26.3	53.6
30/10/2013 16:15	21.4	24.7	26.3	28.6	29.5	28.9	27.1	39.7	26.4	52.9
30/10/2013 16:30	20.2	26.7	25.3	23.7	28.8	24.9	26.8	35.6	26.4	50.0
30/10/2013 16:45	18.9	27.1	23.3	23.5	26.4	22.6	24.8	30.6	25.9	45.6
30/10/2013 17:00	18.3	26.7	21.4	25.0	23.9	23.3	22.7	30.2	25.2	44.2
30/10/2013 17:15	17.4	28.3	20.2	25.5	22.3	24.2	21.3	33.3	24.9	49.5
30/10/2013 17:30	17.1	29.2	19.7	26.8	21.5	25.5	20.8	33.9	24.7	52.4
30/10/2013 17:45	16.5	30.8	19.3	26.1	20.9	24.9	20.5	33.5	24.5	52.1

Table 31 continued:

	DC02		DC11		DC13		DC14		DC16	
Sample	Exterior		STRAW-KERK-1		STRAW-KERK-2		LPN-KERK-3		Woodchips-LWL	
DATE	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)
30/10/2013 18:00	16.2	30.8	18.5	26.4	20.0	24.9	19.7	32.8	24.1	51.4
30/10/2013 18:15	15.4	32.1	17.8	26.4	19.3	24.4	19.2	32.4	23.6	50.4
30/10/2013 18:30	15.4	32.5	17.2	26.8	18.7	24.9	18.7	32.6	23.2	50.9
30/10/2013 18:45	14.8	32.9	16.8	27.0	18.2	25.1	18.4	33.0	22.8	51.4
30/10/2013 19:00	14.5	33.7	16.6	27.2	17.9	25.1	18.2	32.4	22.4	51.6
30/10/2013 19:15	14.5	33.7	16.3	27.5	17.5	25.5	17.8	32.8	22.0	51.4
30/10/2013 19:30	14.0	35.0	16.0	27.7	17.1	24.6	17.5	31.7	21.5	49.7
30/10/2013 19:45	14.0	34.6	15.7	27.9	16.7	24.6	17.1	31.7	21.0	50.4
30/10/2013 20:00	13.4	35.0	15.5	28.3	16.4	25.3	16.8	32.6	20.5	50.4
30/10/2013 20:15	13.4	35.4	15.3	28.1	16.2	25.3	16.5	32.6	20.1	50.7
30/10/2013 20:30	13.4	36.7	14.9	29.0	15.8	25.1	16.1	31.7	19.6	50.0
30/10/2013 20:45	13.4	36.3	14.6	28.8	15.5	25.3	15.8	32.4	19.2	50.4
30/10/2013 21:00	12.8	37.1	14.4	29.0	15.3	25.3	15.5	32.4	18.8	50.7
30/10/2013 21:15	12.6	41.5	14.3	28.8	15.0	25.3	15.3	32.4	18.4	50.7
30/10/2013 21:30	12.6	41.9	14.1	28.8	14.8	25.3	15.0	32.4	18.0	50.7
30/10/2013 21:45	12.6	42.3	13.9	29.4	14.6	25.1	14.7	32.4	17.6	50.9
30/10/2013 22:00	12.3	43.7	13.7	29.9	14.3	25.3	14.5	32.2	17.2	50.9
30/10/2013 22:15	12.3	43.2	13.5	30.1	14.1	25.3	14.2	32.2	16.9	50.7
30/10/2013 22:30	12.0	43.7	13.3	30.1	13.9	25.5	13.9	32.2	16.5	50.7
30/10/2013 22:45	11.7	44.1	13.2	29.9	13.7	25.5	13.7	32.4	16.2	50.7
30/10/2013 23:00	11.5	44.6	13.0	31.2	13.4	25.5	13.4	32.6	15.9	50.9
30/10/2013 23:15	11.5	44.6	12.8	31.6	13.2	25.5	13.2	32.6	15.6	50.7
30/10/2013 23:30	11.2	47.7	12.6	31.6	13.0	25.5	13.0	32.4	15.2	50.4
30/10/2013 23:45	11.2	47.2	12.4	31.2	12.8	25.3	12.7	31.3	14.9	50.2
31/10/2013 00:00	11.5	47.2	12.2	30.7	12.6	25.3	12.5	32.4	14.6	50.2
31/10/2013 00:15	11.2	46.8	12.1	30.7	12.4	25.5	12.3	32.4	14.3	50.4
31/10/2013 00:30	11.2	48.1	11.9	31.2	12.2	25.5	12.1	32.4	14.1	50.7
31/10/2013 00:45	11.2	48.6	11.7	28.8	12.0	24.6	11.9	31.5	13.8	50.0
31/10/2013 01:00	10.6	49.1	11.6	31.0	11.8	25.1	11.7	32.4	13.5	50.7
31/10/2013 01:15	10.6	50.0	11.4	30.1	11.6	24.6	11.5	31.9	13.2	50.0
31/10/2013 01:30	10.6	49.5	11.2	30.3	11.4	24.9	11.3	32.4	13.0	50.0
31/10/2013 01:45	10.6	50.0	11.1	30.1	11.3	24.6	11.1	31.3	12.7	50.0
31/10/2013 02:00	10.6	49.5	10.9	31.0	11.1	25.1	11.0	32.4	12.5	49.5
31/10/2013 02:15	10.4	50.4	10.8	33.4	10.9	25.3	10.8	32.2	12.2	49.7
31/10/2013 02:30	10.4	50.0	10.7	32.9	10.8	25.1	10.7	32.2	12.0	50.0
31/10/2013 02:45	10.6	50.0	10.6	32.1	10.7	25.1	10.6	31.9	11.8	49.7

Table 31 continued:

	DC02		DC11		DC13		DC14		DC16	
Sample	Exterior		STRAW-KERK-1		STRAW-KERK-2		LPN-KERK-3		Woodchips-LWL	
DATE	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)
31/10/2013 03:00	10.4	50.4	10.5	33.8	10.6	25.5	10.4	31.9	11.6	49.7
31/10/2013 03:15	10.4	50.4	10.4	33.4	10.5	25.3	10.3	32.2	11.4	50.4
31/10/2013 03:30	9.8	52.3	10.3	35.7	10.4	25.5	10.2	31.9	11.2	50.2
31/10/2013 03:45	9.6	53.7	10.2	34.5	10.3	25.7	10.1	32.2	11.0	49.7
31/10/2013 04:00	10.4	52.3	10.2	34.1	10.2	25.5	9.9	31.9	10.8	50.0
31/10/2013 04:15	10.1	52.3	10.1	34.8	10.2	25.7	9.9	32.6	10.6	50.4
31/10/2013 04:30	9.6	52.7	10.1	33.6	10.1	25.3	9.8	32.2	10.4	50.0
31/10/2013 04:45	9.0	53.2	10.0	33.2	10.0	24.9	9.7	32.6	10.2	49.5
31/10/2013 05:00	8.5	54.6	9.8	34.3	9.9	25.5	9.6	33.0	10.1	50.2
31/10/2013 05:15	8.3	55.1	9.7	32.9	9.8	25.3	9.5	32.4	9.9	49.5
31/10/2013 05:30	8.3	56.5	9.6	32.7	9.7	25.3	9.4	31.9	9.7	49.7
31/10/2013 05:45	8.3	56.9	9.4	32.9	9.5	25.7	9.3	32.4	9.6	50.2
31/10/2013 06:00	9.0	55.1	9.4	36.6	9.5	30.0	9.3	34.6	9.4	51.6
31/10/2013 06:15	9.3	54.1	9.4	36.8	9.6	29.5	9.4	37.6	9.2	51.2
31/10/2013 06:30	9.3	53.2	9.3	35.2	9.6	27.1	9.5	35.3	9.1	50.4
31/10/2013 06:45	8.5	54.6	9.3	36.4	9.5	26.2	9.5	33.7	8.9	50.4
31/10/2013 07:00	8.8	54.6	9.2	34.5	9.5	26.9	9.5	31.9	8.8	50.7
31/10/2013 07:15	9.8	52.3	9.1	33.2	9.6	26.2	9.6	34.6	8.7	51.4
31/10/2013 07:30	11.2	47.7	9.2	32.7	9.7	29.1	9.7	37.6	8.7	52.1
31/10/2013 07:45	11.7	47.7	9.4	36.8	10.1	29.1	10.2	39.0	8.7	53.8
31/10/2013 08:00	13.1	45.5	10.1	41.9	11.2	33.1	10.9	42.5	8.9	54.6
31/10/2013 08:15	14.5	41.0	10.8	40.7	12.2	32.8	11.4	40.6	9.2	54.8
31/10/2013 08:30	16.2	36.7	11.8	44.6	13.5	38.2	12.1	42.0	9.5	56.2
31/10/2013 08:45	17.4	35.4	13.2	45.6	15.3	40.7	13.2	45.2	10.0	56.5
31/10/2013 09:00	17.4	35.0	14.8	44.6	17.3	37.7	14.5	47.1	10.6	56.2
31/10/2013 09:15	18.3	34.2	16.2	43.5	18.9	36.5	15.7	45.2	11.3	56.2
31/10/2013 09:30	18.9	32.5	17.5	42.3	20.3	36.5	16.8	45.5	12.0	56.2
31/10/2013 09:45	19.9	30.8	18.7	41.9	21.3	37.2	17.8	44.5	12.7	56.0
31/10/2013 10:00	20.5	29.6	19.9	41.0	22.5	36.5	18.8	43.8	13.4	55.3
31/10/2013 10:15	21.1	29.6	21.0	39.3	23.5	35.4	19.9	42.2	14.3	55.0
31/10/2013 10:30	21.4	27.5	22.0	37.5	24.4	33.3	20.7	40.2	15.2	54.8
31/10/2013 10:45	22.4	27.1	22.7	33.4	25.0	32.2	21.3	39.7	16.0	54.3
31/10/2013 11:00	23.4	24.3	23.2	35.7	25.5	32.6	21.9	39.2	16.7	50.9
31/10/2013 11:15	23.7	23.5	23.6	34.5	25.8	31.5	22.4	39.2	17.4	50.2
31/10/2013 11:30	23.4	22.7	24.0	30.1	26.1	29.3	23.0	34.6	18.1	50.7
31/10/2013 11:45	23.4	21.9	24.4	31.8	26.4	30.6	23.5	37.2	18.8	50.4

Table 31 continued:

	DC02		DC11		DC13		DC14		DC16	
Sample	Exterior		STRAW-KERK-1		STRAW-KERK-2		LPN-KERK-3		Woodchips-LWL	
DATE	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)
31/10/2013 12:00	24.4	20.7	24.3	30.7	26.4	29.1	23.6	38.3	19.3	49.0
31/10/2013 12:15	25.1	20.7	24.4	31.2	26.3	30.6	23.9	37.2	19.9	50.9
31/10/2013 12:30	26.1	19.1	24.3	31.4	26.2	30.4	24.1	37.4	20.4	50.0
31/10/2013 12:45	26.1	18.7	23.8	30.7	25.7	29.7	23.9	36.2	20.8	50.7
31/10/2013 13:00	26.1	18.7	23.4	29.4	25.2	28.9	23.7	35.6	21.3	48.5
31/10/2013 13:15	25.8	18.7	23.1	29.9	24.8	29.7	23.8	36.9	21.8	49.7
31/10/2013 13:30	25.1	19.1	23.0	30.1	24.6	29.3	23.9	36.2	22.3	45.8
31/10/2013 13:45	25.1	19.1	23.1	28.1	24.7	29.3	24.3	35.6	22.8	46.6
31/10/2013 14:00	24.7	21.1	22.8	27.9	24.4	28.9	24.4	35.6	23.3	45.4
31/10/2013 14:15	24.4	21.5	22.5	28.6	24.2	27.7	24.5	35.1	23.6	43.3
31/10/2013 14:30	24.1	22.7	22.3	27.7	24.0	26.6	24.6	35.6	24.0	46.1
31/10/2013 14:45	23.7	22.7	22.0	26.6	23.8	25.3	24.7	33.7	24.3	42.6
31/10/2013 15:00	22.7	24.3	21.6	26.8	23.7	25.3	24.7	33.5	24.5	42.1
31/10/2013 15:15	22.4	26.3	21.4	27.7	23.6	25.1	24.7	33.9	24.7	43.3
31/10/2013 15:30	21.8	26.7	21.1	27.7	23.7	24.4	24.6	31.1	24.9	42.1
31/10/2013 15:45	20.8	27.5	20.7	27.5	23.6	24.2	24.4	31.7	24.9	42.3
31/10/2013 16:00	20.2	29.6	20.4	27.7	23.5	24.2	24.1	31.3	24.9	42.3
31/10/2013 16:15	18.9	32.1	20.0	27.7	23.2	24.0	23.6	30.0	24.8	43.3
31/10/2013 16:30	17.7	34.6	19.7	27.9	22.7	24.9	23.4	33.0	24.8	45.8
31/10/2013 16:45	16.8	35.0	19.4	27.7	22.2	24.2	23.3	33.5	24.7	47.0
31/10/2013 17:00	16.2	36.3	19.0	27.9	21.6	24.0	23.1	32.2	24.6	46.8
31/10/2013 17:15	16.5	37.1	18.6	28.8	20.9	23.8	22.8	31.5	24.3	45.8
31/10/2013 17:30	15.7	37.1	18.1	29.2	20.3	24.0	22.3	30.6	23.9	46.1
31/10/2013 17:45	15.7	37.1	17.6	29.9	19.7	24.4	21.8	32.2	23.5	47.0
31/10/2013 18:00	15.1	37.6	17.2	30.3	19.2	24.9	21.4	32.2	23.1	46.8
31/10/2013 18:15	14.8	38.4	16.9	30.7	18.8	25.3	21.0	32.6	22.7	46.3
31/10/2013 18:30	14.5	38.9	16.6	31.0	18.4	25.5	20.6	32.6	22.2	46.8
31/10/2013 18:45	14.0	38.4	16.3	31.4	18.0	25.5	20.1	32.2	21.8	45.8
31/10/2013 19:00	14.2	38.9	15.9	32.5	17.5	26.2	19.5	31.3	21.2	45.1
31/10/2013 19:15	14.0	39.3	15.6	33.2	17.0	26.6	19.0	31.1	20.7	43.7
31/10/2013 19:30	14.2	39.3	15.3	34.1	16.6	27.5	18.5	30.4	20.2	44.6
31/10/2013 19:45	14.0	40.2	15.0	34.8	16.2	28.0	17.9	29.7	19.7	44.0
31/10/2013 20:00	13.4	41.5	14.7	35.9	15.9	29.1	17.4	30.6	19.2	43.0
31/10/2013 20:15	13.4	42.3	14.5	36.1	15.6	29.5	17.0	30.0	18.8	42.8
31/10/2013 20:30	13.4	43.2	14.3	37.3	15.3	30.0	16.5	30.6	18.3	44.0
31/10/2013 20:45	13.1	44.1	14.0	37.7	15.0	31.1	15.9	32.6	17.7	43.0

Table 31 continued:

	DC02		DC11		DC13		DC14		DC16	
Sample	Exterior		STRAW-KERK-1		STRAW-KERK-2		LPN-KERK-3		Woodchips-LWL	
DATE	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)
31/10/2013 21:00	12.8	45.9	13.8	39.8	14.7	32.0	15.4	33.5	17.2	44.0
31/10/2013 21:15	12.6	45.5	13.6	39.1	14.4	32.4	15.0	34.4	16.8	43.7
31/10/2013 21:30	12.6	47.2	13.4	40.7	14.2	33.8	14.6	34.6	16.4	45.1
31/10/2013 21:45	12.3	48.1	13.3	41.6	14.0	34.7	14.5	34.6	16.2	45.1
31/10/2013 22:00	12.3	47.7	13.1	41.0	13.8	34.5	14.2	35.3	15.8	44.4
31/10/2013 22:15	11.7	49.1	12.8	42.1	13.5	34.9	13.9	35.3	15.5	45.4
31/10/2013 22:30	11.5	50.0	12.7	43.0	13.3	35.2	13.8	35.1	15.3	45.6
31/10/2013 22:45	11.2	50.9	12.6	42.6	13.2	35.4	13.8	34.9	15.1	46.8
31/10/2013 23:00	11.5	52.3	12.5	43.5	13.1	35.6	13.7	35.1	14.9	45.8
31/10/2013 23:15	11.2	52.3	12.2	43.9	12.9	36.3	13.4	36.7	14.5	46.3
31/10/2013 23:30	10.9	52.7	11.9	45.3	12.6	37.9	13.0	38.3	14.1	46.8
31/10/2013 23:45	10.6	52.7	11.7	46.3	12.4	38.9	12.7	39.7	13.7	47.0
01/11/2013 00:00	10.9	52.3	11.6	46.5	12.2	40.0	12.4	41.1	13.4	47.0
01/11/2013 00:15	10.9	50.0	11.4	46.0	11.9	39.8	12.1	41.8	13.1	47.3
01/11/2013 00:30	10.6	47.2	11.2	45.6	11.6	39.6	11.8	41.3	12.8	46.8
01/11/2013 00:45	10.6	46.3	10.9	45.6	11.3	40.0	11.5	42.0	12.5	46.6
01/11/2013 01:00	10.6	46.3	10.7	46.0	11.0	40.5	11.1	42.7	12.2	46.8
01/11/2013 01:15	10.4	45.9	10.5	45.8	10.7	40.7	10.8	43.2	11.9	46.8
01/11/2013 01:30	10.4	45.9	10.2	46.0	10.4	41.2	10.5	43.6	11.6	46.8
01/11/2013 01:45	9.8	46.8	10.0	46.3	10.2	41.7	10.2	44.5	11.2	47.0
01/11/2013 02:00	10.1	46.8	9.8	46.8	10.0	41.9	10.0	45.0	11.0	47.3
01/11/2013 02:15	9.8	46.8	9.6	47.0	9.8	42.1	9.7	45.2	10.7	47.5
01/11/2013 02:30	9.6	46.8	9.4	47.2	9.5	42.6	9.5	45.5	10.4	47.5
01/11/2013 02:45	9.6	46.8	9.2	47.5	9.3	42.1	9.3	45.7	10.2	47.5
01/11/2013 03:00	9.6	46.3	9.0	47.2	9.1	42.6	9.1	45.7	10.0	47.5
01/11/2013 03:15	9.3	46.8	8.8	47.5	9.0	41.9	9.0	45.2	9.9	47.8
01/11/2013 03:30	9.0	46.3	8.7	48.0	8.8	42.6	8.9	45.7	9.7	47.5
01/11/2013 03:45	8.8	45.5	8.5	47.7	8.7	43.1	8.7	45.9	9.5	47.5
01/11/2013 04:00	8.5	45.9	8.4	47.7	8.5	42.6	8.5	46.2	9.3	47.8
01/11/2013 04:15	9.0	45.9	8.3	48.2	8.4	43.5	8.4	45.9	9.2	47.8
01/11/2013 04:30	8.8	45.9	8.2	48.0	8.3	42.8	8.4	45.9	9.0	48.0
01/11/2013 04:45	9.0	45.5	8.2	48.2	8.3	43.1	8.4	45.9	9.0	48.0
01/11/2013 05:00	8.8	45.5	8.2	47.7	8.3	43.1	8.3	45.9	8.9	47.8
01/11/2013 05:15	8.8	45.0	8.1	48.0	8.2	43.5	8.3	46.2	8.8	48.0
01/11/2013 05:30	8.5	45.5	8.1	48.2	8.2	43.1	8.3	45.2	8.7	48.0
01/11/2013 05:45	8.5	45.5	8.1	48.2	8.2	42.8	8.3	45.0	8.6	48.3

Table 31 continued:

	DC02		DC11		DC13		DC14		DC16	
Sample	Exterior		STRAW-KERK-1		STRAW-KERK-2		LPN-KERK-3		Woodchips-LWL	
DATE	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)
01/11/2013 06:00	8.8	45.5	8.1	48.0	8.2	43.1	8.3	45.2	8.5	48.3
01/11/2013 06:15	8.8	45.0	8.1	47.5	8.1	43.1	8.2	45.9	8.4	48.5
01/11/2013 06:30	8.8	45.9	8.0	47.7	8.1	42.8	8.2	45.5	8.3	48.3
01/11/2013 06:45	8.5	45.5	7.9	48.2	8.0	43.1	8.1	44.8	8.3	48.5
01/11/2013 07:00	8.8	45.5	8.0	48.7	8.1	43.8	8.1	45.5	8.2	48.7
01/11/2013 07:15	9.8	42.3	8.1	49.4	8.2	46.1	8.2	46.2	8.2	49.2
01/11/2013 07:30	11.5	39.3	8.4	49.6	8.4	47.1	8.3	45.9	8.3	49.5
01/11/2013 07:45	12.6	36.7	8.7	49.6	8.7	48.1	8.4	47.1	8.3	49.5
01/11/2013 08:00	13.4	35.0	8.9	50.1	9.0	48.6	8.5	48.3	8.4	50.0
01/11/2013 08:15	15.1	32.9	9.3	50.4	9.5	49.3	8.8	49.3	8.6	50.7
01/11/2013 08:30	16.2	30.8	9.7	50.1	9.9	48.6	9.1	50.5	8.9	50.9
01/11/2013 08:45	17.7	30.0	10.1	49.9	10.3	48.6	9.5	50.3	9.2	50.9
01/11/2013 09:00	18.3	28.3	10.3	49.9	10.6	48.3	9.8	50.7	9.5	51.9
01/11/2013 09:15	18.9	27.5	10.7	49.6	11.0	48.8	10.1	50.5	9.9	51.9
01/11/2013 09:30	19.9	26.7	11.0	50.1	11.4	49.3	10.6	51.5	10.5	52.4
01/11/2013 09:45	20.5	25.9	11.5	49.9	11.9	49.8	11.0	51.2	11.1	52.6
01/11/2013 10:00	21.4	25.5	11.9	49.2	12.4	49.8	11.5	52.2	11.8	52.9
01/11/2013 10:15	21.8	25.1	12.4	48.7	12.9	48.8	12.1	51.7	12.6	52.1
01/11/2013 10:30	21.8	24.7	12.9	48.0	13.4	48.6	12.7	51.7	13.4	52.1
01/11/2013 10:45	22.7	24.3	13.4	51.3	13.9	51.0	13.3	54.8	14.2	51.2
01/11/2013 11:00	22.7	24.3	14.0	53.7	14.6	51.7	14.3	55.8	15.0	50.9
01/11/2013 11:15	23.1	22.7	14.7	50.6	15.3	53.7	15.2	54.6	15.7	50.2
01/11/2013 11:30	24.1	22.3	15.2	46.3	16.0	49.8	16.0	53.4	16.4	50.4
01/11/2013 11:45	24.4	22.3	15.7	45.8	16.5	47.4	16.6	53.4	17.1	51.2
01/11/2013 12:00	25.1	21.1	16.1	43.5	16.8	47.6	17.1	50.3	17.7	49.7
01/11/2013 12:15	25.4	20.7	16.4	44.6	17.1	47.4	17.4	50.0	18.3	51.4
01/11/2013 12:30	25.4	21.9	16.7	44.9	17.4	48.3	18.0	53.4	19.0	50.4
01/11/2013 12:45	25.4	20.7	17.1	42.8	17.8	46.6	18.6	51.7	19.6	49.2
01/11/2013 13:00	25.1	20.7	17.5	43.5	18.1	44.5	19.1	50.5	20.2	49.5
01/11/2013 13:15	25.4	21.1	17.8	43.2	18.4	46.1	19.5	50.7	20.8	49.5
01/11/2013 13:30	25.1	21.1	18.2	41.4	18.8	48.3	20.1	49.8	21.3	48.0
01/11/2013 13:45	24.4	20.7	18.5	41.0	19.2	45.2	20.6	48.1	21.9	48.3
01/11/2013 14:00	23.7	20.7	19.0	40.7	19.8	45.2	21.3	50.0	22.5	47.0
01/11/2013 14:15	23.7	21.9	19.5	42.8	20.4	45.6	21.8	46.7	23.0	45.1
01/11/2013 14:30	23.7	22.3	19.6	37.3	20.6	41.7	22.1	47.6	23.4	44.4
01/11/2013 14:45	23.1	22.7	19.6	37.3	20.6	39.1	22.4	47.6	23.8	45.1

Table 31 continued:

	DC02		DC11		DC13		DC14		DC16	
Sample	Exterior		STRAW-KERK-1		STRAW-KERK-2		LPN-KERK-3		Woodchips-LWL	
DATE	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)
01/11/2013 15:00	22.7	22.7	19.4	35.7	20.5	34.9	22.4	44.1	24.0	43.3
01/11/2013 15:15	21.8	24.7	19.2	34.5	20.5	36.8	22.4	46.7	24.3	43.5
01/11/2013 15:30	21.1	25.9	19.0	34.5	20.6	36.5	22.6	47.1	24.5	44.9
01/11/2013 15:45	20.8	26.7	18.9	34.1	20.8	34.5	22.8	48.1	24.7	42.6
01/11/2013 16:00	19.9	27.5	18.6	32.5	20.9	30.4	22.9	47.1	24.8	41.4
01/11/2013 16:15	18.9	28.7	18.3	31.8	20.8	32.2	23.0	46.2	24.9	44.4
01/11/2013 16:30	17.4	30.4	18.0	31.4	20.4	32.4	23.0	46.9	24.9	45.8
01/11/2013 16:45	16.2	31.2	17.6	31.2	20.0	32.2	22.8	45.9	24.8	48.0
01/11/2013 17:00	16.0	32.9	17.1	30.5	19.4	30.2	22.4	40.4	24.6	45.4
01/11/2013 17:15	15.1	33.3	16.3	31.6	18.3	30.4	20.4	35.1	23.9	40.2
01/11/2013 17:30	14.8	34.2	15.4	32.9	17.1	31.3	18.4	35.1	23.1	39.6
01/11/2013 17:45	14.2	34.6	14.7	33.6	16.0	31.7	16.6	35.6	22.3	38.9
01/11/2013 18:00	14.0	35.9	14.0	35.0	15.0	32.4	15.1	36.5	21.4	38.9
01/11/2013 18:15	13.7	37.1	13.4	35.7	14.3	33.1	14.1	37.6	20.6	39.6
01/11/2013 18:30	13.4	37.1	12.9	36.8	13.6	34.2	13.3	38.3	19.7	37.9
01/11/2013 18:45	13.1	38.4	12.6	37.7	13.1	34.9	12.8	38.8	18.8	38.4
01/11/2013 19:00	12.8	39.3	12.3	38.2	12.8	35.4	12.4	39.2	18.2	38.9
01/11/2013 19:15	12.6	39.3	12.1	39.1	12.5	36.3	12.2	40.2	17.5	38.4
01/11/2013 19:30	12.6	39.7	11.9	39.8	12.3	36.5	12.0	40.4	16.8	39.3
01/11/2013 19:45	12.3	40.6	11.7	40.5	12.1	37.2	11.8	40.9	16.3	39.8
01/11/2013 20:00	12.3	41.5	11.6	41.0	11.9	37.9	11.7	41.1	15.8	40.0
01/11/2013 20:15	12.0	41.5	11.5	41.2	11.8	38.2	11.6	41.3	15.3	40.5
01/11/2013 20:30	11.7	42.3	11.5	41.9	11.7	38.4	11.5	41.8	14.9	41.2
01/11/2013 20:45	12.0	43.2	11.4	42.3	11.6	38.6	11.4	41.8	14.6	41.6
01/11/2013 21:00	12.0	44.1	11.3	42.6	11.5	39.3	11.4	42.5	14.3	41.9
01/11/2013 21:15	11.7	44.6	11.2	43.5	11.4	39.3	11.4	42.9	14.0	43.0
01/11/2013 21:30	11.2	44.6	11.2	43.7	11.4	39.8	11.3	42.7	13.8	43.0
01/11/2013 21:45	11.5	45.5	11.2	43.9	11.3	40.3	11.3	42.9	13.5	43.5
01/11/2013 22:00	11.5	45.9	11.1	44.6	11.2	40.5	11.2	43.4	13.3	43.7
01/11/2013 22:15	11.5	46.3	11.1	44.6	11.2	40.7	11.2	43.4	13.0	44.0
01/11/2013 22:30	11.2	46.8	11.0	45.1	11.1	41.0	11.1	43.8	12.9	44.2
01/11/2013 22:45	11.2	46.8	11.0	45.3	11.1	41.2	11.1	44.1	12.7	44.4
01/11/2013 23:00	11.5	46.8	10.9	45.6	11.0	41.4	11.0	44.1	12.5	44.6
01/11/2013 23:15	11.5	46.8	10.9	45.6	11.0	41.2	11.0	44.5	12.4	45.1
01/11/2013 23:30	10.9	47.7	10.9	45.8	11.0	41.9	11.0	44.3	12.2	45.1
01/11/2013 23:45	11.2	48.1	10.8	46.3	10.9	42.1	10.9	45.0	12.0	45.8

Table 31 continued:

	DC02		DC11		DC13		DC14		DC16	
Sample	Exterior		STRAW-KERK-1		STRAW-KERK-2		LPN-KERK-3		Woodchips-LWL	
DATE	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)
02/11/2013 00:00	10.9	48.6	10.7	46.5	10.8	41.7	10.9	45.5	11.8	46.1
02/11/2013 00:15	10.6	48.1	10.7	46.3	10.8	41.9	10.8	45.7	11.7	46.1
02/11/2013 00:30	10.6	49.1	10.6	47.0	10.7	42.6	10.8	45.9	11.6	46.6
02/11/2013 00:45	10.6	49.1	10.5	47.2	10.6	43.1	10.7	46.2	11.4	46.8
02/11/2013 01:00	10.6	50.0	10.5	47.5	10.6	43.1	10.7	46.7	11.3	46.8
02/11/2013 01:15	10.1	50.4	10.4	48.0	10.5	43.1	10.6	46.4	11.2	47.3
02/11/2013 01:30	10.4	51.8	10.2	48.2	10.4	43.5	10.4	46.9	11.0	48.0
02/11/2013 01:45	10.1	51.8	10.1	48.9	10.3	44.0	10.3	47.9	10.9	48.3
02/11/2013 02:00	10.4	52.3	10.1	49.4	10.2	45.2	10.3	48.1	10.7	48.5
02/11/2013 02:15	10.1	52.7	10.0	49.6	10.2	44.2	10.2	48.8	10.6	48.3
02/11/2013 02:30	10.1	53.7	10.0	49.6	10.1	44.2	10.2	48.3	10.6	48.0
02/11/2013 02:45	9.8	53.2	9.9	49.2	10.1	43.8	10.2	47.4	10.5	48.0
02/11/2013 03:00	9.6	54.6	9.8	49.2	10.0	43.8	10.1	47.4	10.4	47.8
02/11/2013 03:15	9.6	53.7	9.7	48.9	9.9	43.3	10.0	46.9	10.3	48.0
02/11/2013 03:30	9.3	55.1	9.7	48.4	9.8	43.1	9.9	46.4	10.2	48.0
02/11/2013 03:45	8.5	55.5	9.6	48.2	9.8	43.1	9.9	45.9	10.0	48.0
02/11/2013 04:00	8.5	55.5	9.5	47.7	9.7	42.8	9.8	46.2	9.9	48.5
02/11/2013 04:15	8.3	56.9	9.4	47.2	9.5	42.8	9.7	45.7	9.8	48.3
02/11/2013 04:30	7.7	58.4	9.3	47.5	9.4	42.6	9.6	45.5	9.7	48.0
02/11/2013 04:45	7.5	60.7	9.1	47.2	9.2	42.6	9.5	45.5	9.5	47.3
02/11/2013 05:00	7.2	59.3	8.9	47.5	9.1	42.1	9.3	45.2	9.3	47.0
02/11/2013 05:15	6.7	63.2	8.6	47.2	8.8	42.1	9.1	45.0	9.2	47.0
02/11/2013 05:30	6.7	63.7	8.4	47.0	8.6	41.9	8.9	45.2	9.0	46.3
02/11/2013 05:45	6.7	63.2	8.2	46.8	8.4	42.1	8.7	45.0	8.8	46.3
02/11/2013 06:00	6.9	62.7	8.0	46.5	8.2	41.9	8.5	44.8	8.6	46.1
02/11/2013 06:15	6.2	63.2	7.8	47.2	7.9	41.9	8.3	44.8	8.4	45.8
02/11/2013 06:30	5.9	65.1	7.5	47.7	7.7	41.7	8.1	44.5	8.2	45.8
02/11/2013 06:45	6.2	66.1	7.3	48.0	7.5	41.4	7.9	44.3	8.0	46.1
02/11/2013 07:00	6.9	65.1	7.1	47.2	7.3	41.7	7.7	44.5	7.8	46.1
02/11/2013 07:15	7.5	59.3	7.0	47.0	7.1	41.7	7.5	44.3	7.6	46.1
02/11/2013 07:30	9.0	54.6	6.9	47.0	7.1	41.7	7.4	44.3	7.5	46.6
02/11/2013 07:45	10.6	49.1	6.9	47.7	7.2	47.6	7.5	45.9	7.4	49.2
02/11/2013 08:00	12.0	45.0	7.1	51.6	7.7	51.0	7.7	47.9	7.5	49.2
02/11/2013 08:15	13.1	43.7	7.7	59.8	8.6	58.9	8.3	58.4	7.7	51.9
02/11/2013 08:30	14.2	40.6	8.6	59.1	9.9	61.9	9.1	56.0	8.0	52.6
02/11/2013 08:45	15.4	38.9	9.7	63.1	11.2	64.7	9.9	57.7	8.4	53.6

Table 31 continued:

	DC02		DC11		DC13		DC14		DC16	
Sample	Exterior		STRAW-KERK-1		STRAW-KERK-2		LPN-KERK-3		Woodchips-LWL	
DATE	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)
02/11/2013 09:00	15.7	38.4	11.1	64.1	12.8	65.0	10.9	60.2	9.0	54.3
02/11/2013 09:15	16.5	36.7	12.4	65.8	14.2	63.9	12.1	62.4	9.7	54.8
02/11/2013 09:30	16.8	35.4	13.7	62.6	15.6	62.2	13.3	63.4	10.4	54.8
02/11/2013 09:45	17.1	35.9	15.2	57.6	17.0	59.4	14.7	61.2	11.3	54.1
02/11/2013 10:00	17.4	35.0	16.4	58.6	18.0	56.4	15.9	57.4	12.1	53.6
02/11/2013 10:15	18.3	32.5	17.4	59.8	18.8	52.5	16.7	58.9	13.0	51.2
02/11/2013 10:30	19.2	28.7	18.0	59.6	19.4	52.7	17.4	55.5	13.7	52.1
02/11/2013 10:45	19.9	30.0	18.8	50.1	20.1	51.2	18.1	57.9	14.5	51.9
02/11/2013 11:00	19.5	30.8	19.7	45.3	21.0	46.1	18.9	51.7	15.4	49.7
02/11/2013 11:15	19.5	30.4	20.3	49.9	21.5	42.8	19.3	48.3	16.2	48.0
02/11/2013 11:30	19.5	30.0	20.8	40.7	22.1	41.9	19.9	56.0	16.9	49.0
02/11/2013 11:45	20.2	28.7	21.1	38.9	22.4	41.9	20.2	49.1	17.6	49.2
02/11/2013 12:00	21.1	26.7	21.6	38.2	22.9	41.9	20.6	43.4	18.3	48.5
02/11/2013 12:15	21.8	24.3	22.3	37.7	23.6	41.4	21.2	46.7	18.9	48.5
02/11/2013 12:30	22.1	24.7	22.8	36.4	24.1	39.6	21.6	42.7	19.6	47.0
02/11/2013 12:45	21.4	24.7	23.2	35.4	24.6	38.2	22.0	40.9	20.2	47.8
02/11/2013 13:00	21.4	26.3	23.5	31.8	25.0	34.7	22.1	39.2	20.9	45.6
02/11/2013 13:15	22.1	25.1	23.5	34.1	24.8	35.4	22.1	37.4	21.4	45.6
02/11/2013 13:30	22.1	26.3	23.9	38.9	25.3	34.9	22.2	44.8	22.0	44.2
02/11/2013 13:45	21.4	27.1	24.3	29.6	25.7	30.8	22.5	35.1	22.6	43.7
02/11/2013 14:00	20.8	26.7	24.7	27.9	26.3	28.4	22.7	38.3	23.1	42.1
02/11/2013 14:15	20.8	26.7	24.9	27.0	26.8	25.7	22.8	41.3	23.6	41.6
02/11/2013 14:30	20.5	26.3	25.1	27.2	26.9	25.7	23.1	33.9	24.0	41.2
02/11/2013 14:45	20.2	26.3	25.2	25.5	27.3	24.9	23.0	38.5	24.3	40.0
02/11/2013 15:00	19.9	26.3	25.0	24.2	27.2	22.0	22.9	32.8	24.6	38.9
02/11/2013 15:15	19.9	26.7	24.7	24.2	27.2	22.4	22.5	31.7	24.8	38.9
02/11/2013 15:30	19.2	26.7	24.1	23.3	27.0	20.7	22.2	29.7	25.0	37.5
02/11/2013 15:45	18.9	27.1	23.4	21.4	26.7	19.2	21.9	29.7	25.0	37.0
02/11/2013 16:00	18.3	28.3	22.7	23.5	26.4	19.2	21.7	33.0	25.0	37.2
02/11/2013 16:15	17.4	29.2	22.1	25.7	25.8	24.2	21.7	36.5	24.9	43.7
02/11/2013 16:30	17.1	29.2	21.6	26.1	25.3	24.9	21.5	37.6	24.9	46.6
02/11/2013 16:45	16.5	30.8	21.2	26.6	24.7	26.2	21.4	38.1	24.8	47.8
02/11/2013 17:00	15.7	32.5	20.8	27.0	24.1	26.6	21.1	38.3	24.6	48.0
02/11/2013 17:15	15.1	34.6	20.2	25.7	23.4	27.1	20.8	37.9	24.3	48.0
02/11/2013 17:30	14.5	35.0	19.7	26.4	22.8	26.9	20.4	37.9	24.0	47.8
02/11/2013 17:45	14.2	35.4	19.3	27.0	22.1	26.6	20.0	38.1	23.6	47.5

Table 31 continued:

	DC02		DC11		DC13		DC14		DC16	
Sample	Exterior		STRAW-KERK-1		STRAW-KERK-2		LPN-KERK-3		Woodchips-LWL	
DATE	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)
02/11/2013 18:00	13.7	35.0	18.7	26.8	21.4	25.7	19.6	37.2	23.2	45.4
02/11/2013 18:15	13.7	35.0	18.0	27.5	20.4	24.9	18.2	33.7	22.3	38.4
02/11/2013 18:30	14.0	35.0	17.0	28.6	18.9	26.0	16.3	35.1	21.2	38.2
02/11/2013 18:45	14.0	34.6	16.1	29.4	17.6	26.6	15.1	36.5	20.3	37.9
02/11/2013 19:00	13.7	35.9	15.4	30.3	16.6	27.5	14.2	37.2	19.5	40.0
02/11/2013 19:15	12.8	38.0	14.9	31.0	15.9	27.7	13.7	37.2	19.2	40.2
02/11/2013 19:30	12.6	38.9	14.3	31.2	15.4	28.0	13.4	37.6	18.8	44.0
02/11/2013 19:45	12.3	39.3	14.0	31.2	15.0	28.2	13.2	37.6	18.5	44.6
02/11/2013 20:00	12.0	40.2	13.7	31.8	14.7	28.0	13.1	37.2	18.2	44.9
02/11/2013 20:15	11.5	41.5	13.3	32.3	14.4	28.2	12.9	37.6	17.9	44.9
02/11/2013 20:30	11.2	42.3	13.0	32.7	14.1	28.0	12.7	37.4	17.5	44.9
02/11/2013 20:45	11.2	41.9	12.8	32.7	13.9	28.2	12.5	37.4	17.2	44.9
02/11/2013 21:00	10.6	43.2	12.6	32.7	13.6	28.2	12.4	37.4	16.8	44.6
02/11/2013 21:15	10.4	43.2	12.4	32.9	13.4	28.2	12.2	37.4	16.4	44.9
02/11/2013 21:30	10.4	44.6	12.2	32.9	13.1	28.2	12.0	37.4	16.1	44.9
02/11/2013 21:45	10.1	43.7	12.0	32.9	12.8	28.0	11.8	37.2	15.7	44.6
02/11/2013 22:00	9.8	45.5	11.8	30.7	12.6	27.3	11.6	36.9	15.4	44.0
02/11/2013 22:15	9.6	45.9	11.6	33.4	12.3	28.0	11.4	36.9	15.0	44.4
02/11/2013 22:30	9.0	45.9	11.2	33.4	12.0	27.7	11.2	37.2	14.6	44.4
02/11/2013 22:45	8.8	46.3	11.0	33.6	11.7	28.0	11.0	36.9	14.3	44.6
02/11/2013 23:00	8.5	47.2	10.7	33.8	11.4	27.7	10.7	36.9	13.9	44.6
02/11/2013 23:15	8.5	46.8	10.5	34.1	11.2	27.7	10.5	36.9	13.6	44.6
02/11/2013 23:30	8.8	48.1	10.4	33.4	10.9	28.0	10.3	36.9	13.3	44.4
02/11/2013 23:45	8.3	48.1	10.2	34.1	10.7	28.0	10.1	36.9	13.0	44.0
03/11/2013 00:00	8.3	47.7	10.0	34.1	10.4	27.7	10.0	36.9	12.7	44.4
03/11/2013 00:15	7.7	48.1	9.8	34.1	10.2	28.0	9.7	36.9	12.3	44.6
03/11/2013 00:30	7.7	48.1	9.5	34.8	9.9	27.7	9.5	36.9	12.0	44.2
03/11/2013 00:45	7.5	48.6	9.4	33.8	9.7	27.7	9.4	36.7	11.7	44.2
03/11/2013 01:00	7.7	49.1	9.1	34.1	9.5	27.5	9.2	36.7	11.5	43.5
03/11/2013 01:15	7.7	50.0	8.9	33.8	9.2	26.9	9.0	36.7	11.2	43.5
03/11/2013 01:30	7.2	50.0	8.7	34.3	9.0	27.5	8.8	36.7	10.9	43.5
03/11/2013 01:45	6.9	50.4	8.5	34.5	8.8	27.3	8.6	36.7	10.6	43.7
03/11/2013 02:00	6.7	52.3	8.3	35.7	8.5	27.3	8.4	36.5	10.3	43.3
03/11/2013 02:15	6.4	52.3	8.1	35.4	8.3	27.7	8.2	36.7	10.1	43.0
03/11/2013 02:30	6.7	53.2	7.9	34.5	8.1	27.1	8.0	36.5	9.8	43.5
03/11/2013 02:45	6.4	52.3	7.7	35.7	7.9	27.7	7.8	36.2	9.5	43.5

Table 31 continued:

	DC02		DC11		DC13		DC14		DC16	
Sample	Exterior		STRAW-KERK-1		STRAW-KERK-2		LPN-KERK-3		Woodchips-LWL	
DATE	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)
03/11/2013 03:00	6.4	54.6	7.5	35.2	7.7	26.9	7.6	36.5	9.3	43.5
03/11/2013 03:15	6.2	53.7	7.3	35.2	7.5	27.1	7.4	36.2	9.0	43.0
03/11/2013 03:30	6.2	54.6	7.1	35.7	7.3	27.1	7.2	36.2	8.7	43.0
03/11/2013 03:45	5.9	53.2	6.9	35.9	7.1	27.1	7.1	36.0	8.5	42.6
03/11/2013 04:00	5.7	55.1	6.7	38.2	6.9	27.7	6.9	36.7	8.3	43.3
03/11/2013 04:15	5.9	55.5	6.6	36.6	6.7	26.9	6.7	36.2	8.0	43.0
03/11/2013 04:30	5.7	56.0	6.4	36.1	6.5	26.9	6.6	36.5	7.8	43.0
03/11/2013 04:45	5.4	56.9	6.3	36.4	6.3	27.1	6.4	36.2	7.6	42.3
03/11/2013 05:00	5.1	56.0	6.1	38.0	6.2	27.1	6.2	36.0	7.3	43.0
03/11/2013 05:15	5.1	57.4	5.9	39.6	6.0	27.3	6.1	36.5	7.1	42.8
03/11/2013 05:30	4.9	57.9	5.8	41.2	5.8	28.0	5.9	36.5	6.9	42.8
03/11/2013 05:45	4.6	57.4	5.6	40.3	5.7	27.5	5.8	36.0	6.7	42.8
03/11/2013 06:00	4.9	58.4	5.5	38.2	5.5	26.9	5.6	36.0	6.5	42.8
03/11/2013 06:15	4.9	58.8	5.4	42.3	5.4	27.1	5.5	36.0	6.3	42.8
03/11/2013 06:30	4.9	57.9	5.3	41.6	5.2	26.9	5.3	36.0	6.1	42.8
03/11/2013 06:45	5.1	59.3	5.2	37.5	5.1	26.6	5.2	35.8	5.9	43.0
03/11/2013 07:00	5.7	57.9	5.0	40.0	4.9	26.9	5.1	36.0	5.7	44.2
03/11/2013 07:15	6.9	53.7	5.0	37.5	4.9	26.6	5.0	35.6	5.6	42.8
03/11/2013 07:30	8.3	49.1	4.9	37.3	4.9	27.1	5.0	36.0	5.5	43.3
03/11/2013 07:45	9.6	43.7	5.0	36.6	5.0	27.3	5.1	36.9	5.4	45.8
03/11/2013 08:00	10.6	41.5	5.3	37.5	5.5	28.9	5.4	38.5	5.5	48.0
03/11/2013 08:15	12.6	39.3	5.8	41.4	6.2	34.7	6.0	42.0	5.7	49.2
03/11/2013 08:30	13.1	38.9	7.0	49.6	8.0	42.6	7.0	47.9	6.1	51.6
03/11/2013 08:45	14.0	36.3	8.9	46.5	10.7	40.3	8.6	50.5	6.8	52.1
03/11/2013 09:00	14.8	34.6	10.6	47.0	12.7	39.8	10.0	47.4	7.5	51.9
03/11/2013 09:15	14.8	34.6	12.7	43.9	14.9	37.9	11.6	49.8	8.4	51.6
03/11/2013 09:30	14.8	35.0	14.5	39.8	16.5	33.8	13.3	47.6	9.2	51.4
03/11/2013 09:45	15.4	34.2	15.9	37.7	17.8	32.2	14.6	45.5	10.1	50.2
03/11/2013 10:00	15.7	34.2	17.1	34.8	18.9	30.4	15.9	42.5	11.0	49.5
03/11/2013 10:15	16.2	32.5	18.0	35.4	19.7	29.7	16.7	42.7	11.8	48.3
03/11/2013 10:30	16.5	32.9	18.9	31.4	20.5	28.4	17.7	40.2	12.7	48.0
03/11/2013 10:45	17.4	31.2	19.5	32.3	21.2	29.3	18.5	41.3	13.5	47.8
03/11/2013 11:00	18.0	30.8	20.3	29.9	22.1	25.7	19.3	39.2	14.3	45.6
03/11/2013 11:15	18.0	30.4	20.8	29.9	22.7	25.1	20.0	37.6	15.0	44.9
03/11/2013 11:30	18.3	30.8	21.3	28.3	23.1	24.2	20.5	33.9	15.7	44.6
03/11/2013 11:45	18.9	30.0	21.6	29.6	23.4	24.9	20.8	35.1	16.3	44.6

Table 31 continued:

	DC02		DC11		DC13		DC14		DC16	
Sample	Exterior		STRAW-KERK-1		STRAW-KERK-2		LPN-KERK-3		Woodchips-LWL	
DATE	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)
03/11/2013 12:00	18.6	29.2	21.9	29.6	23.8	25.1	21.2	34.4	16.9	42.8
03/11/2013 12:15	19.2	28.3	22.1	29.0	24.1	25.7	21.5	35.1	17.4	43.0
03/11/2013 12:30	19.9	27.5	22.5	29.2	24.6	26.2	21.9	34.9	17.9	44.2
03/11/2013 12:45	20.5	26.3	22.9	29.4	25.1	25.3	22.3	36.0	18.4	41.4
03/11/2013 13:00	20.2	26.3	23.2	27.2	25.7	25.3	22.7	33.9	19.0	43.3
03/11/2013 13:15	19.9	26.7	23.8	25.0	26.4	20.5	23.2	30.0	19.6	39.3
03/11/2013 13:30	19.9	25.9	24.2	26.1	26.6	21.5	23.5	31.9	20.1	42.6
03/11/2013 13:45	20.2	25.9	24.3	26.6	26.7	22.2	23.6	32.6	20.6	42.6
03/11/2013 14:00	20.5	25.9	24.8	25.3	27.4	20.9	23.9	30.2	21.1	39.8
03/11/2013 14:15	19.9	26.3	25.3	24.6	28.0	20.1	24.2	31.3	21.6	41.2
03/11/2013 14:30	20.2	25.5	25.3	25.0	27.9	20.3	24.2	31.3	21.8	42.6
03/11/2013 14:45	20.5	25.5	25.6	24.2	28.2	20.5	24.3	30.6	22.2	40.7
03/11/2013 15:00	20.5	26.3	25.4	23.3	28.3	19.4	24.4	28.6	22.5	38.9
03/11/2013 15:15	20.2	26.3	25.3	23.3	28.4	20.5	24.5	29.3	22.8	40.2
03/11/2013 15:30	19.9	26.7	25.0	24.2	28.3	21.3	24.5	30.8	23.0	40.9
03/11/2013 15:45	19.5	26.7	24.7	25.0	28.0	20.9	24.3	31.7	23.1	42.8
03/11/2013 16:00	19.2	27.5	24.3	25.0	27.8	22.0	24.1	32.2	23.2	41.6
03/11/2013 16:15	18.3	28.7	23.9	25.5	27.4	23.3	23.9	33.3	23.3	45.8
03/11/2013 16:30	17.7	30.4	23.4	25.0	26.9	23.5	23.6	32.8	23.3	46.1
03/11/2013 16:45	16.5	32.1	22.9	24.8	26.4	23.5	23.3	33.3	23.2	47.8
03/11/2013 17:00	16.0	32.9	22.4	24.2	25.8	23.1	22.8	32.2	23.1	48.0
03/11/2013 17:15	15.1	33.3	21.7	24.8	25.0	22.9	22.3	32.8	22.9	48.3
03/11/2013 17:30	15.1	33.7	21.1	24.4	24.2	22.4	21.6	31.5	22.6	47.0
03/11/2013 17:45	14.8	34.2	20.5	24.2	23.5	22.2	21.0	31.5	22.3	46.3
03/11/2013 18:00	14.2	35.0	19.9	24.4	22.7	22.0	20.4	31.1	22.0	46.8
03/11/2013 18:15	13.7	35.4	19.4	24.4	22.0	21.8	19.9	31.3	21.6	46.6
03/11/2013 18:30	13.4	36.7	18.7	24.6	21.2	21.5	19.2	30.8	21.2	46.1
03/11/2013 18:45	13.1	37.1	18.1	24.8	20.5	21.5	18.6	30.8	20.8	46.1
03/11/2013 19:00	12.8	37.6	17.5	25.0	19.9	21.3	18.0	30.8	20.3	45.6
03/11/2013 19:15	12.6	38.9	16.9	25.0	19.2	21.1	17.5	30.8	19.9	45.6
03/11/2013 19:30	12.3	38.4	16.4	25.5	18.6	21.1	17.0	31.1	19.5	45.4
03/11/2013 19:45	12.0	38.9	16.0	25.7	18.1	20.9	16.6	31.1	19.0	45.1
03/11/2013 20:00	11.7	39.3	15.5	25.9	17.5	21.1	16.3	31.3	18.6	45.1
03/11/2013 20:15	11.5	39.7	15.2	25.9	17.0	21.1	16.0	31.5	18.2	45.1
03/11/2013 20:30	11.2	40.2	14.8	26.1	16.6	21.1	15.6	31.5	17.8	44.9
03/11/2013 20:45	11.2	41.5	14.5	26.6	16.1	21.1	15.3	31.1	17.4	44.9

Table 31 continued:

	DC02		DC11		DC13		DC14		DC16	
Sample	Exterior		STRAW-KERK-1		STRAW-KERK-2		LPN-KERK-3		Woodchips-LWL	
DATE	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)
03/11/2013 21:00	10.4	43.2	14.1	26.8	15.7	20.9	15.0	30.8	17.0	44.9
03/11/2013 21:15	10.4	44.1	13.7	27.0	15.2	20.9	14.6	30.8	16.6	44.6
03/11/2013 21:30	10.1	43.7	13.4	26.8	14.8	20.9	14.3	31.1	16.2	44.6
03/11/2013 21:45	9.6	45.5	13.1	27.5	14.4	20.9	13.9	30.8	15.9	44.9
03/11/2013 22:00	9.6	45.9	12.7	27.2	14.0	20.9	13.6	30.8	15.5	44.6
03/11/2013 22:15	9.3	46.3	12.4	28.3	13.6	20.9	13.3	30.8	15.1	44.6
03/11/2013 22:30	9.0	46.8	12.1	27.7	13.3	20.9	12.9	30.8	14.7	44.6
03/11/2013 22:45	8.5	47.2	11.8	29.4	12.9	20.9	12.6	30.6	14.4	44.6
03/11/2013 23:00	8.8	48.1	11.5	28.8	12.6	20.9	12.3	30.8	14.0	44.0
03/11/2013 23:15	8.5	48.6	11.2	28.8	12.2	21.1	12.0	30.8	13.7	44.0
03/11/2013 23:30	8.3	48.1	10.9	30.5	11.9	21.3	11.7	31.1	13.3	43.7
03/11/2013 23:45	8.3	47.2	10.6	30.1	11.6	21.1	11.4	30.8	13.0	44.0
04/11/2013 00:00	8.3	48.1	10.4	30.1	11.3	20.9	11.2	30.8	12.7	43.7
04/11/2013 00:15	8.0	49.1	10.2	29.4	11.0	20.7	10.9	30.8	12.4	43.7
04/11/2013 00:30	8.0	50.4	10.0	29.4	10.8	20.5	10.7	30.8	12.1	43.7
04/11/2013 00:45	8.3	50.0	9.8	30.7	10.5	21.1	10.5	30.8	11.8	43.7
04/11/2013 01:00	8.0	50.0	9.6	30.1	10.3	20.7	10.2	30.6	11.5	43.5
04/11/2013 01:15	8.0	50.0	9.4	30.1	10.0	20.7	10.0	30.6	11.2	43.7
04/11/2013 01:30	8.0	50.4	9.3	30.3	9.8	20.7	9.8	30.4	10.9	43.3
04/11/2013 01:45	7.7	50.0	9.1	31.4	9.5	20.7	9.6	30.4	10.7	43.3
04/11/2013 02:00	7.7	50.0	8.9	32.5	9.3	20.9	9.4	30.6	10.4	43.5
04/11/2013 02:15	7.7	50.4	8.7	32.3	9.1	20.9	9.2	30.6	10.1	43.3
04/11/2013 02:30	7.5	51.3	8.5	31.4	9.0	20.7	9.0	30.4	9.9	43.3
04/11/2013 02:45	7.2	50.9	8.3	32.9	8.8	20.9	8.8	30.6	9.7	43.3
04/11/2013 03:00	6.9	51.8	8.1	33.4	8.6	20.7	8.6	30.6	9.4	43.3
04/11/2013 03:15	6.7	51.8	8.0	33.6	8.4	20.9	8.4	30.6	9.2	43.5
04/11/2013 03:30	6.4	53.7	7.8	33.4	8.2	20.9	8.2	30.6	9.0	43.5
04/11/2013 03:45	5.9	54.6	7.6	33.2	8.0	20.7	8.1	30.6	8.7	43.3
04/11/2013 04:00	6.2	53.7	7.5	34.8	7.8	20.9	7.9	30.4	8.5	43.3
04/11/2013 04:15	5.9	54.6	7.3	33.2	7.6	20.7	7.7	30.6	8.3	43.0
04/11/2013 04:30	5.9	55.5	7.2	33.6	7.4	20.5	7.5	30.4	8.1	42.8
04/11/2013 04:45	5.4	56.5	7.0	37.3	7.2	20.7	7.4	30.8	7.8	42.8
04/11/2013 05:00	5.7	56.0	6.9	34.3	7.1	20.9	7.2	30.6	7.6	43.0
04/11/2013 05:15	5.4	56.9	6.7	36.4	6.9	20.9	7.0	31.3	7.4	42.8
04/11/2013 05:30	5.1	58.4	6.5	37.3	6.8	21.1	6.9	31.7	7.2	43.0
04/11/2013 05:45	5.1	58.4	6.4	38.9	6.6	20.9	6.7	31.1	7.0	42.8

Table 31 continued:

	DC02		DC11		DC13		DC14		DC16	
Sample	Exterior		STRAW-KERK-1		STRAW-KERK-2		LPN-KERK-3		Woodchips-LWL	
DATE	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)
04/11/2013 06:00	5.4	57.9	6.3	39.1	6.5	21.1	6.6	31.1	6.8	43.3
04/11/2013 06:15	5.4	58.8	6.2	38.9	6.3	20.9	6.5	31.1	6.7	43.3
04/11/2013 06:30	5.7	57.9	6.1	35.9	6.2	20.7	6.3	30.8	6.5	43.7
04/11/2013 06:45	6.2	56.0	6.0	35.0	6.0	20.7	6.2	30.6	6.3	43.3
04/11/2013 07:00	6.7	56.0	6.0	36.1	5.9	21.3	6.1	31.3	6.1	43.7
04/11/2013 07:15	7.5	51.3	5.9	33.6	5.9	20.5	6.0	30.4	6.0	44.4
04/11/2013 07:30	8.5	48.1	5.9	34.5	5.9	21.1	6.0	30.8	5.9	43.7
04/11/2013 07:45	10.4	43.7	6.0	35.7	6.1	22.2	6.1	30.8	5.9	46.1
04/11/2013 08:00	11.7	40.6	6.1	37.5	6.5	24.9	6.4	33.0	6.0	46.3
04/11/2013 08:15	12.8	39.3	6.6	44.6	7.6	39.1	7.3	45.2	6.2	49.2
04/11/2013 08:30	14.2	36.7	7.6	47.7	10.0	40.5	8.9	45.7	6.5	50.2
04/11/2013 08:45	14.0	36.7	8.9	45.6	11.7	34.9	10.3	45.9	7.1	51.9
04/11/2013 09:00	14.5	35.4	10.4	44.2	13.2	33.5	11.7	44.5	7.7	51.4
04/11/2013 09:15	15.1	32.5	12.2	42.1	14.9	31.7	13.2	36.7	8.5	51.6
04/11/2013 09:30	16.2	32.1	14.2	38.9	16.6	30.0	14.5	36.9	9.5	50.0
04/11/2013 09:45	17.1	30.4	15.7	36.1	18.0	28.4	15.6	37.4	10.3	49.2
04/11/2013 10:00	17.4	29.2	16.9	34.5	19.3	27.3	16.8	35.8	11.2	48.0
04/11/2013 10:15	17.7	30.0	17.7	34.3	20.1	27.3	17.8	35.3	12.0	47.8
04/11/2013 10:30	18.0	28.3	18.5	32.7	20.9	27.3	18.6	34.4	12.7	47.0
04/11/2013 10:45	18.3	28.3	19.1	31.2	21.5	26.4	19.4	33.3	13.4	46.8
04/11/2013 11:00	18.6	27.1	19.5	32.1	22.0	26.0	20.0	33.3	14.1	46.3
04/11/2013 11:15	19.2	26.3	20.1	31.0	22.7	26.6	20.5	32.8	14.7	45.8
04/11/2013 11:30	19.5	25.9	20.9	32.3	23.6	25.1	21.2	31.9	15.4	43.5
04/11/2013 11:45	19.5	26.3	21.8	29.4	24.5	22.6	22.0	30.2	16.2	42.8
04/11/2013 12:00	19.5	25.9	22.8	24.2	25.5	20.1	22.7	28.9	17.1	40.9
04/11/2013 12:15	20.2	24.7	23.2	25.5	26.1	20.9	23.3	28.6	17.9	42.1
04/11/2013 12:30	20.5	24.3	23.9	25.5	26.8	20.3	23.7	28.6	18.5	40.2
04/11/2013 12:45	20.5	24.3	24.5	23.7	27.5	19.7	24.2	28.2	19.1	41.2
04/11/2013 13:00	21.8	22.7	24.9	26.1	28.0	20.5	24.6	30.2	19.7	42.8
04/11/2013 13:15	21.8	23.1	25.5	24.4	28.7	20.5	24.9	29.1	20.3	41.4
04/11/2013 13:30	21.4	23.1	26.1	24.2	29.3	19.9	25.2	29.5	20.8	41.2
04/11/2013 13:45	22.1	22.3	26.3	25.0	29.5	19.7	25.4	30.0	21.2	41.9
04/11/2013 14:00	21.8	22.7	26.7	23.3	30.0	18.6	25.7	27.8	21.6	40.9
04/11/2013 14:15	21.4	23.1	26.9	22.9	30.3	17.3	26.1	27.1	22.1	38.6
04/11/2013 14:30	21.4	22.7	27.1	20.7	30.6	16.9	26.4	25.3	22.6	38.4
04/11/2013 14:45	21.8	22.7	27.0	21.8	30.4	16.1	26.3	26.6	22.9	38.2

Table 31 continued:

	DC02		DC11		DC13		DC14		DC16	
Sample	Exterior		STRAW-KERK-1		STRAW-KERK-2		LPN-KERK-3		Woodchips-LWL	
DATE	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)
04/11/2013 15:00	20.8	23.5	27.1	20.5	30.4	15.4	26.2	24.4	23.3	38.6
04/11/2013 15:15	20.8	23.5	26.6	20.1	30.2	16.9	26.1	22.9	23.6	38.4
04/11/2013 15:30	20.5	23.9	26.2	19.1	29.9	15.0	25.9	23.1	23.8	37.0
04/11/2013 15:45	20.5	24.3	25.7	20.3	29.6	17.5	25.7	24.4	23.9	38.6
04/11/2013 16:00	20.2	25.1	25.2	20.9	29.1	18.4	25.4	26.0	24.0	39.8
04/11/2013 16:15	18.9	26.3	24.7	21.6	28.7	18.8	25.1	27.3	24.1	44.6
04/11/2013 16:30	18.0	26.7	24.3	21.6	28.2	19.0	24.9	27.5	24.1	45.1
04/11/2013 16:45	17.4	27.5	23.8	22.2	27.6	19.2	24.6	28.2	24.0	46.8
04/11/2013 17:00	16.5	27.9	23.3	21.2	27.0	19.2	24.2	28.0	23.9	46.6
04/11/2013 17:15	15.7	28.7	22.6	20.9	26.2	18.8	23.7	28.0	23.6	46.8
04/11/2013 17:30	15.4	28.7	22.0	21.4	25.4	18.8	23.2	28.2	23.4	46.6
04/11/2013 17:45	15.1	26.7	21.4	21.4	24.7	18.6	22.7	28.4	23.1	45.6
04/11/2013 18:00	15.4	27.9	20.9	20.9	23.9	18.6	22.2	27.8	22.7	45.1
04/11/2013 18:15	14.8	28.3	20.3	20.7	23.2	18.6	21.7	26.0	22.3	44.6
04/11/2013 18:30	14.8	27.9	19.8	20.9	22.5	18.4	21.1	27.5	21.9	44.6
04/11/2013 18:45	14.8	27.9	19.3	20.9	21.8	18.2	20.6	27.3	21.5	44.9
04/11/2013 19:00	14.2	28.7	18.7	20.7	21.1	18.2	20.1	27.3	21.0	44.6
04/11/2013 19:15	14.0	30.8	18.1	20.5	20.4	18.0	19.6	27.5	20.6	44.2
04/11/2013 19:30	13.4	31.2	17.6	20.7	19.8	18.0	19.1	25.1	20.1	43.3
04/11/2013 19:45	13.1	32.1	17.1	21.2	19.2	18.0	18.6	27.8	19.7	44.2
04/11/2013 20:00	12.3	32.9	16.6	21.2	18.6	17.8	18.1	27.5	19.2	44.2
04/11/2013 20:15	11.7	36.7	16.0	22.2	18.0	17.3	17.6	27.1	18.8	44.0
04/11/2013 20:30	11.5	37.6	15.3	22.6	17.4	17.3	17.1	26.9	18.3	43.7
04/11/2013 20:45	11.2	39.3	14.9	22.4	16.9	17.3	16.7	27.1	17.9	43.7
04/11/2013 21:00	10.9	39.3	14.6	22.9	16.4	16.9	16.2	25.8	17.5	43.5
04/11/2013 21:15	10.6	39.3	14.2	23.5	15.9	17.1	15.8	26.9	17.1	43.5
04/11/2013 21:30	10.6	39.3	13.8	24.0	15.4	17.1	15.3	26.9	16.6	43.5
04/11/2013 21:45	10.6	38.0	13.5	23.3	15.0	17.1	15.0	27.3	16.3	43.5
04/11/2013 22:00	10.1	39.3	13.2	24.0	14.6	17.1	14.6	26.9	15.9	43.5
04/11/2013 22:15	10.4	39.3	12.9	24.2	14.2	17.1	14.2	27.1	15.5	43.5
04/11/2013 22:30	10.1	39.3	12.6	24.6	13.9	17.1	13.9	26.9	15.1	43.3
04/11/2013 22:45	9.8	39.3	12.3	25.3	13.5	17.3	13.6	27.1	14.8	43.3
04/11/2013 23:00	9.6	40.2	12.1	25.0	13.2	17.1	13.2	27.1	14.4	43.0
04/11/2013 23:15	9.6	41.0	11.9	24.4	12.9	16.9	13.0	27.3	14.1	43.0
04/11/2013 23:30	9.6	40.6	11.6	26.1	12.6	17.1	12.7	26.9	13.8	42.8
04/11/2013 23:45	9.6	41.5	11.4	26.4	12.3	17.1	12.4	27.1	13.5	42.6

Table 31 continued:

	DC02		DC11		DC13		DC14		DC16	
Sample	Exterior		STRAW-KERK-1		STRAW-KERK-2		LPN-KERK-3		Woodchips-LWL	
DATE	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)
05/11/2013 00:00	9.8	41.5	11.2	25.0	12.0	16.7	12.2	26.6	13.2	43.0
05/11/2013 00:15	9.0	41.5	11.0	25.9	11.7	16.9	11.9	27.1	12.9	42.8
05/11/2013 00:30	9.3	41.5	10.8	26.4	11.5	16.9	11.7	27.1	12.6	43.0
05/11/2013 00:45	9.6	41.5	10.7	25.9	11.2	16.9	11.5	27.3	12.3	42.8
05/11/2013 01:00	9.3	41.9	10.5	27.5	11.0	16.7	11.3	27.3	12.1	43.0
05/11/2013 01:15	9.0	42.3	10.3	28.8	10.8	16.9	11.1	27.3	11.8	42.8
05/11/2013 01:30	9.0	43.7	10.2	27.7	10.6	16.9	10.9	27.1	11.6	43.0
05/11/2013 01:45	9.0	42.3	10.1	30.1	10.5	16.9	10.7	27.3	11.4	43.0
05/11/2013 02:00	9.0	42.3	9.9	26.8	10.3	16.9	10.5	27.3	11.2	43.5
05/11/2013 02:15	9.0	42.3	9.8	28.3	10.1	16.9	10.4	27.3	11.0	43.5
05/11/2013 02:30	9.0	43.7	9.7	31.2	10.0	17.1	10.3	27.5	10.8	42.8
05/11/2013 02:45	9.0	42.3	9.6	28.3	9.9	16.9	10.1	27.3	10.6	43.5
05/11/2013 03:00	8.8	42.3	9.5	31.6	9.7	16.9	10.0	27.5	10.4	43.7
05/11/2013 03:15	9.0	42.8	9.5	31.0	9.6	17.1	9.9	27.3	10.3	42.6
05/11/2013 03:30	9.0	41.9	9.4	28.6	9.5	16.9	9.8	27.5	10.1	44.0
05/11/2013 03:45	9.0	41.9	9.3	29.9	9.4	17.1	9.7	27.3	10.0	42.8
05/11/2013 04:00	8.8	42.3	9.2	29.2	9.3	16.9	9.6	27.5	9.8	43.7
05/11/2013 04:15	8.8	43.7	9.2	32.3	9.2	17.1	9.5	28.0	9.7	43.3
05/11/2013 04:30	9.0	42.3	9.1	29.0	9.2	16.9	9.4	27.5	9.5	43.7
05/11/2013 04:45	9.0	44.1	9.1	34.1	9.1	17.3	9.3	28.2	9.4	43.3
05/11/2013 05:00	9.0	43.2	9.0	32.7	9.0	17.3	9.3	28.2	9.3	44.2
05/11/2013 05:15	8.8	44.6	9.0	29.2	9.0	17.1	9.2	27.8	9.2	43.5
05/11/2013 05:30	8.8	44.1	8.9	32.9	8.9	17.3	9.1	28.0	9.1	42.8
05/11/2013 05:45	8.5	45.9	8.9	32.9	8.9	17.5	9.0	28.4	9.0	43.0
05/11/2013 06:00	8.8	44.1	8.9	33.4	8.8	17.5	9.0	28.0	8.8	42.8
05/11/2013 06:15	8.8	43.7	8.8	33.6	8.8	17.5	8.9	28.6	8.8	43.5
05/11/2013 06:30	8.5	43.2	8.8	35.4	8.7	17.5	8.9	28.9	8.6	43.7
05/11/2013 06:45	9.0	43.2	8.8	32.7	8.7	17.5	8.9	28.9	8.6	43.7
05/11/2013 07:00	9.3	43.2	8.8	29.9	8.6	17.3	8.8	27.8	8.5	43.0
05/11/2013 07:15	9.6	42.8	8.7	30.5	8.6	17.5	8.8	28.6	8.4	44.2
05/11/2013 07:30	10.1	43.7	8.7	29.6	8.6	17.5	8.8	28.0	8.3	44.0
05/11/2013 07:45	10.4	41.0	8.7	32.7	8.6	18.0	8.8	27.8	8.3	44.9
05/11/2013 08:00	10.6	42.8	8.7	33.8	8.7	17.8	8.8	28.0	8.3	46.1
05/11/2013 08:15	10.9	40.6	8.8	33.4	8.8	18.2	8.9	29.1	8.3	45.8
05/11/2013 08:30	11.2	41.5	8.9	29.9	8.9	17.5	9.0	28.0	8.3	45.1
05/11/2013 08:45	11.2	41.5	9.0	36.4	9.0	19.0	9.1	29.7	8.3	45.6

Table 31 continued:

	DC02		DC11		DC13		DC14		DC16	
Sample	Exterior		STRAW-KERK-1		STRAW-KERK-2		LPN-KERK-3		Woodchips-LWL	
DATE	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)
05/11/2013 09:00	12.0	37.1	9.2	29.2	9.2	17.1	9.2	27.8	8.4	45.1
05/11/2013 09:15	12.8	40.2	9.4	31.4	9.4	18.2	9.4	28.9	8.5	45.8
05/11/2013 09:30	13.7	34.6	9.7	30.5	9.7	18.0	9.6	28.2	8.7	46.3
05/11/2013 09:45	14.0	33.3	10.2	32.7	10.6	19.7	10.1	29.3	8.9	45.8
05/11/2013 10:00	13.7	37.1	10.7	30.7	11.3	20.5	10.5	28.2	9.1	46.3
05/11/2013 10:15	14.2	35.0	11.2	31.4	11.8	20.5	11.0	29.3	9.3	46.6
05/11/2013 10:30	14.8	35.0	11.8	31.4	12.5	23.3	11.5	30.4	9.6	47.5
05/11/2013 10:45	15.1	32.1	12.9	32.7	14.0	24.4	12.3	29.7	10.1	46.8
05/11/2013 11:00	16.5	29.2	14.2	31.8	15.9	27.1	13.2	30.4	10.7	46.1
05/11/2013 11:15	17.4	28.3	15.8	32.3	17.8	26.4	14.3	30.2	11.4	45.4
05/11/2013 11:30	17.1	28.7	17.0	29.6	19.1	23.3	15.5	30.6	11.9	44.2
05/11/2013 11:45	17.1	29.6	17.5	28.8	19.5	22.0	16.2	30.0	12.2	44.2
05/11/2013 12:00	16.8	29.2	17.9	28.3	19.8	22.0	16.9	29.5	12.7	44.0
05/11/2013 12:15	17.4	29.2	18.2	28.3	20.0	22.4	17.3	29.3	13.1	44.4
05/11/2013 12:30	17.4	28.7	18.6	28.1	20.3	23.8	17.6	29.7	13.5	44.6
05/11/2013 12:45	18.0	29.2	19.3	27.9	20.8	23.8	17.9	30.2	14.0	44.0
05/11/2013 13:00	17.4	30.0	19.7	26.6	21.2	22.2	18.4	29.3	14.5	42.6
05/11/2013 13:15	17.7	30.4	20.2	26.8	21.5	23.5	18.9	29.3	15.1	41.9
05/11/2013 13:30	18.3	30.4	20.8	25.3	22.1	22.0	19.4	28.6	15.8	40.2
05/11/2013 13:45	17.7	30.8	20.8	25.0	22.1	20.9	19.8	28.0	16.2	40.2
05/11/2013 14:00	17.4	30.8	20.5	24.8	21.7	21.5	20.0	27.1	16.4	39.8
05/11/2013 14:15	16.8	32.1	20.1	25.3	21.3	21.8	19.9	26.4	16.6	39.6
05/11/2013 14:30	16.8	32.9	19.8	25.5	20.8	22.0	19.7	26.9	16.7	40.0
05/11/2013 14:45	16.5	33.3	19.3	25.9	20.2	23.1	19.4	27.1	16.8	39.6
05/11/2013 15:00	16.5	32.5	18.9	26.8	19.7	24.2	19.1	27.3	16.9	38.9
05/11/2013 15:15	16.8	32.5	18.6	27.0	19.2	24.4	18.8	27.1	16.9	38.2
05/11/2013 15:30	16.2	32.5	18.2	27.7	18.8	25.1	18.5	27.3	16.9	37.9
05/11/2013 15:45	16.2	33.7	17.8	28.1	18.4	25.1	18.2	27.3	16.8	38.4
05/11/2013 16:00	16.0	34.6	17.5	28.6	18.1	25.1	18.0	27.8	16.7	39.1
05/11/2013 16:15	15.7	35.0	17.2	29.0	17.8	25.1	17.8	27.8	16.7	39.6
05/11/2013 16:30	15.1	36.3	17.0	29.0	17.6	24.9	17.6	27.1	16.6	40.7
05/11/2013 16:45	14.8	36.7	16.8	28.8	17.4	24.9	17.4	28.0	16.6	42.1
05/11/2013 17:00	14.5	37.6	16.7	28.6	17.2	24.4	17.3	28.0	16.5	42.1
05/11/2013 17:15	14.2	38.4	16.5	28.3	17.0	24.4	17.1	28.2	16.5	42.6
05/11/2013 17:30	13.7	39.3	16.3	28.1	16.7	24.4	16.9	28.0	16.4	42.6
05/11/2013 17:45	14.2	37.6	16.0	27.9	16.5	23.8	16.7	27.3	16.2	41.2

Table 31 continued:

	DC02		DC11		DC13		DC14		DC16	
Sample	Exterior		STRAW-KERK-1		STRAW-KERK-2		LPN-KERK-3		Woodchips-LWL	
DATE	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)	T. (°)	RH (%)
05/11/2013 18:00	13.7	38.9	15.6	28.3	16.2	24.2	16.4	27.5	16.0	41.6
05/11/2013 18:15	13.4	39.3	15.4	28.1	15.9	24.2	16.2	27.8	15.9	42.3
05/11/2013 18:30	13.1	39.7	15.2	27.7	15.7	24.0	16.0	27.3	15.7	42.3
05/11/2013 18:45	12.3	41.5	15.0	28.3	15.4	23.8	15.8	28.0	15.5	42.8
05/11/2013 19:00	12.6	41.0	14.7	29.0	15.2	23.3	15.6	27.3	15.3	42.3
05/11/2013 19:15	12.3	41.5	14.5	28.6	14.9	23.8	15.3	27.8	15.1	42.8
05/11/2013 19:30	12.8	40.6	14.3	28.6	14.7	24.0	15.1	27.8	14.9	42.1
05/11/2013 19:45	13.1	40.2	14.1	28.6	14.5	24.2	14.9	27.5	14.7	42.3
05/11/2013 20:00	12.8	40.6	13.9	30.7	14.3	26.0	14.7	28.2	14.5	42.1
05/11/2013 20:15	13.4	41.0	14.1	34.8	14.5	30.2	14.6	30.0	14.3	42.6
05/11/2013 20:30	13.7	41.9	14.3	34.5	14.7	29.7	14.7	30.8	14.1	42.8
05/11/2013 20:45	14.0	41.0	14.4	32.3	14.8	26.4	14.7	29.7	14.0	42.8
05/11/2013 21:00	13.7	40.6	14.3	32.7	14.7	26.9	14.7	30.2	13.9	42.8
05/11/2013 21:15	13.7	41.9	14.2	31.4	14.7	25.7	14.6	29.3	13.8	43.3
05/11/2013 21:30	13.1	43.7	14.1	31.2	14.5	25.5	14.6	29.3	13.7	43.0
05/11/2013 21:45	12.8	43.2	14.0	31.0	14.4	25.3	14.5	29.1	13.6	43.0
05/11/2013 22:00	13.1	44.1	13.9	32.1	14.3	24.9	14.3	29.3	13.5	42.8
05/11/2013 22:15	12.6	45.0	13.8	31.4	14.2	25.1	14.2	28.9	13.4	43.3
05/11/2013 22:30	12.3	46.3	13.6	31.0	14.0	24.6	14.1	29.1	13.3	43.3
05/11/2013 22:45	11.5	50.0	13.5	31.0	13.9	24.6	14.0	29.1	13.2	43.5
05/11/2013 23:00	11.7	51.8	13.4	31.2	13.7	24.6	13.9	28.9	13.1	43.3
05/11/2013 23:15	11.5	50.4	13.2	30.7	13.6	24.6	13.8	29.1	13.0	43.3
05/11/2013 23:30	11.5	51.3	13.1	30.7	13.4	24.6	13.6	29.1	12.9	43.7
05/11/2013 23:45	11.2	51.8	12.9	30.3	13.2	24.4	13.5	28.9	12.8	44.0
06/11/2013 00:00	11.5	51.8	12.8	30.1	13.1	24.4	13.3	29.1	12.6	44.0

Table 32: Raw Data of the Heated Boxes with surface temperatures, samples STRAW-KERK-1, STRAW-KERK-2 and LPN-KERK-3-A

	DL12		DL02				DL14			DL17			
Sample	EXTERIOR		STRAW-KERK-1				STRAW-KERK-2			LPN-KERK-3			
DATE	T. (°C)	RH (%)	T. (°C)	RH (%)	Ext T. (°C)	Int T. (°C)	T. (°C)	RH (%)	Int T. (°C)	T. (°C)	RH (%)	Ext T. (°C)	Int T. (°C)
24.03.2015 18:00	4.38	68.9	5.5	88.2	5.7	2.7	5.2	83.5	5.5	5.4	83.8	3.4	6.1
24.03.2015 18:15	4.09	68.7	5.5	89.1	5.5	2.5	5.1	84.4	5.4	5.4	84.4	3.1	5.9
24.03.2015 18:30	3.88	69.2	5.4	89.5	5.3	2.7	5.1	84.8	5.2	5.4	84.9	3.1	5.8
24.03.2015 18:45	3.83	70.6	5.4	90.1	5.2	3.1	5	85	5.1	5.4	84.8	3.4	5.7
24.03.2015 19:00	3.83	71.1	5.3	90	5.1	2.9	4.9	85.3	4.9	5.3	85.1	3.3	5.6
24.03.2015 19:15	3.8	70.4	5.2	90	4.9	2.8	4.8	85.5	4.8	5.3	85.7	3.2	5.5
24.03.2015 19:30	3.78	70.4	5.1	90.1	4.8	2.8	4.7	85.8	4.7	5.3	86	3.3	5.4
24.03.2015 19:45	3.75	71.2	5	90.3	4.7	2.2	4.6	85.8	4.6	5.2	86.1	2.6	5.3
24.03.2015 20:00	3.64	72.4	4.9	90.3	4.6	1.6	4.5	86	4.5	5.1	86.3	1.9	5.2
24.03.2015 20:15	3.54	73	4.7	90.6	4.5	1.7	4.4	86.1	4.3	5.1	86.3	2	5.1
24.03.2015 20:30	3.49	73.5	4.6	90.7	4.4	1.7	4.3	86.3	4.2	4.9	86.5	2.1	5
24.03.2015 20:45	3.46	72.4	4.5	90.8	4.2	1.2	4.2	86.4	4	4.9	86.6	1.5	4.9
24.03.2015 21:00	3.35	72.2	4.4	90.9	4.1	0.9	4.1	86.5	3.9	4.7	86.7	1.1	4.8
24.03.2015 21:15	3.2	71.9	4.2	91.1	3.9	0.6	3.9	86.6	3.7	4.6	86.8	0.9	4.6
24.03.2015 21:30	3.09	71.9	4.1	91.2	3.8	0.4	3.8	86.7	3.6	4.5	86.9	0.6	4.5
24.03.2015 21:45	2.98	72.2	3.9	91.3	3.6	0.2	3.6	86.7	3.4	4.4	87	0.4	4.4
24.03.2015 22:00	2.85	72.4	3.8	91.4	3.5	0.2	3.5	86.7	3.3	4.3	86.9	0.3	4.2
24.03.2015 22:15	2.77	72.7	3.6	91.5	3.3	0	3.4	86.9	3.1	4.1	87	0	4.1
24.03.2015 22:30	2.72	73.1	3.5	91.6	3.1	-0.3	3.2	86.9	2.9	4	87.1	-0.3	3.9
24.03.2015 22:45	2.64	73.4	4.6	95.5	5.5	-0.5	3.9	89	5.1	4.5	88.6	-0.5	4.6
24.03.2015 23:00	2.64	75.2	7.9	97.2	9.1	-0.5	6.3	89.5	9.1	6.5	89.2	-0.5	6.6
24.03.2015 23:15	2.64	78	11.2	97.2	12.5	-0.5	9.2	88.4	12.7	8.6	88	-0.5	8.7
24.03.2015 23:30	2.61	77	13.9	96.1	15.2	-0.5	12.1	86.3	16.1	11.2	86.1	-0.6	11.2
24.03.2015 23:45	2.56	76.2	16	94.7	17	-0.5	14.6	83.3	18.2	13.6	83	-0.6	13.6
25.03.2015 00:00	2.56	77.8	17.8	91.2	17.8	-0.3	16.8	81.1	20	15.7	79.8	-0.5	15.4
25.03.2015 00:15	2.56	80.3	19.7	88.5	18.9	-0.3	19	79.2	21.4	17.1	77.1	-0.5	16.4
25.03.2015 00:30	2.56	79.7	22	87.4	21.2	-0.2	21.2	76.8	23.1	18.7	76.1	-1	18.1
25.03.2015 00:45	2.56	79.8	24.2	82	23.4	0.2	23.3	74.7	24.9	20.7	73.8	-0.1	20.1
25.03.2015 01:00	2.56	78.2	26.4	79.9	25.5	0.7	25.3	72.4	26.9	22.7	71.8	0.2	22
25.03.2015 01:15	2.53	76	28.5	75.5	27	1	27.3	70.5	28.7	24.6	69.9	0.3	23.5
25.03.2015 01:30	2.5	76	30.3	71.7	28.7	1.3	29.2	68	30.5	26.5	68.5	0.3	25.2
25.03.2015 01:45	2.45	75.4	31.8	70.3	30.4	1.8	31	65.4	32.2	28.1	66.8	0.4	26.7
25.03.2015 02:00	2.42	75.2	33.1	68.1	31.6	2.2	32.5	63	34	29.5	65	0.4	28
25.03.2015 02:15	2.37	74.7	33.9	66.7	32.6	2.6	34	61.3	35.5	30.8	63.7	0.4	29.2
25.03.2015 02:30	2.26	74.2	34.6	65.9	33.8	3.5	35.1	59	37	31.9	62.1	0.7	30.3
25.03.2015 02:45	2.16	74.1	35.3	64.1	34.9	4.7	36.3	57.5	38.4	32.8	60.6	1.3	31.3

(Ext T. for external surface temperature and Int T. for internal surface temperature)

Table 32 continued:

	DL12		DL02				DL14			DL17			
Sample	EXTERIOR		STRAW-KERK-1				STRAW-KERK-2			LPN-KERK-3			
DATE	T. (°C)	RH (%)	T. (°C)	RH (%)	Ext T. (°C)	Int T. (°C)	T. (°C)	RH (%)	Int T. (°C)	T. (°C)	RH (%)	Ext T. (°C)	Int T. (°C)
25.03.2015 03:00	2.13	74.1	35.9	63.7	35.7	5.8	37.5	55.8	39.8	33.6	59.7	1.9	32.2
25.03.2015 03:15	2.16	74.6	36.7	62.8	36.5	6.6	38.8	54.6	41	34.6	58.5	2.3	33
25.03.2015 03:30	2.21	74.8	37.5	61.4	37.1	7.1	39	53.4	39.1	35.7	58	2.7	33.9
25.03.2015 03:45	2.26	75	36.3	60.2	34.5	7.4	36.6	54.8	35.5	36.6	57.1	2.6	34.8
25.03.2015 04:00	2.29	74.5	33.4	62.3	31.7	7.8	34.1	56.6	32.7	36.4	55.9	3.1	34
25.03.2015 04:15	2.26	74.2	30.9	64.4	29.3	8	31.7	58.5	30.4	33.7	57.4	3.4	31.2
25.03.2015 04:30	2.18	73.8	28.6	67.1	27.2	8	29.5	59.5	28.3	31.1	59.5	3.1	29
25.03.2015 04:45	2.07	74.3	26.4	68.7	25.1	8.4	27	60.9	26.1	28.5	61.3	2.9	26.9
25.03.2015 05:00	1.91	73.2	24.6	70.4	23.7	7.6	25.3	62.8	24.7	26.1	61	2.8	25.1
25.03.2015 05:15	1.7	74	23	71.6	22.4	7.3	23.7	63.9	23.3	24.1	63.3	2.1	23.6
25.03.2015 05:30	1.59	74.1	21.5	72.6	21.1	6.9	22.2	64.9	22	22.7	65.1	3.1	22.3
25.03.2015 05:45	1.51	73.6	20.2	73.3	19.9	6.3	20.8	65.5	20.7	21.2	65.3	2.2	21.1
25.03.2015 06:00	1.48	77	18.9	74.2	18.7	5.1	19.3	66.4	19.2	19.6	66.9	-8.4	19.6
25.03.2015 06:15	1.7	76.3	17.9	75.2	17.8	4.9	18.2	67	18.3	18.6	68.3	2.2	18.8
25.03.2015 06:30	2.85	75.4	16.9	75.9	16.8	4.9	17.2	68.2	17.3	17.7	69.6	1.3	17.9
25.03.2015 06:45	4.17	72.6	16	76.5	15.8	5.1	16.2	68.8	16.3	16.7	70.3	2.7	17
25.03.2015 07:00	5.28	70.3	15.2	77.4	14.9	4.3	15.3	69.5	15.5	15.9	71.2	4.5	16.2
25.03.2015 07:15	6	67.4	14.4	77.8	13.9	5.1	14.6	70.7	14.6	15.2	72.1	4.2	15.4
25.03.2015 07:30	5.67	66.3	13.6	78.1	13	3.8	13.9	72.3	13.9	14.5	72.8	3	14.6
25.03.2015 07:45	5.08	66	12.9	78.4	11.9	3.7	13.2	72.5	13.2	13.8	73.6	4.6	13.9
25.03.2015 08:00	4.45	67.5	12.2	78.6	10.9	3.6	12.4	72.2	12.4	13.2	74.2	-1.4	13.1
25.03.2015 08:15	4.09	68.5	11.6	79.5	10.2	4.8	11.7	72.3	11.7	12.6	75.1	1.7	12.5
25.03.2015 08:30	3.96	69.5	11.2	80.9	9.8	6.3	11.2	73.3	11.1	12.2	76	8	12
25.03.2015 08:45	4.01	70.3	10.8	80.3	9.4	7	10.7	73.5	10.7	11.8	76.3	8.9	11.6
25.03.2015 09:00	4.17	70.3	10.4	80.5	9.1	7.1	10.4	74.3	10.3	11.5	76.9	-7.8	11.2
25.03.2015 09:15	4.35	69.9	10.1	80.8	8.8	10.5	10	74.9	10	11.2	77.4	-0.4	10.9
25.03.2015 09:30	4.66	70.6	9.8	81.5	8.6	13	9.8	77	9.9	11	78.1	-94.8	10.7
25.03.2015 09:45	4.95	67.7	9.6	81.8	8.7	10.3	9.7	78.8	9.9	10.9	78.7	13.1	10.7
25.03.2015 10:00	4.95	68.5	9.5	82	8.8	11.8	9.8	78.7	10	10.8	78.9	15.6	10.6
25.03.2015 10:15	5.23	69	9.5	84.5	9	13.4	9.9	82.4	10.3	10.8	80.2	17.2	10.7
25.03.2015 10:30	5.54	67.5	9.6	84.8	9.3	15.7	10.1	83	10.6	10.8	80.3	19.6	10.9
25.03.2015 10:45	5.82	65.4	9.8	85.4	9.6	12.2	10.2	82.9	10.8	10.9	80.3	14.1	11
25.03.2015 11:00	5.87	66.8	9.9	86.9	10	17.4	10.2	82.8	11	10.9	81.1	21	11.2
25.03.2015 11:15	6.05	63.6	10.2	87.6	10.4	19.7	10.2	83.2	11.2	11	81	23.3	11.4
25.03.2015 11:30	6.2	63.5	10.4	88.1	10.9	20.2	10.2	82.7	11.3	11	80.5	23.7	11.4
25.03.2015 11:45	6.31	57.7	10.8	88.5	11.6	20.8	10.3	81.9	11.7	11	80.7	24.9	11.6
25.03.2015 12:00	6.36	64.5	11.1	88.3	12	23.2	10.3	82	11.9	11.1	80.8	28	11.9

(Ext T. for external surface temperature and Int T. for internal surface temperature)

APPENDIX D

PICTURES OF TEST BOXES AND SAMPLES

In this section, explanatory pictures of produced blocks and boxes are given.

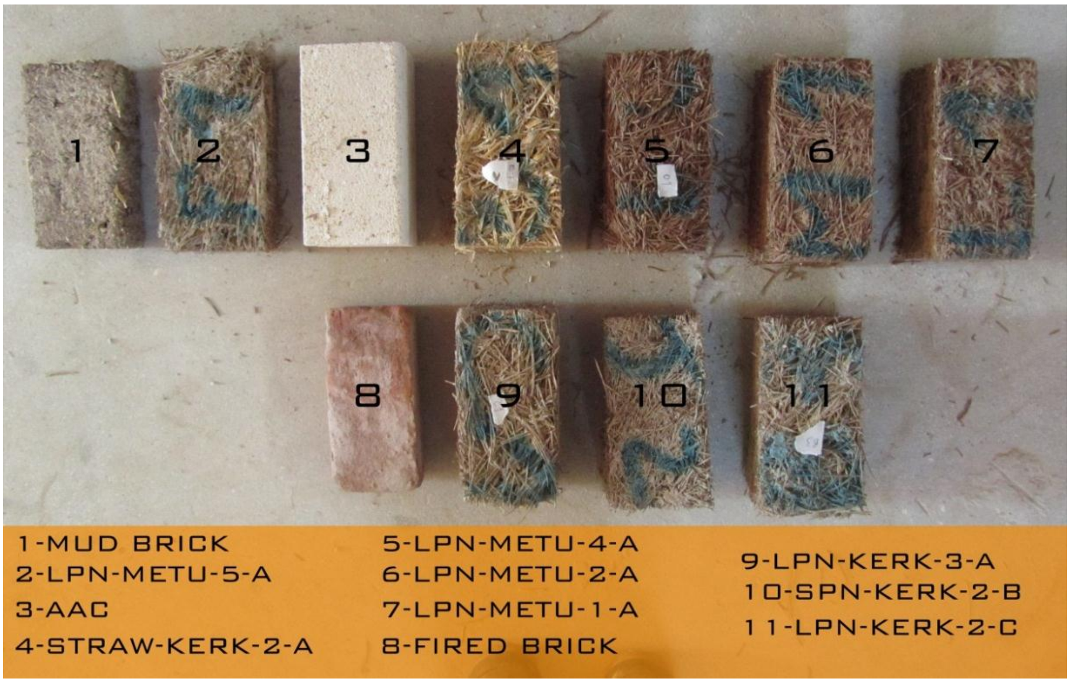

Figure 107: Mixes used on vapor resistivity test are shown.

Figure 108: LPN-KERK-3 box closed.

Figure 109: LPN-KERK-3 box open with data logger inside.

Figure 110: STRAW-KERK-1 box closed.

Figure 111: STRAW-KERK-1 box open with data logger and surface sensor inside.

Figure 112: STRAW-KERK-2 box closed.

Figure 113: STRAW-KERK-2 box open with data logger and surface sensor inside.

Figure 114: Woodchips LWL box closed.

Figure 115: Woodchips LWL box open with data logger inside.

Figure 116: Mud brick box closed.

Figure 117: Mud brick box open with data logger and surface sensor inside.

Figure 118: LPN-METU-1 box closed.

Figure 119: LPN-METU-1 box open with data logger and surface sensor inside.

Figure 120: LPN-METU-2 box closed.

Figure 121: LPN-METU-2 box open with data logger and surface sensor inside.

Figure 122: LPN-METU-4 box closed.

Figure 123: AAC box closed with exterior surface sensor.

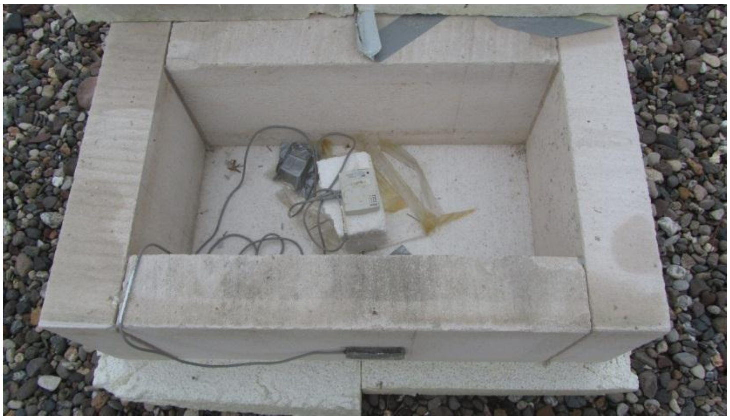

Figure 124: AAC box open with data logger and exterior surface sensor.

Figure 125: Polystyrene (XPS) box closed.

Figure 126: Polystyrene (XPS) box open with data logger and interior surface sensor