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EDİTÖR KURULU

İletişim/Contact
Fenerbahçe Üniversitesi Mühendislik ve Mimarlık Fakültesi Dekanlığı
Tel: (0216) 910 19 07
e-mail: dae@fbu.edu.tr

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Fenerbahçe Üniversitesi Tasarım, Mimarlık ve Mühendislik Dergisi'nin 2024 yılı son sayısı olan 4. Cilt, 2. sayısını sizlerle paylaşıyor olmaktan mutluluk duyuyoruz.

Dergimizin ilgili sayısının yayına hazırlanmasında emek veren editörlerimiz Dr. Öğretim Üyesi Özge DEVAL ve Dr. Öğretim Üyesi Ayşe Gülçin Ural ve Dr. Öğr. Üyesi Sevim ŞAHİN katkıları için teşekkürlerimi sunarım. Yayın Kurulunu oluşturan değerli öğretim üyelerimize, büyük bir özveriyle dergi sekretaryasını yürüten Araştırma Görevlisi Zeynep Tutku EREN ve Berrak ERDAL'a, yazıların dil kontrolü aşamasında bize destek sunan dil editörlerimiz; Dr. Öğretim Üyesi Serhat UYURKULAK ve Araştırma Görevlisi Kübra YÜCEL KARABAŞ'a, sayının mizanpajı için çokça emek harcayan Araştırma Görevlisi Meltem AĞAN ve Araştırma Görevlisi Nisanur ÖZÇELİK'e, son olarak teknik editörlerimiz Araştırma Görevlisi Uğur ÖZBALKAN ve kapak tasarım-sosyal medya paylaşımları konusunda destek sunan sevgili öğrencilerimiz Ayşenur EROL ve Volkan ÜSTKAYA'ya teşekkür ederim.

Dergi içeriğinin oluşmasına çalışmalarıyla katkı sunan değerli yazarlarımıza, kıymetli vakitlerinden ayırarak makaleleri değerlendiren hakemlere teşekkürlerimi sunarım.

Mimarlık, İç Mimarlık ve Mühendislik alanlarında bilimsel çalışmaların yer aldığı dergimizin bu sayısında tamamı araştırma makalesi olmak üzere dört makaleden oluşan içeriği siz değerli okuyucularımıza sunmaktayız. Bu sayının sizler için faydalı olmasını umuyor, iyi okumalar diliyorum.

Saygılarımla,

Prof. Dr. Fatma KANCA

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2021 yılında yayın hayatına başlayan Fenerbahçe Üniversitesi Tasarım, Mimarlık ve Mühendislik Dergisi (FBU-DAE) uluslararası hakemli bir dergidir. Dergimiz; Mühendislik, Mimarlık ve Tasarım alanlarında özgün ve bilimsel çalışmaların etik kurallar çerçevesinde değerlendirilerek okuyucuya iletilmesini sağlamaktadır. Dergimiz Haziran ve Aralık ayında olmak üzere yılda iki sayı yayınlamaktadır. Dergi yayın dili Türkçe ve İngilizce'dir. Dergimizde kör hakemlik sistemi uygulanmakta, dergimize gönderilen makalelerin başka bir yerde yayınlanmış ya da yayınlanmak üzere sırada olmaması gerekmektedir. Yazar/yazarlar yayınlanmak üzere gönderdikleri makalelerin yayın ve telif hakkını Fenerbahçe Üniversitesi Tasarım, Mimarlık ve Mühendislik Dergisi'ne (FBU-DAE) devretmeyi ve ücret talep etmemeyi kabul eder. Yayınlanmış tüm makaleler dergi ve yazarlara atıf yapılmak suretiyle herkese açıktır.

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ARCHITECTURAL DESIGN APPROACH OF A PUBLIC BUILDING; BOLU REGIONAL DIRECTORATE OF FORESTRY

BİR KAMU BİNASINDA MİMARİ TASARIM YAKLAŞIMI; BOLU ORMAN BÖLGE MÜDÜRLÜĞÜ

Mine TUNÇOK SARIBERBEROĞLU*

ABSTRACT

When the concept of space is considered at the social level, it appears as a set of relationships rather than any product or object. It is possible to define public service buildings, which can be divided into education, art, and health, which are essential parts of the social order, as areas where a service-based relationship takes place and where buildings mediate communication between society and the state. The space can increase or restrict social interaction with its arrangements in public buildings, which are intended to respond to the users' needs and society's general expectations. In addition, public administrative service buildings, which exist to serve the public and consist of institutions affiliated with the state, are an architectural design problem that includes several factors such as environmental sensitivity, sustainability, aesthetic concerns, and purpose, function, budget, and identity concepts. This study examines the conceptual and systematic approach to the architectural project design of a public building, Bolu Regional Directorate of Forestry Building. The study focuses on how a public building design problem is addressed and the design principles of the developed architectural preliminary design and implementation projects.

Keywords: Architectural Design, Spatial Organization, Public Service Buildings, Design Process

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*
Mimarlık Bölümü,
Bolu Abant İzzet Baysal Üniversitesi
Bolu/ Türkiye

Architecture Department,
Bolu Abant İzzet Baysal University
Bolu/ Turkey

ORCID: 0000-0002-6931-0539

mine.tuncoksariberberoglu@ibu.edu.tr

ÖZET

Mekân kavramı toplumsal düzeyde ele alındığında herhangi bir ürün ya da nesneden ziyade bir ilişkiler bütünü olarak karşımıza çıkmaktadır. Toplumsal düzenin önemli bir parçası olan eğitim, sanat ve sağlık olarak ayrılabilecek kamu hizmet binalarını da hizmet temelli bir ilişkinin gerçekleştiği, binaların toplum ve devlet arasındaki iletişime aracılık ettiği alanlar olarak tanımlamak mümkündür. Kullanıcıların ihtiyaçlarına ve toplumun genel beklentilerine cevap vermesi amaçlanan kamu binalarında mekan sahip olduğu düzenlemelerle toplumsal etkileşimi artırıcı veya kısıtlayıcı olabilmektedir. Bunun yanı sıra kamuya hizmet vermek için var olan ve devlete bağlı kurumlardan oluşan kamu idari hizmet binaları amaç, işlev, bütçe ve kimlik kavramlarının yanı sıra çevresel duyarlılık, sürdürülebilirlik ve estetik kaygılar gibi bir dizi faktörü de içeren bir mimari tasarım problemidir. Bu çalışma, bir kamu binası olan Bolu Orman Bölge Müdürlüğü Binası'nın mimari proje tasarımına yönelik kavramsal ve sistematik yaklaşımı incelemektedir. Çalışma kapsamında bir kamu binası tasarım probleminin nasıl ele alındığına ve geliştirilen mimari ön tasarım ve uygulama projelerinin tasarım ilkelerine odaklanmaktadır.

Anahtar Kelimeler: Mimari Tasarım, Mekânsal Organizasyon, Kamu Hizmet Binaları, Tasarım Süreci

1. INTRODUCTION

In Production of Space, Lefebvre (1991) states that the concept of space builds a relationship between the mental and the cultural, the social with the historical. “Space” is neither a pure abstraction or object, nor just a concrete, physical entity. In all its dimensions and forms, space is both a concept and reality; that is, it is social. On the other hand according to Habermas (2003), the boundaries of using the concepts of public in everyday language are unclear. These concepts with contents that have become ambiguous, are increasingly blurred because a disciplinary definition cannot be made, and spaces open to everyone’s use are considered public spaces. In this sense, while the subject of the public or public space is “the public”, defining the state’s institutions as public buildings because they are open to public use means designating the state as a public power (Odabaş, 2018). In other words, Habermas declares that the state’s position in defining public space is the state’s responsibility to society. As such, in the relationship established between the state and society, political management power can be achieved in the public sphere controlled by laws made for the benefit and service of the society.

Public administration buildings act as intermediaries for communication between society and the state. Buildings representing political power and dominance due to state ownership are responsible for serving the public. Benefiting from services, obtaining information, and reaching the central government or relevant unit through institutions, buildings are the public's access to space and also become a public activity area (Çelik, 2022).

Government buildings are also called official buildings, administrative buildings, or service buildings defined as “general administration buildings in which official duties are carried out”, in the State Buildings Operation, Maintenance and Repair Regulation published in the Official Gazette in 1971 (Public Buildings Operation, Maintenance and Repair Regulation, 1971). In this context, public administration buildings belong to administrative and official institutions that serve society (Çelik, 2022).

Furthermore, any concept of public architecture to be defined also relates to structures or built forms that symbolize unidentified entities (Cuff, 2012). The production and rearrangement of the physical environment involves solution-oriented approaches in architectural design. Architectural design developed within the framework of a defined problem is an essential process for forming the physical environment. A physical environment is created through controlled or uncontrolled design processes, from the smallest housing unit up to an urban scale. From this point of view, buildings built within the framework of specific design rules and within the institutional system appear as the essential elements of the physical environment (Wolfe & Rivlin, 1987; Tunçok Sarıberberoğlu, 2020).

In his study, Graham (2006) asks, “Can there be public architecture?” and states that a building is appropriated by a user when that user understands its features to be “fit for purpose”. Such appropriation is necessary for the building to be functional. The practical properties of a building suitably become functional only when appropriated by someone who then uses the building. What constrains the appropriation of function? Appropriation is more than just perceiving fitness for purpose; the building must serve the purpose in question. As a result, good design and qualified construction improve the quality of life.

The question arises if it is possible to define space, which is more than a simple volume that surrounds us, as a physical form (such as length, width, scale, geometry, etc.) that can be easily resolved and defined with its concrete structure. Conversely, space has abstract and complex features shaped by codes and rules that make it meaningful (Dursun, 2012). Architectural design is more than just finding spatial solutions to specific regulations. Some theories emphasize that the physical setup will also support the social structure in the space. Hillier and Hanson (1984) states that a relationship exists between the forms produced and the social structure. Lawson (2007) also emphasizes that we can socialize and interact with our environment more richly in areas when the building is designed holistically. The boundaries, connections, and divisions created in the spaces designed within this holistic structure also determine the relationships between people. Furthermore, Carr et al. (1992) state that public spaces, seen as common areas where activities are conducted, are accessible, democratic, and meaningful, have a visual identity and connect people to society.

This study explores the architectural design process of the Bolu Regional Directorate of Forestry Administrative Building, located in a province of the country that stands out with its forests. The design in question presents the principles of architectural preliminary design and application projects, with a focus on the basic approaches to spatial design.

2. CONCEPTUAL APPROACH OF THE PROJECT

The space syntax theory, which emphasizes that the physical setup will also support the social structure in the space, suggests that there is a relationship between the forms produced and the social structure. Lawson (2007), who states that visual perception is essential to be able to examine the social structure of spatial behavior and space construction, also emphasizes that we can socialize more and better interact with our environment in areas where we have visual dominance (Tunçok Sarıberberoglu, 2018).

Public buildings should be considered holistic structures with different functional uses, corridors, and office units. The boundaries, connections, and divisions created inside the spaces designed within this holistic structure also determine the relationships between people. The social logic of space suggests that daily life should not be disconnected, and social relations can be shaped, which constitutes the basic conceptual approach in a building setup (Peponis & Wineman, 2002).

According to Hillier (2003), the layout not only affects movement and circulation but also enables the individual to understand the relationship between spaces and to form an image of that relationship. If it is difficult to understand how one space is connected to another, orientation in spatial layout becomes difficult. At this point, visibility and intelligibility of the space become vital, and therefore, corridors in public buildings appear as the primary design element in the perception of space. Spatial legibility is one of the critical aspects of understanding the space in a coherent pattern in an imaginable way. Spatial characteristics influence the legibility of a layout. Readable and perceivable environments contain elements that are relatively simple, coherent, comprehensible, and organized (Lynch, 1960); at this point, it is possible to say that as the level of complexity in spatial layout increases, the cognitive relationship established with space will weaken.

The subject of this article is the need for a new public building that serves the community and its occupants effectively. The subject is The Bolu Regional Directorate of Forestry, which manages the region's affairs under the provisions of legislation and instructions of the General Directorate and organizes and controls the activities of the affiliated units to implement plans, projects, and annual programs (Url-1). The need for a holistic building is vital for a city with multiple forests and natural environments.

In line with all these formal and conceptual data, the building in question was aimed to function on the axis of city culture, public service, and life during the design phase, for which a holistic design was intended. Henceforth, the basic design approach for the building setup is presented.

3. ARCHITECTURAL DESIGN PROCESS

Architectural design is a complex and multifaceted process that requires a thorough understanding of various factors, including the client's needs, site conditions, zoning regulations, and sustainable design principles (Norouzi et al., 2015). Designing involves both the analysis and synthesis of the elements, characteristics, and requirements for a work of architecture. In the context of a new architectural design, the methodology for explaining the design can be broadly divided into three main stages: research and analysis, conceptual design, and detailed design (Stanković et al., 2018; Ziff, 2000).

On the other hand, the formation process of buildings and spaces consists of a series of feed-forward steps, defined as the architectural planning process. This process, which starts with preliminary design studies or strategic planning steps, creates a cycle of many steps, such as planning, design implementation, use, and evaluation (Preiser & Schramm, 1997).

At the beginning of the design process, the required functions, and sub-meanings of the spaces in the public service building are determined. The functional and semantic equivalents of the physical spaces to be designed are emphasized, and the preliminary existence of the building is questioned. Within the scope of the design process, the spatial identity requirements of the design problem were examined, and the requirements of spatial functions based on spatial order were considered.

The functional and semantic equivalents of the spaces intended to be designed were questioned based on the social, cultural, and economic expectations of the subject. At the decision stage, the main goal was to create an environment supporting public–city interaction and administrative unit form search. In this context, spatial and functional data shaped the process starting with the analysis and design phase. The keywords for the design were determined as efficiency in the office units, while privacy, productivity and functionality were required. Also at the same time, it was aimed to create a system that supports social interaction and establishes visual dominance over the landscape (Figure 1).

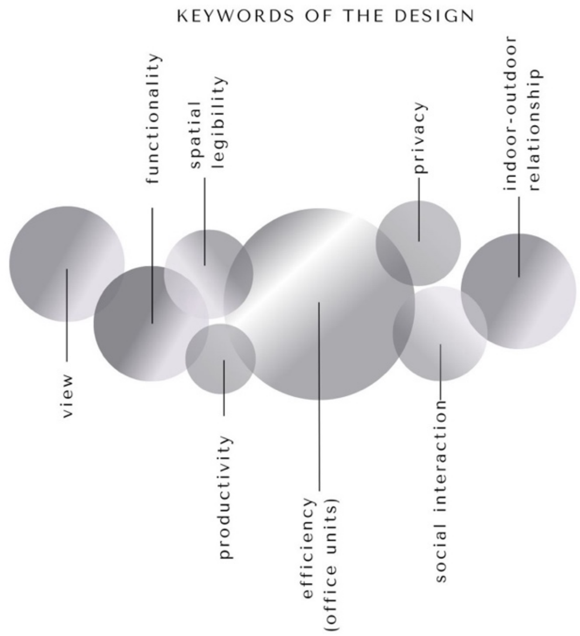

Figure 1. Keyword diagram of the design (produced by the author).

The requirements program constitutes another important stage of the design phase. In the needs program setup, an attempt was made to create a scheme based on the requirements determined by the business directorates within the regional directorate. To be considered a holistic structure, the building should include these main categories: regional directorates, educational and social areas, central administrative units, open-air and closed parking areas, and technical areas (Figure 2).

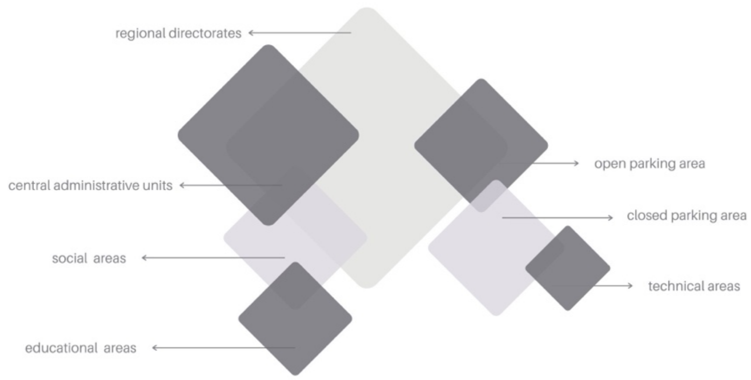

Figure 2. Structural program diagram of the design (produced by the author).

The design process, which started with determining user needs (public and people), was performed by establishing a relationship between conceptual approach and form. Considering the program's intensity and the land's shape, an inner garden was created as the best approach to provide natural lighting. Courtyards can positively impact occupant comfort in office buildings in several ways such as thermal comfort (Bekar & Manioğlu, 2018), daylighting and views (Taleghani et al., 2012; Qi et al., 2021), air quality (Ghaffarianhoseini et al., 2015).

Inner courtyards act as a central void, shaping the flow of movement within the building. This can reduce reliance on long, enclosed corridors and create a more intuitive and pleasant circulation experience (Jamaludin et al., 2016). Moreover, courtyards introduce natural light into the building's core, reducing the need for artificial lighting and creating a more inviting and stimulating environment. This natural light can penetrate surrounding rooms, brightening the interior spaces and fostering a connection with the outdoors (Taleghani et al., 2012). However, the design of the courtyard itself is crucial to maximizing these benefits. Factors like the courtyard's orientation, size, and the presence of vegetation all play a role in its effectiveness in enhancing occupant comfort (Ghaffarianhoseini et al., 2015).

3.1. Project Site

A project's site location is fundamental in architectural design as in context and user experience. A building should respond to its surroundings, whether it's a bustling urban street or a serene natural landscape (van Nes & Yamu, n.d), and how people will access and move through the site is crucial. Proximity to transportation, amenities, and views all contribute to the user experience (Özgece et al., n.d). It is vital to consider all these factors to create designs that are not only aesthetically pleasing but also functional, sustainable, and integrated with their surroundings.

The project site is located in Bolu's city center, which is between the capital Ankara and İstanbul, Turkey. In the south of the project area, there is a main road, D-100, also known as Bolu–Ankara Road. In the southeast of the project area is Atatürk Forest Park, which is essential for the province of Bolu and spreads over a wide area. Due to the location of the project area, the administrative building in question was designed to interact visually with this park to enrich the user experience not only aesthetically but also integrated with the surrounding (Figure 3).

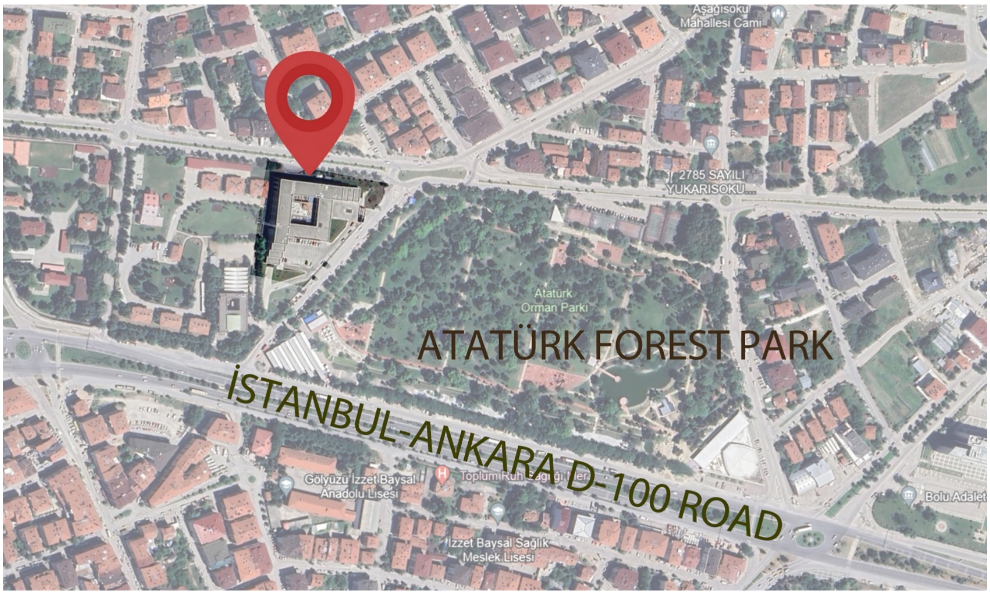

Figure 3. Project site (produced by the author).

3.2. Conceptual Frame of the Design

Seamon (1982; 1987) defines the dimensions of the person–space relationship by analyzing the daily experiences of places, spaces, and environments and states that the dialectic of space (inside–outside) is the essence of the experience of space. The site's strong relationship with the largest open green area in the city center has also influenced the building's general shaping decisions. The dominant façade of the building is terraced towards the upper floors to strengthen the relationship with the dominant landscape. The general form of the building consists of administrative units located around a square inner courtyard to achieve a dialectic of inside-outside concept, while Inner courtyards and gardens significantly impact a public building's circulation and light. On the other hand, the north and west corridors on the ground floor gradually decrease in length on the upper floors and turn into open terrace areas. Due to the receding floor plans on the upper floors, open areas were transformed into small terrace gardens. Also, this structuring enables users to view the forest park from the administrative upper floors (Figure 4).

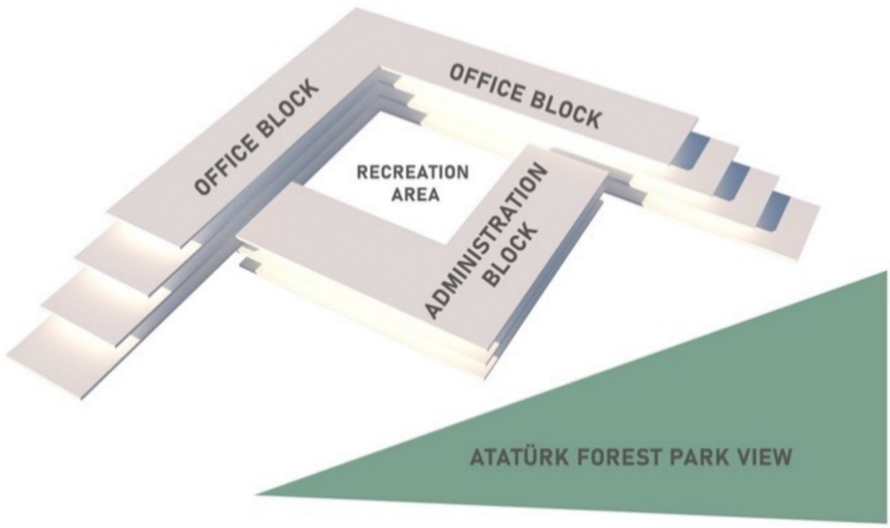

Figure 4. Graphical layout of the design (produced by the author).

Norberg-Schultz (1980) discussed the concept of place through a sense of belonging, orientation, and identification, of which its essence could be amounted to the "atmosphere" of that place. Therefore, the structure of the place is defined by its landscape, settlement, space, and character. Based on this discourse, an attempt was made to create an atmosphere in which the sense of belonging could be strengthened by providing orientation with the designed corridor system and, at the same time, visually increasing the indoor-outdoor relationship. However, the building's main characteristic is being an office building, necessitating a corridor-based approach. The interior garden aims to maintain recreation and strengthen the bright and green perception of the corridor spaces. The main design decision is based on the accessibility of spaces and the legibility of their relationships. A design approach with an inner garden connecting the corridors was preferred to maintain architectural designs that are readable and perceivable environments that contain elements that are relatively simple, coherent, comprehensible, and organized, as Lynch (1960) described.

3.3. Design Process

The main design for the building consists of a basement, ground floor, and three additional floors with a total construction area of 16,509 m2. The building was designed to accommodate several directorates, such as the Aladağ Forestry Operation Directorate, Bolu Forestry Operation Directorate, Bolu Forestry Operation Directorate, National Parks Directorate, and Research Directorate, which are within the Bolu Regional Directorate of Forestry, within a single building, with each floor divided into one or two different operation directorates. The main request for the design was for the growing Operation Directorate units to be together under one roof. In addition to the desire for each unit to have its own space, accessibility between units was also considered important. A meeting room within the building where the units could come together, and meetings could be organized on a provincial and national scale when necessary was also a prime necessity. Another factor influencing design decisions is that building owners approach the overall identity of the building as a matter of regional prestige. For this reason, the landscape factor, which effectively shapes the building's basic form, has caused the management and protocol spaces to be considered in this area. In the square-based plan scheme, the corners are handled as core spaces for vertical circulation, and the corner of the building that establishes a relationship with the landscape view is designed for the upper management units.

As in detail, the ground floor plan, which has a construction area of 3,490 m2, includes the Aladağ Forestry Operation Directorate and Bolu Forestry Operation Directorate. The building is entered through a large entrance hall designed toward the Forest Park. In addition, a second personnel entrance to the west of the building provides access to the lodging area. The building has five staircases and four elevator units to ensure vertical circulation. In addition to the administrative (protocol) stairs and elevator area in the entrance hall, there are also stairs and elevators in the administrative unit corridors. This floor has a 300 m2 meeting room with a foyer directly opposite the entrance hall. This hall is located under the inner courtyard of the building and is an area that interacts with the open garden areas on its right and left sides (Figure 5).

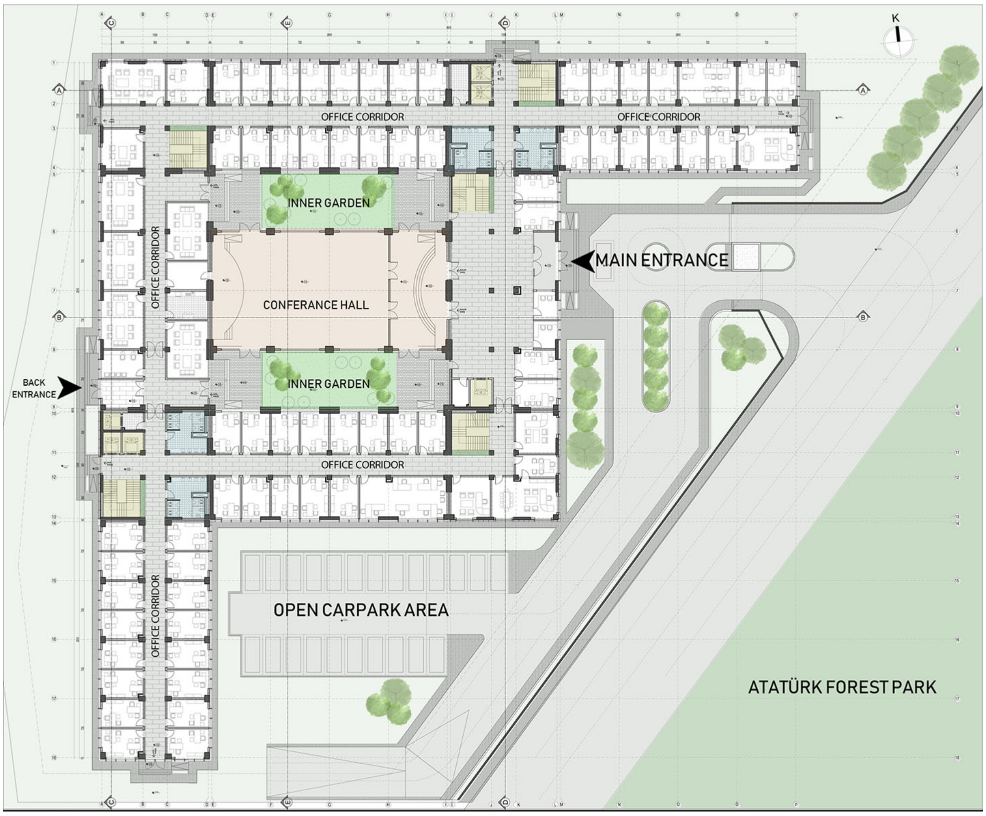

Figure 5. Ground floor plan (produced by the author).

In the preliminary design process, the north wing of the ground floor was designed as an exhibition hall for forestry science. In this area, an interaction was intended to occur between the public and forestry. However, later in the design process, the management changed. The new management wanted to convert this area into an office space.

The first floor has a construction area of 2,858 m2, and the entire floor is reserved for Bolu Regional Directorate of Forestry. This floor is directly above the entrance hall, where the Regional Directorate waiting hall and the Manager’s room are located. Direct access to this area is via the protocol staircase in the ground floor entrance hall. From this floor, there is access to the planted inner courtyard terrace area of the building (Figure 6).

Figure 6. First floor plan (produced by the author).

The most important area on this floor is the roof terrace courtyard created by the conference hall located on the lower floor. The open courtyard system, which exits from the wide corridor area created in the block where the administrative units are located, is designed to allow employees to access fresh air during the day.

Although the concept of environment is defined with different meanings by various disciplines, when associated with behavior it is considered a social environment that is shaped and given meaning by the physical space (Proshansky et al., 1983; Barker, 1968; Golledge, 2001). Public service, one of the most fundamental areas that supports and organizes the quality of social life, is essential in terms of its potential to define a social interaction environment rather than just being considered a daily business practice.

The second floor covers a construction area of 2,667 m2, and the National Parks Directorate and the Research Directorate are located on this floor. On this floor area, administrative units are located in line with the needs of the relevant directorates (Figure 7). The floor setup consists of office units lined up along the main corridor. Thanks to the ascending and gradual design, it is aimed to break the long monotony of the floor layout.

Figure 7. Second floor plan (produced by the author).

The third floor has an area of 1,518 m2. On this floor, the Regional Directorate, a dining hall, and a prayer room are found. Guest restrooms were designed before the terrace areas at the end of the corridors. The view of Bolu can be seen from the terraces created by the general architectural form of the building, and especially on the last floor, the dining hall and recreation areas are allowed to connect with the view of the Bolu (Figure 8).

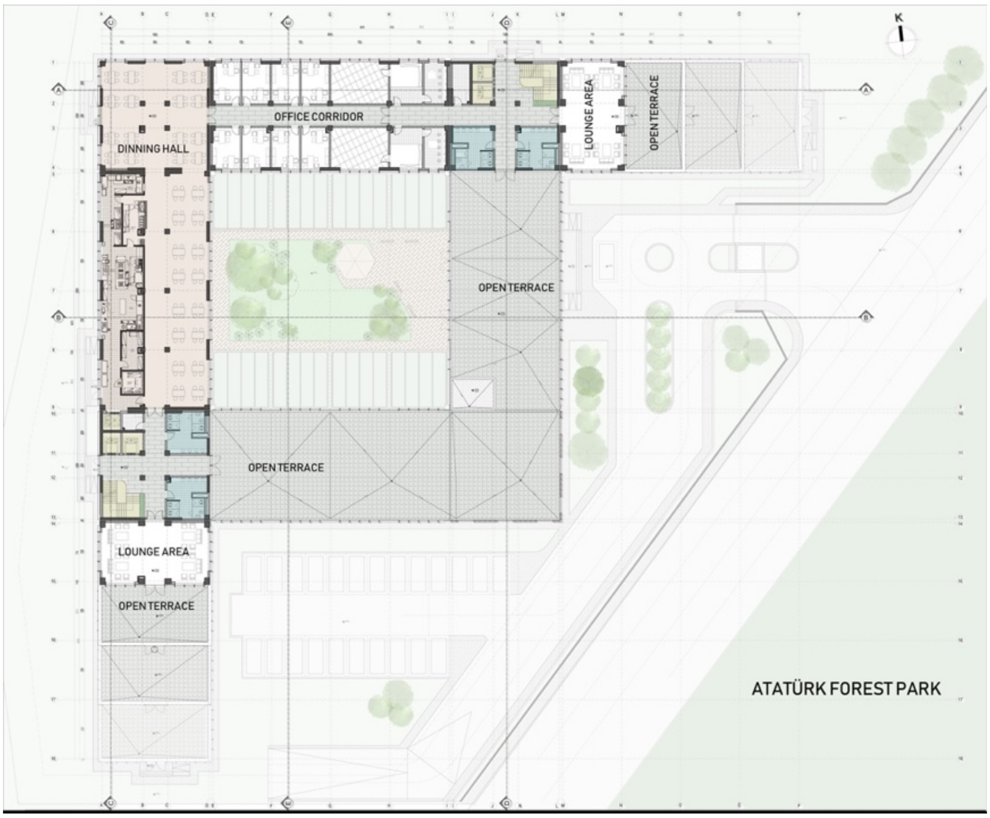

Figure 8. Third floor plan (produced by the author).

Due to its dominant view, the top floor was designed as a entirely closed recreation area at the initial design phase. Just as the exhibition area on the ground floor was converted into office units, the initial design decisions for the top floor were also abandoned. At the first stage, the space was designed entirely as a dining area and guest reception area, but the dining area was reduced in size, and office units and prayer area were added to the northern corridor.

The building, which has a total basement floor construction area of 3,900 m2, includes the shelter area directly under the inner garden and archive and warehouse units belonging to the Directorates. In addition, laboratory areas have also been designed and are suitable for use when needed. Furthermore, a total of 2,076 m2 is designated for an indoor parking area with a capacity of 32 cars, 25 pickups, and a car wash area on the basement floor. This area is accessed via a ramp behind the open car parking area for 23 vehicles in the south of the building (Figure 9).

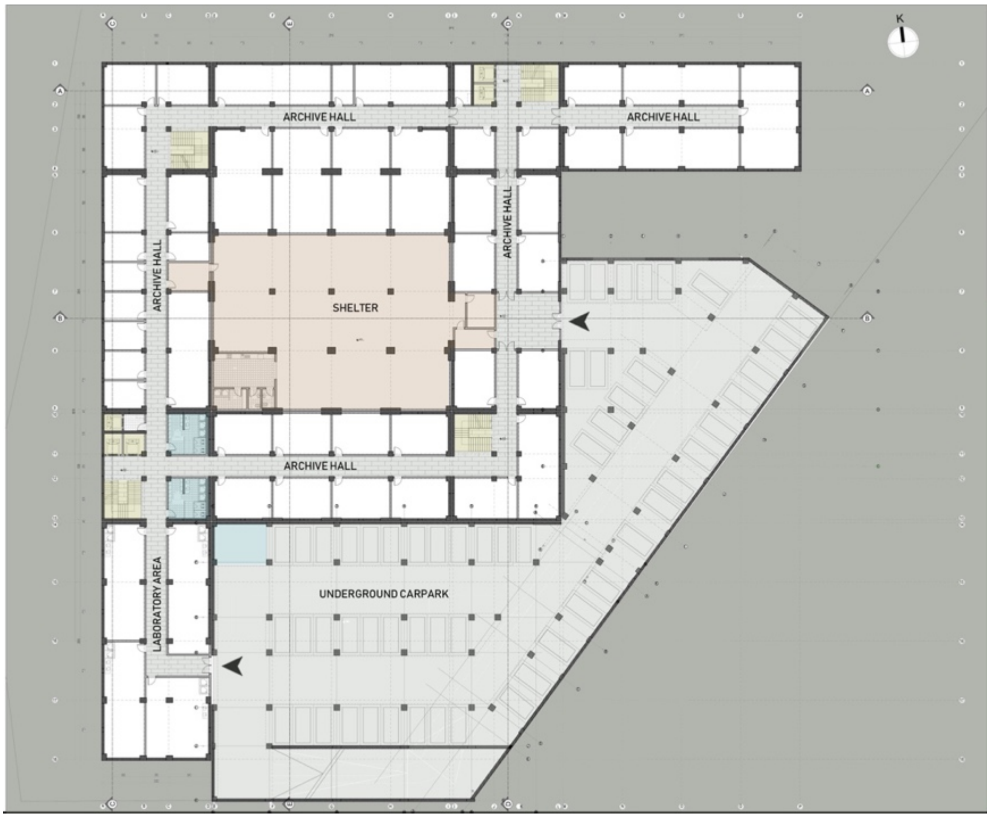

Figure 9. Basement floor plan (produced by the author).

The design of office buildings significantly impacts the productivity, well-being, and overall satisfaction of the employees who occupy them. One crucial aspect of office design that has been gaining increasing attention is the concept of spatial flexibility (Shahu, 2017; Gibson, 2003). The top three factors determining employee productivity are comfort, access to people and equipment, privacy, and flexibility (Zawawi et al., 2014). These factors are all closely tied to the spatial configuration and layout of the office (Gibson, 2003). Employees desire access to the spaces and resources they need to execute their tasks efficiently and opportunities for privacy and social interaction (Anuar et al., 2019).

As the nature of office work continues to evolve, the demand drivers for office space are also changing with the increasing use of information and communication technologies (Gibson, 2003). Flexible workspaces that can accommodate a variety of work styles and activities are becoming more important. For this reason, the size of the office units in the corridor area has been altered based on the main axes of the building. Administrative room units throughout the building are derived from 340x500 cm dimensions. Room dimensions are as follows: 340x500, 705x500, and 1060x500 cm. The basic room types, with an area of 17 m2 for 340x500 cm dimensions, are designed to accommodate two staff members and a third external person (Figure 10). Larger volumes are intended for meetings and situations where more staff need to congregate. Volumes smaller than these ratios are generally reserved for technical and warehouse use. The primary purpose of this design is a flexible structuring proposal for office spaces that might be needed in the future. When there is a need for expansion in office areas, it is aimed to have new large areas on the floors with minimum space, using fixed axes.

Figure 10. 340x500 cm2 plan of a typical office layout (produced by the author).

An important purpose of the design was to allow visual access of the Atatürk Forest Park with stepped terraces. While achieving this, the Atatürk Forest Park should be visible from the end of the office corridors with the stepped terraces. In addition, alternative outdoor recreation is created for spaces where the Forest Park cannot be seen. With the central courtyard, the interior offices are to benefit from natural light. The terrace roof of the conference hall in the middle area can also be used as a recreational area and is designed to be accessible to all employees. Alternative outdoor recreation areas were created with interior gardens at two different elevations, allowing users to access them (Figure 11).

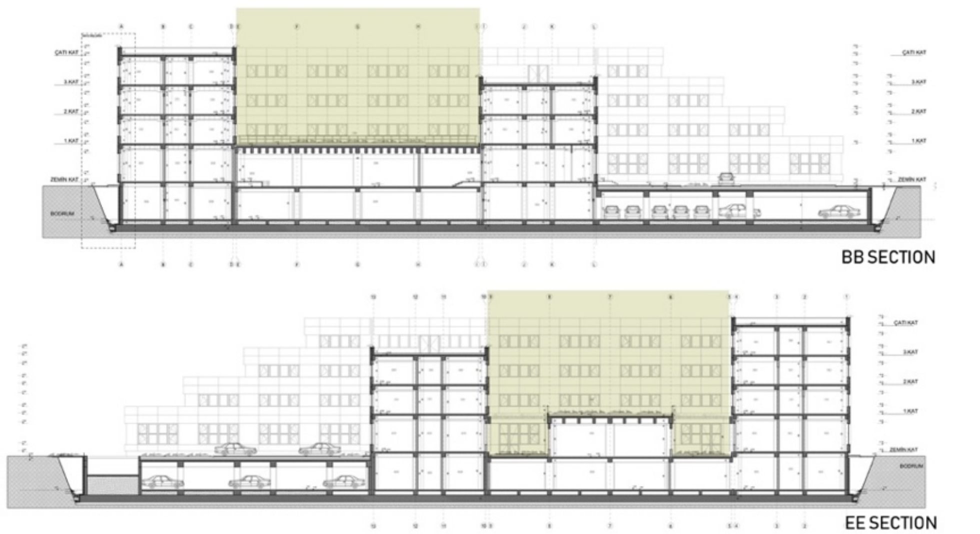

Figure 11. Selected sections of the building (produced by the author).

When making aesthetic decisions, the building was evaluated as a whole. Priority was given to strengthening the perceptual form of the building and strengthening the visual interaction with the inner garden. The conceptual stance of the area and the building's design problem is related to the tradition to the future. It has been deemed appropriate to use wooden vertical panels, a traditional material, and composite coating systems, which can be considered as a modern material. An attempt was made to achieve form-based balance with vertical elements in the window openings to manage the horizontal form of the area and the building (Figure 12).

Figure 12. 3D model of the building (produced by the author).

4. CONCLUSIONS

The design of administrative buildings is often seen as a cultural object closely tied to a particular social context and the historical moment of the nation. Public buildings, fundamental elements in forming common culture and social belonging, also appear as prestigious buildings with their official identities. This paper uses the paradigm of structuralism and the principles of semiotics as a methodological approach to analyze the Bolu Regional Directorate of Forestry building. The architect's design principles emphasized local and regional characteristics to highlight the role of environment and culture. The design process of the building was intended to meet maximum physical requirements and to strengthen the social and emotional relationship with the building and its spaces. In other words, in the Bolu Regional Directorate of Forestry building, which contains both public and official identity, the spatial organization designed in line with the needs program and the symbolic identity of the building are aimed to come to the fore with structural movements on the facade. In the design process, the relationship of the spaces with each other and with the user was considered. Possibilities for growth aligned with future needs have been explored, and solutions have been produced accordingly. In the design, the architectural form of the building and the details on the facade are aimed at reflecting and contributing to the identity of the building.

This study is an example of the conceptual approach to considering the spatial needs of a public building design nourished by traditions and aimed at directing the future. The building, for which the design process and scope have been described, was open for use at the end of 2022. In the future, evaluating the design performance of the building through post-use evaluation analyses can provide important information to shed light on basic design approaches in public buildings.

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A METHODOLOGICAL ANALYSIS FOCUSED ON COMBUSTION PROPERTIES FOR THE USE OF IMPREGNATED WOOD IN ARCHITECTURE

MİMARİDE EMPRENYELİ AHŞAP MALZEME KULLANIMI İÇİN YANMA DAVRANIŞINA ODAKLI YÖNTEMSEL BİR ANALİZ

Habibe ÖZTÜRK*, Z. Sevgen PERKER**

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*
Yüksek Mimar

Master Architect

ORCID: 0009-0001-6769-0486

habibeeoztrk@gmail.com

**
Mimarlık Bölümü,
Bursa Uludağ Üniversitesi,
Bursa / Türkiye

Department of Architecture,
Bursa Uludağ University,
Bursa / Turkey

ORCID: 0000-0002-6640-111X

zsperker@uludag.edu.tr

ABSTRACT

Wood has superior properties, enabling it to be used in architecture throughout history. On the other hand, wood is one of the primary materials of sustainable architecture. However, wood can be damaged at various levels depending on the type and magnitude of the negative factor it encounters. It is necessary to ensure for wood to be resistant to adverse factors and to have a long life in terms of efficient use of raw material resources. Fire, which results from out-of-control burning, has caused damage or loss of some architectural structures throughout history. In order to increase the fire performance of architectural structures where wood is used as a material, structural solutions such as taking construction measures, providing sufficient cross-sections, and designing heat-resistant element combination details can be produced. However, it is also essential to take precautions on a material scale. In this context, this study aims to analyze experimental research focusing on the combustion properties of wood and to provide a guiding holistic diagram that can help architects select impregnated wood focusing on combustion performance.

Keywords: Architecture, Building Material, Combustion, Impregnation, Wood.

ÖZET

Ahşap, tarih boyunca mimarlık ürünlerinde yer almış, üstün özellikleri olan bir malzemedir. Diğer yandan ahşap, sürdürülebilir mimarlığın başlıca malzemelerinden biridir. Bununla birlikte ahşap, karşılaştığı olumsuz etkenin türü ve etki büyüklüğüne göre, çeşitli düzeylerde zarar görebilmektedir. Ahşabın olumsuz etkenler karşısında dayanım gösterebilmesi ve hammadde kaynaklarının verimli kullanımı açısından uzun ömürlü olmasının sağlanması gerekmektedir. Kontrolden çıkan yanma olayının bir sonucu olan yangın, tarih boyunca birtakım mimari yapıların zarar görmesine veya yitirilmesine neden olmuştur. Malzeme olarak ahşabın kullanıldığı mimari yapıların, yangın karşısındaki performanslarının yükseltilmesi amacıyla; konstrüksiyon önlemleri alma, yeterli kesit sağlama, ısıya dayanıklı eleman birleşim detayları tasarlama gibi yapısal çözümler üretilebilmektedir. Bununla birlikte, malzeme ölçeğinde de önlem alınması önem taşımaktadır. Bu bağlamda bu çalışmanın amacı, konuyla ilgili deneysel araştırmaları analiz ederek, ahşabın yanma özelliklerinin olumlu yönde geliştirilmesini sağlayan emprenye uygulamalarını bütüncül olarak ortaya koymak ve böylelikle mimarların, emprenyeli ahşabın yanma performansı odaklı seçimlerine yardımcı olabilecek, rehber niteliğinde bir diyagram sunmaktır.

Anahtar Kelimeler: Mimarlık, Yapı Malzemesi, Yanma, Emprenye, Ahşap.

1. INTRODUCTION

Throughout the ages, wood has enabled the production of architectural products that reflect the cultural traces of human life. An essential part of the universal cultural heritage consists of structures produced using wood. It is an important responsibility to transfer these structures to future generations. On the other hand, wood, which is the primary material of architectural products compatible with the climate and healthy for humans and the environment in every geography where it is used, is also of great importance for the future of sustainable architecture.

Wood has superior properties, enabling it to participate in the building tradition throughout history. However, wood may deteriorate due to some negative factors (Perker, 2004; Perker & Akıncıtürk, 2006). It is possible for wood to be resistant to adverse factors and to have a long life in terms of efficient use of raw material resources. Although various applications improve the wood against negative factors, impregnation is the most common (Bozkurt et al., 1993). Impregnation, which means deep protection of wood using various substances, can be applied for different purposes.

Wood is used as a building material. Parts of the building, such as walls, floors, stairs, roofs, carriers, joinery, and coating, can be involved in various tasks. Since the function of each building element is different, the performances expected from each element also vary. On the other hand, the type of wood produced for each building element using wood, the shape, and dimensions of the element are also different. All of these cause the behavior of building elements made of wood to differ in the face of negative factors. This necessitates impregnation applications focused on specific performances in some buildings instead of general-purpose impregnation processes extending wood's service life against various influences.

Fire, which results from out-of-control combustion, is a disaster that can lead to loss of life and property if precautions are not taken. Fires that have occurred in the world, from past to present, especially in historical settlements or structures, have caused significant losses in the universal architectural heritage and caused the continuity of architectural culture to be interrupted. Against fire in wooden structures, Structural solutions such as taking construction measures, providing sufficient cross-section, and designing heat-resistant element combination details can be used (Kılıç, 2011; Şimşek, 2020). In addition to the mentioned precautions, applications such as protecting wood and extending the durability period by reducing the combustion rate of the material can also be carried out (Akıncıtürk & Perker, 2003). In this sense, impregnation research and applications focusing on the combustion properties of wood is gaining importance.

There are various experimental studies on impregnating wood in Turkey-based literature. However, in the relevant literature, holistic research that can guide and help architects select impregnated wood based on combustion performance has yet to be found. In this context, this study aims to analyze experimental research on the subject and to present a holistic scheme as a guide for impregnation applications that enable improvement of the combustion properties of wood.

2. WOOD IN ARCHITECTURE

Wood is used in architecture; production methods can be handled in two ways: natural and engineered. As a result of the processes of cutting trees, drying them, shaping and sizing them as required by the element to be used in the structure, the material used in architecture is called natural wood (Kartal, 2015). Natural wood can generally be applied as structural elements, cladding, joinery, and interior architectural elements in architectural structures (Öztürk, 2024) (Figure 1, 2, 3, 4).

Figure 1. Structural wood in architecture (Izba) (Ancient wooden Russian hut in winter, 2024)

Figure 2. Use of wood on the facade (Fidan, 2018)

Figure 3. Use of wood in door and window (Codden, 2024)

Figure 4. Use of wood in roof and flooring (Stock, 2024)

Engineered wood used in architecture is obtained by combining wood fibers or particles with resin and other binders. Engineered wood types such as GLT (Glued Laminated Timber), LVL (Laminated Veneer Lumber), CLT (Cross Laminated Timber), OSB (Oriented Strand Board), MDF (Medium Density Fiberboard), Plywood can be used for various purposes in architecture. The discovery of engineered wood made using smaller diameter tree trunks and other industrial waste possible. Engineered wood can be produced in a more resistant and homogeneous structure compared to natural wood, and it finds a wide range of uses in architecture due to the variety of shapes and sizes it offers (Çolak & Değirmentepe, 2020; Demir & Aydın, 2016).

Engineered wood is generally applied as a structural element, cladding, panel, or interior architectural element in architectural structures. Engineered wood is frequently preferred for floor and ceiling claddings, wall panels, or interior architectural elements in indoor spaces of architectural buildings. In addition, engineered wood in architecture can be used as facade cladding, roof, and floor cladding, etc. (Coşkun & Yardımlı, 2022) (Figure 5, 6).

Figure 5. GLT beam and plywood ceiling cladding - LeMay Museum, Tacoma / ABD (LeMay Museum / LARGE Architecture, 2024)

Figure 6. CLT facade - OMM, Eskişehir / Türkiye (Menezes, 2019)

3. THERMAL PROPERTIES AND COMBUSTION BEHAVIOR OF WOOD

Natural wood has low thermal conductivity because it contains air due to the heat-resistant properties of its essential component, cellulose, and its porous structure. However, the thermal conductivity of wood may vary depending on the moisture in the wood, its type, and fiber direction (Perker, 2004).

The low thermal conductivity of natural wood delays the outer surface temperature of the wood from reaching the inner parts of the wood in the event of a possible combustion. This feature is considered an advantage for wood in case of fire (Özgünler et al., 2002).

On the other hand, natural wood expands when exposed to heat and contracts when cooled. However, these expansion and contraction rates are pretty small in wood compared to other materials. This feature is interpreted as an advantage in preserving the structure's integrity in case of fire, as it causes the volume of the wood to expand very little in case of fire (Anonymous, 1980; Örs & Keskin, 2001).

If the natural wood comes into contact with an element at a high temperature, decomposition occurs in the cellulose and hemicellulose molecules, and the material is damaged. In case of fire, wood dries up to 1700C, releases CO, CO2, and water vapor up to 2700C, and ignites between 2500C and 3000C. The encounter of the released hot gases with O2 in the environment causes the combustion to continue. As long as the combustion process continues, the cross-section of the wooden element decreases. If the cross-section of the wooden element falls below the safe cross-section, the system collapses (Özgünler et al., 2002).

On the other hand, the combustion behavior of processed wood depends on the type of tree from which it is produced and the combustion behavior of other raw materials used in its production. In addition, the shape and dimensions of engineered wood also significantly affect its combustion properties. Thin and dry veneer sheets may be more susceptible to fire due to their large surface area and may catch fire quickly. However, the risks can be reduced when these boards are applied on solid wood or chipboard or turned into plywood. The surface-to-volume ratio is an important factor that determines the sensitivity of the material to fire (Göker & Ayrılmış, 2002; Peker & Atılgan, 2015).

Engineered wood can also produce various gases of a flammable nature when exposed to high temperatures. Flammable gases can cause fire to spread rapidly and endanger people's safety (Ayrılmış, 2006).

4. IMPREGNATION IN WOOD PROTECTION

Impregnation is the process of deeply protecting wood with various substances to increase its durability against different effects. Impregnation methods are commonly discussed under two headings. These are non-pressure methods and pressure methods. Methods that do not apply pressure include: It is classified under four headings: brushing or spraying, dipping, hot-cold bath, and soaking methods. Methods where pressure is applied are; It is discussed under four headings: full-cell method, empty-cell method, vacuum process, and oscillating pressure process (Bozkurt & Erdin, 2011; Örs & Keskin, 2001; Öztürk, 2024).

Impregnation method to be applied: It varies depending on the type of tree from which the wood is obtained, the conditions of the environment, and the place of use. Impregnation of natural wood: This is done to increase the durability of wood against external factors such as moisture, insects, fungi, and fire and to extend its life. If natural wood is to be impregnated with chemicals before being placed in its place of use, pressure-applied methods are generally preferred. In these methods, chemicals penetrate the wood. If natural wood is placed at the place of use without being impregnated with chemicals, protective substances are generally applied to the surface by brushing or spraying (Bozkurt & Erdin, 2011).

Impregnation methods used for engineered wood vary depending on the type of tree from which the wood is obtained and its intended use. The impregnation process is mainly applied to board products by either adding it to glue, chips, or fibers during the production stage or by dipping it into the board with pressure, applying it with a brush, or spraying it after production (Ayrılmış, 2006).

It is very important to protect the wood used in architecture against fire. Fire protection aims to make it difficult for wood to catch fire and prevent fire spread. Fire inhibitors should make it harder for the wood to catch fire and deteriorate, reduce the rate of charring, prevent the flame from spreading at different levels, and stop combustion when the heat source is removed (Küçükosmanoğlu, 1993). When wood is effectively impregnated with fire-retardant substances, good protection against fire can be provided (Ayrılmış, 2006; Bozkurt & Erdin, 2011; Demir & Aydın, 2016). Thanks to the impregnation of wood with various substances, the combustion time of the material during a fire can be extended, and a safe escape opportunity can be provided in case of fire (Ayrılmış, 2006).

5. METHOD

The material to be studied within the scope of the research consists of academic articles with experimental content based in Turkey and published in Turkish. A search was made on the "DergiPark" database to obtain the research material with the keyword "impregnation." The articles encountered as a result of the search were examined in detail, and a list of articles focusing on the effect of impregnation on the combustion behavior of wood was prepared. Ten articles in the created list constituted the study material of this research (Table 1).

Table 1. Information about the articles in the dataset

Title of Journal	Authors, Year
Artvin Çoruh University Faculty of Forestry Journal	Atılgan & Peker, 2012
Düzce Universty Journal of Forestry	Var, 2008
Erciyes University Journal of The Institute of Science and Technology	Baysal, 2003
Journal of Advanced Technology Sciences	Yaşar & Atar, 2017
Journal of Bartın Faculty of Forestry	Özcan, 2019
Kastamonu University Journal of Forestry Faculty	Yuca et al., 2014
Pamukkale University Journal of Engineering Sciences	Yalınkılıç et al., 1998 Örs et al., 1999 Özen & Özçiftçi, 2001
Turkish Journal of Forestry	Aslan & Özkaya, 2004

Within the scope of the research, first of all, a table was created containing the titles, journal names, authors, and years of the articles that constitute the study material. Then, the contents in the articles, the tree/wood type, impregnation material, and impregnation method, were analyzed and evaluated regarding the effect of impregnation on the wood's combustion properties.

6. RESULTS AND DISCUSSION

It was determined that the type of wood used in the studies covered within the scope of the research was in two different categories: natural wood and engineered wood. The wood used include softwood such as Scots pine, Douglas fir, red pine, Anatolian black pine, and Cedar of Lebanon. Hardwood species include oriental beech, quercus petraea, walnut, eucalyptus, black poplar, and beech (Table 2).

WOOD SPECIES			ARTICLES 1	2	3	4	5	6	7	8	9	10
NATURAL WOOD	SOFTWOOD	Scotch Pine				X			X		X	
		Douglas Fir	X									
	HARDWOOD	Oriental Beech							X		X	
		Quercus Petraea									X	
		Walnut										X
		Eucalyptus		X								
ENGINEERED WOOD	SOFTWOOD	Red Pine						X				
		Scotch Pine			X							
		Anatolian Black Pine						X				
		Cedar of Lebanon						X				
	HARDWOOD	Black Poplar					X	X				
		Beech								X		

Table 2. Wood species used in the articles (Table 2 was prepared by the authors using the sources in Table 1)

It was observed that four different groups of impregnation materials were used in the studies covered within the scope of the research. Natural preservatives include colophon (pine resin), fruits of oaf tree, red pine bark, sumac leaf abd valex (acorn) extract, and alkyd resin from oil-borne preservatives. The water-borne preservatives used in the studies are ammonium sulfate (AS), ammonium tetra fluoroborate, borax (Bx), boric acid (BA), cement-borax mixture, copper azole, copper-chrome-borate (Tanalith-CBC)/(Wolmanit-CB), diammonium phosphate (DAP), Immersol-WR 2000, monoammonium phosphate (MAP), phosphoric acid (PA), polyethylene glycol (PEG-400) / (PEG-1000), potassium carbonate, pyresote (Pyr), sodium borate, sodium silicate, sodium tetraborate, Vacsol-WR, zinc chloride. Among organic solvent impregnation materials, Styrene (St), Methylmethacrylate (MMA), and Isocyanate (ISO) were used. (Table 3).

PRESERVATIVES		ARTICLES 1	2	3	4	5	6	7	8	9	10
NATURAL	Colophon (Pine Resin)						X				
	Fruits of Oak Tree				X						
	Red Pine Bark				X						
	Sumac Leaf				X						
	Valex (Acorn) Extract				X						
OIL-BORNE	Alkyd Resin						X				
WATER-BORNE	Ammonium Sulfate		X								X
	Ammonium Tetrafluoroborate							X			
	Borax	X	X		X	X	X				X
	Boric Acid	X	X		X		X		X		X

Table 3. Preservatives used in articles (Table 3 was prepared by the authors using the sources in Table 1)

	Cement-Borax Mixture							■			
	Copper Azole									■	
	Copper-Chrome-Borate		■	■		■	■			■	
	Diammonium Phosphate										■
	Immersol-WR 2000		■	■			■				
	Monoammonium Phosphate	■									
	Phosphoric Acid	■									
	Polyethylene Glycol	■	■								
	Potassium Carbonate					■					
	Pyresote	■									
	Sodium Borate			■							
	Sodium Silicate										■
	Sodium Tetraborate			■							
	Vacsol-WR		■								
	Zinc Chloride										■
ORGANIC SOLVENT	Isocyanate	■									
	Methyl Methacrylate	■									
	Styrene	■									

In studies on the effect of impregnation on the combustion behavior of wood, it is seen that both non-pressure and pressure methods are preferred as impregnation methods. The studies preferred brushing/spraying, and dipping methods as impregnation methods without applying pressure. Vacuum methods were used as the pressure-applied method (Table 4).

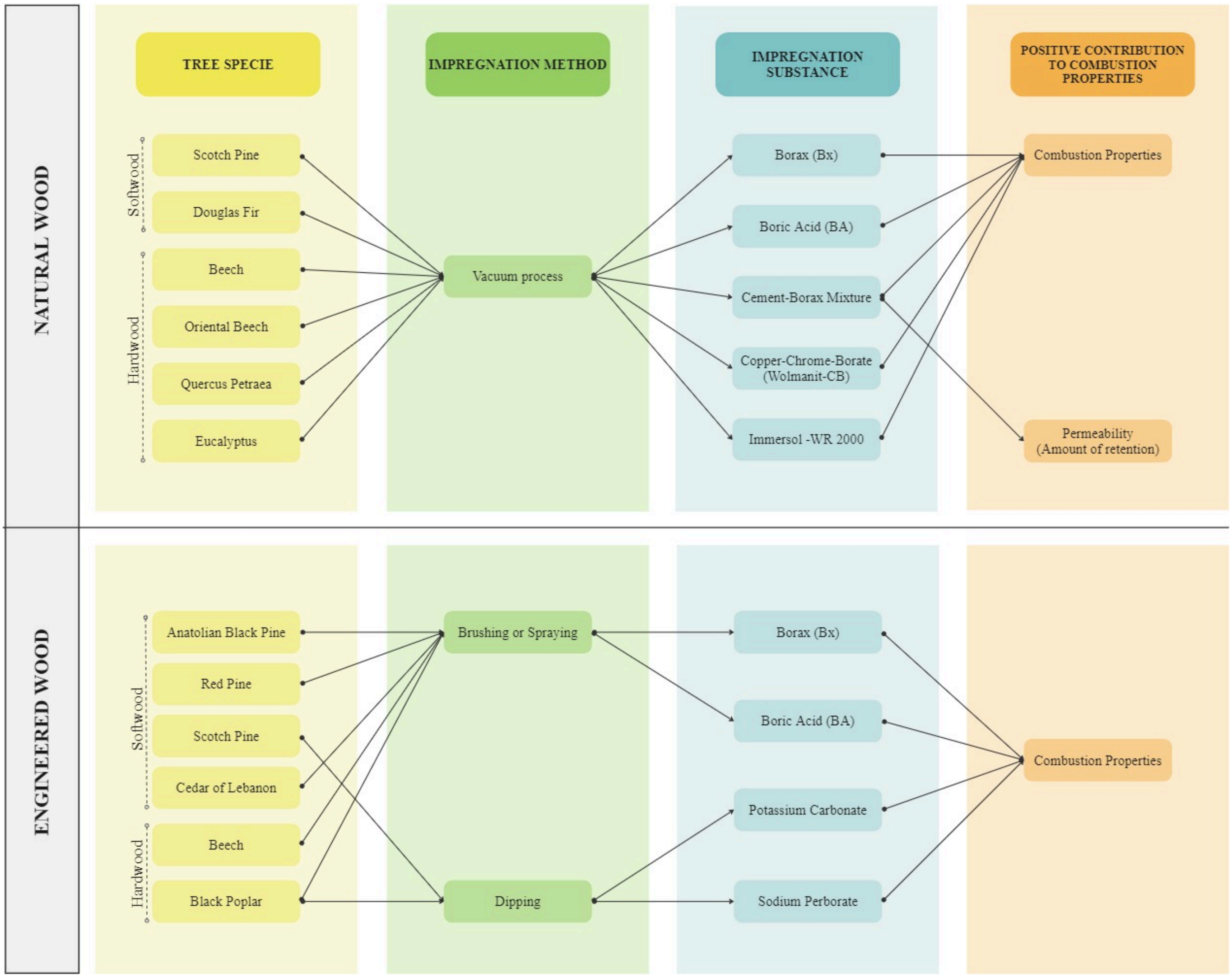
IMPREGTANION METHODS		ARTICLES									
		1	2	3	4	5	6	7	8	9	10
NON-PRESSURE	Brushing or Spraying					■	■		■		
	Dipping			■		■					■
	Hot-Cold Bath										
	Soaking										
PRESSURE	Full Cell Process										
	Vacuum process	■	■		■			■		■	

Table 4. Impregnation methods used in articles (Table 4 was prepared by the authors using the sources in Table 1)

In studies focusing on the effect of impregnation on the combustion behavior of wood, the change in the combustion properties of wood was evaluated based on factors such as the material's combustion resistance, flammability properties, and ignition temperature. In this context, when the combustion resistance of the wood is high and its flammability is low due to the impregnation process, this is described as a positive development in terms of the combustion behavior of the material. In the studies discussed, it was determined that boron compounds (boric acid, borax) used as impregnation materials have properties that increase the combustion resistance of the material (Yalınkılıç et al., 1998; Baysal, 2003; Var, 2008; Yuca et al., 2014). It has been determined that the impregnation material named Wolmanit-CB has properties that increase the material's combustion resistance due to its boron component (Yaşar & Atar, 2017). As an impregnation agent, potassium carbonate is one of the substances that positively affects the material's combustion behavior (Aslan & Özkaya, 2004). However, it has been observed that the combustion resistance of natural tanning materials is insufficient due to the flammable components they contain, and Tanalith-CBC has high flammability properties (Baysal, 2003; Özen & Özçiftçi, 2001; Örs et al., 1999). In some of the studies focusing on the effect of impregnation on the combustion properties of wood, it has been determined that the wood type, impregnation material, and impregnation method used affect the permeability properties as well as the combustion properties of the wood. The change in permeability values that affect the effectiveness of the impregnation in wooden materials varies according to the amount of retention. Accordingly, as the amount of retention increases, its permeability, such as its impregnation efficiency, also increases. Related studies also determined that Vacsol and the cement-borax mixture had high retention rates (Örs et al., 1999; Atılgan & Peker, 2012; Öztürk, 2024).

As a result of analyzing the experimental studies included in the research, a scheme was created that holistically reveals the positive effect of impregnation on the combustion behavior of wood (Figure 7). The diagram includes research results that positively affect the combustion behavior of wood.

Figure 7. Scheme for the Positive Contribution of Impregnation to the Combustion Behavior of Wood (Figure 7 was prepared by the authors using the sources in Table 1)



When the findings obtained within the scope of the research are compared based on natural wood samples, It is observed that impregnation materials such as borax, boric acid, cement-borax mixture, copper-chrome-borate (Wolmanit-CB), and Immersol WR 2000 used with the vacuum process method have a positive effect on the combustion behavior of natural wood. The specified method and impregnation materials are natural softwood species such as Scotch Pine and Douglas Fir. It is understood that it is effective on natural hardwood species: Beech, Oriental Beech, Quercus Petraea, and Eucalyptus.

When the findings are compared based on engineered wood samples, it is seen that impregnation substances such as borax and boric acid, used with the brushing or spraying method, and potassium carbonate and sodium perborate, used with the dipping method, have a positive effect on the combustion behavior of engineered wood. It is understood that substances such as borax and boric acid used together with the brushing or spraying method are effective on engineered wood samples, especially Anatolian black pine, red pine, Scotch pine, cedar of Lebanon, which are softwood species, and beech-based engineered wood samples, which are hardwood species. It is observed that impregnation materials such as potassium carbonate and sodium perborate used together with the dipping method are effective on black poplar-based engineered wood samples from hardwood species.

7. CONCLUSION

Within the scope of the research, ten articles written in Turkish, obtained from the DergiPark database, and focusing on the effect of impregnation on the combustion behavior of wood was systematically analyzed. Contents of the articles within the scope of analysis: tree/wood type, impregnation material, impregnation method, and the effect of the impregnation process on the combustion properties of the wood are discussed.

In some studies, focusing on the effect of impregnation on the combustion behavior of wood, the treatment was carried out on natural and engineered wooden samples. In experimental studies conducted on natural wood samples, it has been determined that natural, water-borne, or organic solvent impregnation materials are used as impregnation materials. In studies that conducted experimental research on engineered wood samples, it was observed that natural, oil-borne, or water-borne preservatives were used as impregnation materials.

In experimental studies conducted on natural wood samples, it was determined that both pressure and non-pressure methods were used as impregnation methods. In the studies conducted on engineered wood samples, it was seen that only vacuum methods were used as an impregnation method among the methods that do not apply pressure.

When the findings obtained from the research are evaluated for use in architecture, it is seen that borax, boric acid, and cement-borax were used with the vacuum process method to improve the combustion behavior of Scotch Pine, Douglas Fir, Beech, Oriental Beech, Quercus Petraea, which are natural wood species that are likely to be used in architectural structures. Impregnation materials such as mixture and copper-chrome-borate come to the fore. In order to improve the fire behavior of engineered wood that can be used in architecture, impregnation materials such as borax or boric acid are noteworthy, especially for softwood species such as Anatolian black pine, red pine, Scotch pine, and cedar of Lebanon-based products, along with the brushing or spraying method. For black poplar-based products, it can be concluded that impregnation materials such as potassium carbonate, sodium perborate, and the dipping method are beneficial.

As a result of the research, a scheme was created that holistically reveals the positive contribution of impregnation to the burning behavior of wood. It is believed that architects can use the created scheme as a rational selection aid in the selection of impregnated wood.

Conducting new research on the combustion behavior of different types of wood that can be used in architectural structures and not covered in current research will contribute to the widespread use of wood in architecture. On the other hand, it is thought that studies of the different performances expected from wood to be used in architecture, together with its combustion behavior, will make valuable contributions to the use of wood in architecture.

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