THE TYPES OF TEXTILES USED IN THE FACADE AND ROOFING SYSTEMS OF STADIUM FACILITIES IN TURKEY

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ABSTRACT

Technical textiles are functional fabrics that have applications across including both construction (BuildTech) and architecture (ArchiTech). This technical textile is developed for high-tech and high-performance applications. In modern architecture, high-performance textile materials are highly valued and widely used in various applications, including self-cleaning, low-maintenance structures, fabric canopies, and energy-efficient buildings. They are also utilized for high-performance façades, energy-harvesting curtains, flexible mega-structures, responsive phase-change materials, air-supported fabric constructions, thermal regulation, green roofs, smart living spaces, acoustic solutions, advanced building materials, and creating habitable spaces in extreme weather conditions.

In this study, the types of textiles used in the facade and roofing systems of stadium facilities in Türkiye have been examined. The advantageous properties of textiles employed in stadium structures characterized by substantial roof and facade openings at the structural scale have been critically analyzed in relation to other conventional building materials. The technical textile material summary demonstrates the tremendous diversity of today's membrane materials using stadium facilities in Turkey.

KEYWORDS

Technical textiles; Stadium facilities; Facade and roofing system.

INTRODUCTION

Technology-driven materials, designs, and construction techniques play a major role in façades and roofing systems, becoming essential elements of modern architecture (Göppert and Paech,2015).

Technical textile provide limitless opportunities for architectural expression, allowing for free-form and complex geometries that are both structurally viable and economically appealing in stadium building.

In Architextile composite structures, the use of glass, ceramic, carbon fibers, aramids, liquid crystal polymers, and high-modulus polyethylenes provides textile materials with high performance and quality (Gezer, 2008).

In a building, façade cladding materials serve different functions based on their various applications. When assessing the potential demands for each cladding material, the following can be highlighted as the most important.

That are protection from external environmental conditions (wind, rain, temperature, sun, etc.), creation of private interiors, cladding to withstand outer loads (wind, temperature,maintenance loads, etc.), thermal performance, solar/light performance, fire behaviour, durability, acoustic performance, aesthetic surface appearance (translucency, colour, etc.), possible complex architectural geometries, material weight for substructure design, material cost, installation cost/time and modularity, maintenance requirements, and/or replacement methods, recyclability, sustainability (Göppert and Paech,2015., Hernández, 2006).

According to the literature, it can be observed that studies on the performance of textile materials used in the façades and roof coverings of stadium structures have focused on topics a, b, and c.

The relationship between early textile architecture in history and in modern period textile façade and roofing systems differs from a period where materials were applied in layer by layer to a more technologically advanced approach that integrates these layers together.

A wide variety of fabric materials are used in architecture. These are evaluated as PVC Fabric (PVC-Coated Polyester), PVDF, PVF, PTFE Fabric (PTFE Coated Fiberglass), Fabric options – PVC and

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PTFE, PVC / Polyester fabric, and PTFE / Fiberglass fabric (Gandi, 2020., Kamal, 2020).

In stadium structures, a wide variety of textile membrane composite materials are used in façade systems. Based on the expected demand requirements from these materials, combinations of various materials are utilized for textile membrane composites. Architectural fabrics are commonly woven from polyester (PES) yarns coated with polyvinyl chloride (PVC) or from glass fiber yarns coated with either polytetrafluoroethylene (PTFE) or silicone. The purpose of the coating is to shield the yarn fibers from environmental factors while also enabling individual membrane segments to be welded together. Uncoated fabrics are typically composed of PTFE or polyvinylidene fluoride (PVDF).

Uncoated fabrics are typically made from PTFE or polyvinylidene fluoride (PVDF). Textile membranes can either be fully coated to create a water- and wind-proof fabric with translucencies of approximately 0–40%, or woven with gaps between the yarns to form an open mesh membrane with localized yarn coatings. These mesh membranes are commonly used for sunscreens and architectural envelopes that provide views in two directions. Various mesh patterns are available, differing in size and arrangement of open areas. Both glass/PTFE and PES/PVC membranes come in multiple colors, with some being printable for a customized appearance. Depending on structural requirements, different strength classes are offered. Recently, laminated open mesh membranes have been developed, featuring a continuous lamination of transparent fluoropolymers, offering high transparency (>50%) and material strengths up to 60 kN/m (Göppert and Paech,2015).

Different fibrous materials shaped by knitting and weaving techniques in textile technology are also used in architectural façades (Gezer, 2007/a; Garcia, 2006). Woven and knitted fabrics made from metal fibers, as well as steel wire meshes, are examples of materials used in stadium façades.

The performance of fabric structures is significantly influenced by the environment in which they are located. Key factors affecting fabric performance include geographic latitude and temperature, UV radiation, humidity, pollution levels, dust accumulation, cleaning frequency, deposition of plant matter, staining from rainwater runoff, and exposure to rainfall that helps remove dirt and dust (Tolani, 2016., Kamal, 2020). The characteristics of textile materials used in stadium structures built in Türkiye have been grouped according to these factors. The grouping has been evaluated based on regions, taking into account the differing seasonal characteristics.

THE ROOFING MATERIALS USED IN STADIUM STRUCTURES

Factors determining the selection of roofing materials include climate, architectural and structural design, and cost estimation. The roof surface is a layer exposed to external elements. The roofing material must be resistant to atmospheric conditions. Therefore, the covering material should have water and thermal insulation properties, a long service life, and be lightweight while also conforming to the shape of the roof (Durgut, 2019).

MATERIAL PROPERTIES

Materials should be selected and designed according to the function of the structure. The materials used for the façade and covering systems of stadium structures directly affect user comfort. Therefore, the compatibility between structure and covering materials in stadium buildings is a crucial issue that must be addressed (Durgut, 2019). Materials have a direct impact on visual, acoustic, and climatic comfort. Technological advancements and innovations in façade and covering materials have brought criteria such as long-term durability, fire resistance, ease of replacement and repair, material permeability, sustainability, and user comfort to the forefront. With a material selected for its permeability feature, daylight can easily enter the field, ensuring the healthy growth of the field grass (Seçgin, 2023).

With advancing technology, newly developed materials are frequently preferred due to characteristics such as their lightness, strength, flexibility, and load-bearing capacity. Today, a wide variety of materials are predominantly used in stadium structures, including steel, concrete, new-generation plastics (ETFE, PTFE, PVC, etc.), aluminum, galvanized sheet metal, and smart materials.

PVC (Polyvinyl Chloride) and PVDF (Polyvinylidene Fluoride) Membrane Covering

While the lifespan of PVC is between 10 and 15 years, it can extend up to 25 years with a PVDF (Polyvinylidene Fluoride) coating. It offers a variety of colors and is more cost-effective than other building materials. PVC is waterproof and, with its light-transmitting property, allows natural light to enter the space, reducing the need for artificial lighting. It has strong UV resistance, high fire resistance, and is a lightweight, recyclable material (Alioğlu, 2018; Uğurlu, 2021).

PTFE (Polytetrafluoroethylene) Textile Membrane

PTFE is a textile material used in façade and covering systems, consisting of fiberglass fabric coated with Teflon resin. Commercially known as Teflon, it has a

lifespan of approximately 30-50 years and starts to degrade above 250 degrees Celsius. It offers strong UV resistance, high fire resistance, and reflects about 60% of light. It does not mold or yellow under atmospheric conditions and is waterproof. PTFE withstands temperatures ranging from -73°C to +232°C. Single-layer membrane structures made with PTFE reflect 75% of sunlight and absorb 10% of it (Krüger, 2009; Durgut, 2019).

ETFE (Ethylene Tetrafluoroethylene) Membrane Covering

ETFE is a fluorine-based plastic material used in air-supported covering systems, with a thickness between 0.05 and 0.20 mm. It has high light and UV transmittance, an approximate lifespan of 100 years, and is recyclable (Compagno et al., 2004; Durgut, 2019). ETFE allows 90-97% of light to pass through. Thanks to the air between the foil layers in ETFE cushions, it provides better insulation than glass panels. ETFE foils are flame-resistant and can withstand temperatures up to 270°C (Durgut, 2019). ETFE material can also be integrated with textile materials in façade and covering systems.

Carbon Fiber (CF)

Carbon fiber is a technologically advanced material with a fibrous structure composed of tar, nylon, and orlon, known for being rigid, lightweight, and durable. It offers high strength, is resistant to corrosion and fire, and is non-flammable. Although it is costly, its application requires specialized experience and equipment (Bajpai, 2013).

REVIEW OF STADIUMS IN TÜRKIYE ACCORDING TO ROOF AND FACADE MATERIAL SELECTIONS

In the literature, due to the direct impact of materials on comfort, Türkiye's 7 climate zones have been examined, and façade and roof covering material selections for stadium structures have been analyzed according to these regions. Table 1 provides an overview of technical textiles used in stadium architecture applications in Türkiye.

The use of textiles as façade and roofing materials is achieved through one of the textile types: plain PVC, perforated (mesh), PTFE (Teflon), and ETFE materials. When grouping these textile types according to regions, eight stadium structures built in the Marmara Region were examined. Of these, one stadium uses only PVC membrane covering, while three use a combination of PVC membrane covering and other cladding materials. One stadium uses both PVC membrane and PTFE textile covering along with other cladding materials. Another uses PTFE textile covering, one employs aluminum roofing, and another combines PVC membrane and PTFE textile coverings. Overall, a mixed covering system has been applied in five of the stadiums.

In the Aegean Region, four stadium structures were examined. Of these, two use only PVC membrane covering, one uses a combination of PVC membrane and other (composite cladding) covering systems, and one utilizes an alternative (polycarbonate cladding) system. In the Central Anatolia Region, five stadiums were studied; two of these use a mixed system of PVC membrane and other covering materials, while another two use a combination of PVC membrane and PTFE textile covering. Lastly, one uses an aluminum roof covering. In the Black Sea Region, three stadiums were analyzed, all of which share PVC membrane covering as a common feature. Among these, one employs a combination of PVC membrane and PTFE textile covering, one combines PVC membrane and other covering materials (PVC mesh), and one uses PVC membrane alone. In the Mediterranean Region, of the five stadiums constructed, two use PVC membrane alone, two combine PVC membrane with other covering systems (PVC mesh and standing seam roof), and one uses a combination of PVC membrane, ETFE membrane, and other (standing seam roof) systems. In Southeastern Anatolia, three stadiums were examined: one uses a mixed system of PVC membrane, PTFE textile, and other (GFRC, GRC precast) covering systems, one uses ETFE membrane, and one employs other (composite cladding). In Eastern Anatolia, two stadium coverings were analyzed: one uses PVC membrane, while the other combines polycarbonate and standing seam roofing systems.

In Figure 1, the distribution of materials used in stadiums by region can be seen. In Figure 2, the usage rates of materials used in stadiums across Türkiye are shown.

In Türkiye, regarding the roofing material usage in stadiums, a single roof material using is utilized in 43,3% of cases, while 56.7% prefer composite material usage. A stadium roof design plays a critical role in determining the amount of light that penetrates the field, thereby affecting the growth of the turf. If the roof design is not covered with an appropriate light-transmitting material, artificial lighting has to be used to sustain grass growth. This practice contradicts the principle of sustainability and results in significant energy costs. In line with the UN (United Nations)'s SDG 7 and SDG 11 principles, it is recommended that the design of the southern facade and roof sections of stadium structures incorporate a light-transmitting textile material to promote low-energy, sustainable living environments

RESULT

Technological advancements playing a role in architectural textile interactions are influencing the shaping of architectural structures. As a sustainable material, the high-performance textile group stands out and diversifies into new composite forms through technological advancements. This diversity not only

Table 1. Material Selections and Stadium Facilities in Türkiye.

Region	Photo	Stadium Name	City	Construction Year	Construction Site	Capacity (Spectators)	Classification According to Cover System	Classification According to Stadium Tribune Covering System	Facade and Covering System	Materials
Marmara Region		Atatürk Olympic Stadium (1,2)	İstanbul	2002	240.929 m² (Land Area)	77563	Semi-Covered	Semi-Covered	Steel, Concrete	1. PVC Membrane Covering
		Ali Sami Yen Sports Complex Rams Park (1,3,4,31)	İstanbul	2011	82.000 m²	52600	Semi-Covered	Covered	Steel, Membrane	1. PVC Membrane Covering, 4.Other(Compact Laminate Panel)
		Fenerbahçe Şükrü Saraçoğlu Stadium (1,5,6)	İstanbul	Renewal: 2006	55.000 m²	50530	Semi-Covered	Covered	Steel, Membrane ve Aluminum	1. PVC Membrane Covering, 4.Other(Composite)
		Beşiktaş Park Stadium (1,7,8,9)	İstanbul	2016	50.000 m²	42590	Semi-Covered	Covered	Steel, Concrete, Membrane	2. PTFE Textile Membrane Covering
		Yüzüncüyıl Atatürk Stadium (Bursa Timsah Arena) (1,7,10,11,64)	Bursa	2015	179.611 m²	43361	Semi-Covered	Covered	Steel, Membrane	1.PVC Membrane Covering ,2.PTFE Textile Membrane Covering
		Kocaeli Stadium (7,12)	Kocaeli	2018	90.700 m²	34829	Semi-Covered	Covered	Steel, Aluminum	4.Other (Aluminum Roof Covering)
		Sakarya Stadium (7,14,15,16,69)	Sakarya	2017	128.000 m²	28154	Semi-Covered	Covered	Steel, Membrane	1. PVC Membrane Covering,2.PTFE Textile Membrane Covering ,4.Other (PVC Mesh)
		Başakşehir Fatih Terim Stadium (34,35,36,37)	İstanbul	2014	160.000 m²	17300	Semi-Covered	Covered	Steel, Aluminum	1. PVC Membrane Covering, 4.Other (Glass, Composite)
Aegean Region		İzmir Atatürk Stadium (17)	İzmir	Renewal:2005	216.330 m² (Land Area)	51337	Uncovered	Semi-Covered	Steel, Concrete, Membrane	1. PVC Membrane Covering
		Gürsel Aksel Stadium (38,39,40)	İzmir	2020	94.541 m²	25000	Semi-Covered	Covered	Steel, Aluminum	4.Other (Precast, Polycarbonate)
		İzmir Alsancak Stadium (18,61)	İzmir	2021	22.500 m²	15000	Semi-Covered	Semi-Covered	Steel, Membrane	1. PVC Membrane Covering
		Akhisar Stadium (67)	Manisa	2018	52.137 m² (Land Area)	12139	Semi-Covered	Covered	Steel, Membrane	1. PVC Membrane Covering, 4.Other (Composite)
Central Anatolia Region		Konya Metropolitan Municipality Stadium (1,7,19,65)	Konya	2014	90.000 m²	42000	Semi-Covered	Covered	Steel, Membrane	1. PVC Membrane Covering, 4. Other (Transparent Membrane)
		Yeni Eskişehir Stadium (41,42)	Eskişehir	2016	86.783 m²	34930	Semi-Covered	Covered	Steel, Aluminum	1. PVC Membrane Covering, 4.Other (Aluminum Panel)
		Kayseri Kadir Has City Stadium (32,33)	Kayseri	2009	80.000 m²	32864	Semi-Covered	Covered	Steel, Aluminum	4. Other (Aluminum Roof Covering)
		Sivas 4 Eylül Stadium (43,44,45)	Sivas	2016	58.700 m²	27532	Semi-Covered	Covered	Steel, Aluminum	1- PVC Membrane Covering ,2.PTFE Textile Membrane Covering
		Eryaman Stadium (46,47)	Ankara	2016	37.462 m²	20672	Semi-Covered	Covered	Steel, Aluminum	1. PVC Membrane Covering,2. PTFE Textile Membrane Covering
Black Sea Region		Şenol Güneş Sports Complex (Akyazı Stadium) (7,20,21,63)	Trabzon	2016	170.000 m²	41131	Semi-Covered	Covered	Steel, Membrane	1. PVC Membrane Covering,2.PTFE Textile Membrane Covering
		Samsun 19 Mayıs Stadium (22,23,66)	Samsun	2017	140.000 m²	33919	Semi-Covered	Covered	Steel, Membrane	1. PVC Membrane Covering, 4.Other (PVC Mesh)
		Giresun Çotanak Sports Complex (24,62)	Giresun	2022	89.673 m²	21500	Semi-Covered	Covered	Steel, Membrane	1. PVC Membrane Covering
Mediterranean Region		Yeni Adana Stadium (28,29,30)	Adana	2021	78.012 m²	33543	Semi-Covered	Covered	Steel, Membrane	1. PVC Membrane Covering, 4.Other (PVC Mesh)
		Antalya Stadium (48,49,50)	Antalya	2015	87.331 m²	29307	Semi-Covered	Covered	Steel, Aluminum	1. PVC Membrane Covering, 4.Other (Standing Seam Roof)
		Mersin Stadium (1,7,25,68,70)	Mersin	2013	55.000 m²	25534	Semi-Covered	Covered	Steel, Membrane	1. PVC Membrane Covering
		Yeni Hatay Stadium (58,59)	Hatay	2021	55.395 m²	25000	Semi-Covered	Covered	Steel, Aluminum, Standing Seam	1. PVC Membrane Covering
		Alanya Oba Stadium (57)	Alanya	2011	23.000 m²	9789	Semi-Covered	Covered	Steel, Composite	1. PVC Membrane Covering, 3.ETFE Membrane Covering, 4.Other (Standing Seam Roof)
Southeastern Anatolia Region		Gaziantep Stadium (7,13,26)	Gaziantep	2017	61.215 m²	33502	Semi-Covered	Covered	Steel , Aluminum	1. PVC Membrane Covering,2. PTFE Textile Membrane Covering, 4.Other (PTFE Mesh, GFRC, GRC Precast)
		Diyarbakır Stadium (27)	Diyarbakır	2018	50.000 m²	33000	Semi-Covered	Covered	Steel,Membrane	4. Other (Composite)
		11 Nisan Stadium (55,56)	Şanlıurfa	2009	36.400 m²	28965	Semi-Covered	Covered	Steel, Aluminum	3.ETFE Membrane Covering
Eastern Anatolia Region		Yeni Malatya Stadium (52,53,54)	Malatya	2017	93.000 m²	25745	Semi-Covered	Covered	Steel, Aluminum	1. PVC Membrane Covering
		Elazığ Atatürk Stadium (51,60)	Elazığ	Renewal: 2023	55.395 m²	17600	Semi-Covered	Covered	Concrete, Steel, Standing Seam	4. Other (Polycarbonate, Standing Seam Roof)

(1): Arslan,2016. , **(2)**: Url-1, **(3)**: Url-2, **(4)**: Url-3, **(5)**: Url-4, **(6)**: Url-5, **(7)**: Bülbül,2017, **(8)**: Uğurlu,2021, **(9)**: Url-6, **(10)**: Kara,2020, **(11)**: Url-7, **(12)**: Url-8, **(13)**: Url-9, **(14)**: Url-10, **(15)**: Url-11, **(16)**: Url-12, **(17)**: Url-13, **(18)**: Url-14, **(19)**: Kurumak,2019, **(20)**: Url-15, **(21)**: Url-16, **(22)**: Url-17, **(23)**: Url-18, **(24)**: Url-19, **(25)**: Url-20, **(26)**: Url-21, **(27)**: Url-22, **(28)**: Url-23, **(29)**: Sürgülü, 2023, **(30)**: Url-24, **(31)**: Gözütok, 2019, **(32)**: Url-25, **(33)**: Url-26, **(34)**: Url-27, **(35)**: Url-28, **(36)**: Url-29, **(37)**: Ceylan,2020, **(38)**: Url-30, **(39)**: Url-31, **(40)**: Url-32, **(41)**: Url-33, **(42)**: Url-34, **(43)**: Url-35, **(44)**: Url-36, **(45)**: Url-37, **(46)**: Url-38, **(47)**: Url-39, **(48)**: Url-40, **(49)**: Url-41, **(50)**: Url-42, **(51)**: Url-43, **(52)**: Url-44, **(53)**: Url-45, **(54)**:Url-46, **(55)**: Url-47, **(56)**: Url-48, **(57)**: Url-49, **(58)**: Url-50, **(59)**: Url-51, **(60)**:Url-52, **(61)**: Url-53, **(62)**: Url-54, **(63)**: Url-55, **(64)**: Url-56, **(65)**: Url-57, **(66)**: Url-58, **(67)**: Url-59, **(68)**: Url-60, **(69)**:Url-61, **(70)**: Url-62

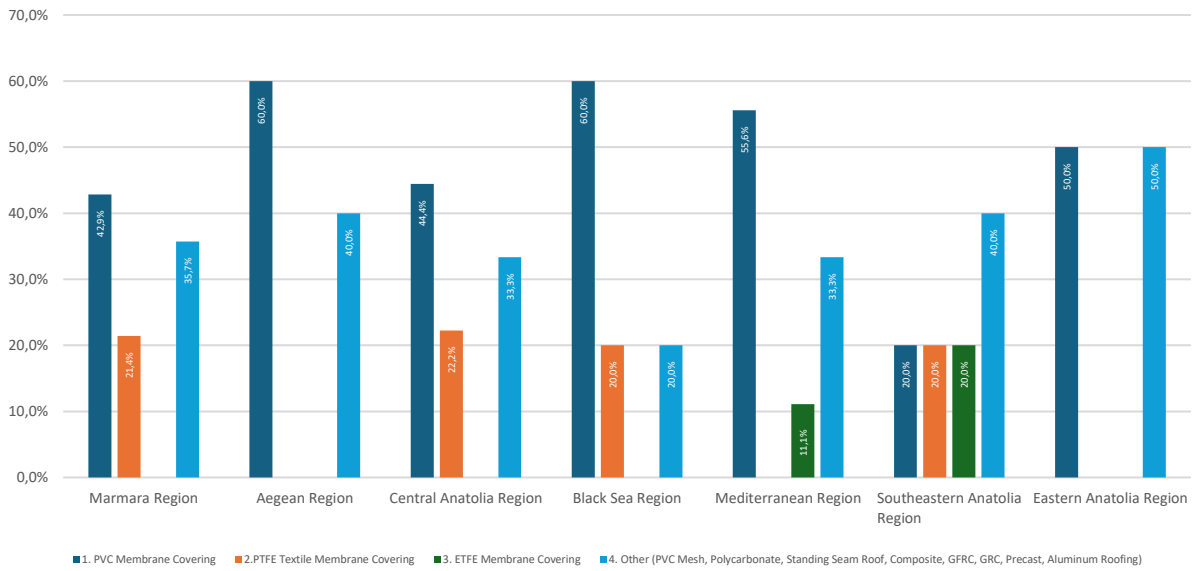

Figure 1. Materials Used in Stadiums by Region.

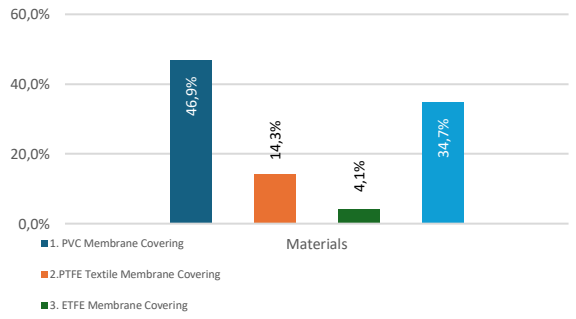

Figure 2. The Use of Materials in Stadiums in Türkiye.

makes significant contributions to stadium architectural design but also alters the symbolic values of the structure on an urban scale. Among the examined examples, regional differences have been observed in the textile materials used for stadium facades and roofing. Facade and roofing materials selected in harmony with the covering system and structural characteristics play a key role in the formal shaping of stadium structures, enhancing their visibility within the city. Material choices become the focal point of stadium designs, and the way the selected material is used gives the structure an iconic quality. This study has presented that PVC membrane coverings are the most commonly used in stadiums in Türkiye. The study has shown that the use of composite materials is also prevalent as a secondary choice in facade and covering systems.

The findings of the study have shown that in Türkiye, covering materials used in stadiums were not selected in accordance with the climate characteristics of the regions, nor was light permeability taken into consideration. This lack of alignment could lead to issues in the development of grass in stadiums, supporting the hypothesis that this relational mismatch may contribute to such problems. In this context, the study serves as a foundation for further research.

REFERENCES

1. Alioğlu T.: Tekstil Esaslı Malzemelerin Mimaride Kabuk Tasarımında Kullanımı ve Sürdürülebilirlik Açısından Değerlendirilmesi. Doktora Tezi, İstanbul Aydın Üniversitesi, Fen Bilimler Enstitüsü, İstanbul, Türkiye, 2018.
2. Arslan N.: Stadyum Yapılarının Tasarım Kriterlerinin Uluslararası Yönetmelikler Doğrultusunda İncelenmesi, Yüksek Lisans Tezi, Yıldız Teknik Üniversitesi Fen Bilimleri Enstitüsü, İstanbul, Türkiye, 2016.
3. Bülbül E.: Stadyum Yapılarındaki Strüktür Sisteminin Biçim Oluşumuna Etkisi, Yüksek Lisans Tezi, Gazi Üniversitesi, Fen Bilimleri Enstitüsü, Ankara, Türkiye, 2017.
4. Ceylan E.E.: Enerji Etkin Stadyum Tasarım Kriterleri Önerisi, Yüksek Lisans Tezi, Konya Teknik Üniversitesi Lisansüstü Eğitim Enstitüsü, Konya, Türkiye, 2020.
5. Durgut S.: Stadyum Yapılarında Çekmeye Çalışan Çatı Strüktürleri Kullanımının Kronolojik Değerlendirilmesi, Yüksek Lisans Tezi, Dokuz Eylül Üniversitesi Fen Bilimleri Enstitüsü, İzmir, Türkiye, 2019.
6. Göppert K., Paech C.: High-performance materials in façade design Structural membranes used in the building envelope. Steel Construction 8 (4), 2015, pp. 237-243. https://doi.org/10.1002/stco.201510033
7. Garcia G.: November- December “Prologue For A History and Theory of Architextiles”, Architectural Design-Architextiles, 2006, pp. 13-20.
8. Gandhi U.: Design and Construction of Tension Membrane Structures, 2020, online: http://homepages.cae.wisc.edu/~ukgandhi/documents/tensile%20structures_paper.pdf [cit. 25.07.2020]
9. Gezer H.: Titanyum’un Konut Mimarisinde ve İç Mekan Düzenlemelerinde Kullanılması. TMMOB Mimarlar Odası Yayını, ISBN 9944-89-196-7, İstanbul, 2006, pp. 480-487.
10. Gezer H.: Üretim Alanında Tekstil ve Mimari Arasındaki Etkileşim. İstanbul Ticaret Üniversitesi Fen Bilimleri Dergisi Yıl:7 Sayı:13 Bahar, 2008, pp. 21-49.
11. Gözütok M.M.: Stadyumlarda Uygun Akustik Ortamın Oluşturulması Bağlamında Genel İlkelerin Belirlenmesi, Yüksek Lisans Tezi, Yıldız Teknik Üniversitesi, Fen Bilimleri Enstitüsü, İstanbul, Türkiye, 2019.
12. Hernández M.J.J.: Fabric Membranes As Daylighting Control Systems In Buildings. Doctor of Philosophy, The University of Nottingham, 2006.
13. Kamal A.M.: An investigation into tensile structure system: construction morphology and architectural interventions.

Journal of Building Materials and Structures, 7, 2020, pp. 236-254. https://doi.org/10.34118/jbms.v7i2.776
14. Kurumak M.: Stadyum Tasarımında Ulusal/Uluslararası Standartlara Göre Seyirci Mekanlarının Analizi, Konya Büyükşehir Stadyumu Örneği, Yüksek Lisans Tezi, Necmettin Erbakan Üniversitesi, Fen Bilimleri Enstitüsü, Konya, Türkiye, 2019.
15. Seçgin M.: Stadyumların Örtü Sistemlerinin Örneklerle İncelenmesi, Yüksek Lisans Tezi, İstanbul Aydın Üniversitesi Lisansüstü Eğitim Enstitüsü, İstanbul, Türkiye, 2023.
16. Sürgülü U.: Stadyum Yapılarında Çatı Strüktürlerinin İncelenmesi, Yüksek Lisans Tezi, Yıldız Teknik Üniversitesi, Fen Bilimleri Enstitüsü, İstanbul, Türkiye, 2023.
17. Uğurlu İ.: Stadyum Yapılarında Hareketli Cephe ve Örtü Malzemelerinin Mimari Biçim Oluşumu Üzerindeki Etkileri, Yüksek Lisans Tezi, Fatih Sultan Mehmet Vakıf Üniversitesi Lisansüstü Eğitim Enstitüsü, İstanbul, Türkiye, 2021.
18. https://yuzuncuyilgalerisi.eba.gov.tr/tema/ataturk-olimpiyat-stadyumu 18#:~:text=Atat%C3%BCrk%20Olimpiyat%20Stad%C4%B1%2C%20Uluslararas%C4%B1%20Atletizm,antrenman%20ve%20%C4%B1s%C4%B1nma%20alan%C4%B1%20mevcuttur.
19. https://erkel.com.tr/referanslarimiz/turk-telekom-arena/
20. http://www.mtfproje.com.tr/portfolios/turk-telekom-arena/
21. https://tr.wikipedia.org/wiki/Fenerbah%C3%A7e_%C5%9E%C3%BCkr%C3%BC_Saraco%C4%9Flu_Stadyumu#:~:text=Mimarisi%20dikd%C3%B6rtgen%20%C5%9Feklinde%20olan%20bu,100%20tane%20VIP%20locas%C4%B1%20bulunmaktad%C4%B1r.
22. https://www.ozaymuhendislik.com.tr/pg_212_sukru-saracoglu-fenerbahce-stadyumu
23. https://www.dbarchitects.com.tr/tr/bjk-vodafone-arena/
24. https://tr.wikipedia.org/wiki/Y%C3%BCz%C3%BCnc%C3%BC_Y%C4%B1l_Atat%C3%BCrk_Stadyumu
25. https://alperaksoy.com.tr/proje/kocaeli-arena-stadyumu-35000-kapasite-146
26. https://www.tensaform.com/tr-TR/catalogue/tamamlanmis-projeler/39?searchText=stadyum
27. https://www.asma-germe.com/tr/projeler
28. https://alperaksoy.com.tr/proje/sakarya-arena-stadyumu-105#
29. https://www.erduman.com.tr/project/sakarya-stadyumu/
30. https://en.wikipedia.org/wiki/%C4%B0zmir_Atat%C3%BCrk_Stadium
31. https://alperaksoy.com.tr/proje/izmir-alsancak-stadyumu-159
32. https://www.erduman.com.tr/project/trabzonspor-senol-gunes-stadyumu/
33. https://www.trthaber.com/haber/spor/ktuden-medical-park-stadyumu-aciklamasi-655114.html
34. https://tr.wikipedia.org/wiki/Samsun_19_May%C4%B1s_Stadyumu
35. https://www.passo.com.tr/tr/mekan/25715/25715
36. https://www.tucsa.org/tr/celik_yapilar_yazi.aspx?yazi=1013
37. https://tr.wikipedia.org/wiki/Mersin_Stadyumu
38. https://www.tucsa.org/images/celik_yapilar/54/53_celik_yapilar.pdf
39. https://tr.wikipedia.org/wiki/Diyarbak%C4%B1r_Stadyumu
40. https://www.stendustri.com.tr/adana-stadi-projesinde-serge-ferrari-farki
41. https://www.dbarchitects.com.tr/tr/adana-stadyumu/
42. https://tr.wikipedia.org/wiki/Kayseri_Kadir_Has_%C5%9Eehir_Stadyumu
43. https://bkaarchitecture.com/projects-item/kayseri-kadir-has-stadium/
44. https://tr.wikipedia.org/wiki/Ba%C5%9Fak%C5%9Fehir_Fatih_Terim_Stadyumu
45. http://www.suldem.com/basaksehir_fatih_terim_stadyumu.html
46. https://erketasarim.com/projelerimiz/sosyal-kullanim-amacli-projeler/basaksehir-fatih-terim-stadyumu
47. https://www.dbarchitects.com.tr/tr/goztepe-gursel-aksel-stadyumu/
48. https://www.polikarbonat.com/goztepe-gursel-aksel-stadyumu-10-mm-solid-polikarbonat-cati-kaplamasi/
49. https://www.raf.com.tr/goztepe-gursel-aksel-stadyumu/
50. https://www.eskisehirspor.org.tr/stadyum
51. https://stadiumdb.com/stadiums/tur/eskisehir_stadyumu
52. https://tr.wikipedia.org/wiki/Yeni_4_Eyl%C3%BCl_Stadyumu
53. https://bkaarchitecture.com/projects-item/sivas-stadium/
54. https://www.passo.com.tr/en/venue/45216/45216
55. https://www.dbarchitects.com.tr/tr/ankara-eryaman-stadyumu/
56. https://tr.wikipedia.org/wiki/Eryaman_Stadyumu
57. https://tr.wikipedia.org/wiki/Antalya_Stadyumu
58. https://www.antalyaspor.com.tr/tr/tesislerimiz/antalyaspor-stadyumu.html
59. https://eskametal.com/tr/uygulama-birimi/
60. https://alperaksoy.com.tr/proje/elazig-ataturk-stadyumu-ve-spor-salonu-17600-kapasite-200#
61. https://atakeng.com.tr/portfolio-items/malatya-stadyumu/
62. https://bkaarchitecture.com/projects-item/malatya-stadium/
63. https://ilci.com.tr/proje/25-000-ki%CC%87s%CC%A7i%CC%87-kapasi%CC%87teli%CC%87-malatya-s%CC%A7ehi%CC%87r/
64. https://tr.wikipedia.org/wiki/11_Nisan_Stadyumu
65. https://azaksu.com/tr/spor/urfa-stadyumu
66. https://tr.wikipedia.org/wiki/Alanya_Oba_Stadyumu
67. https://alperaksoy.com.tr/proje/hatay-arena-stadyumu-30000-kapasite-136#
68. https://www.baselyapi.com.tr/projects/proje-adi-03/
69. https://tucsa.org/tr/celik_yapilar_yazi.aspx?yazi=1443#:~:text=Projede%20çim%20sahanın%20gün%20ışığından,çatıda%20ve%20cephede%20yırtıklar%20açılmıştır