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Research Article

Determination of Physical and Mechanical Properties of Veneered OSB

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Abstract: The aim of this study is to investigate the physical and mechanical properties of OSB boards whose surfaces are covered with wood veneer. In the study, veneered OSB boards were produced with a final thickness of 18 mm using poplar and beech veneers. Phenol formaldehyde and urea formaldehyde glues were used as glue. Air dry, oven dry and wet densities of the veneered OSB boards produced were determined. On the other hand, 2, 24 and 72 hours water absorption and thickness swelling properties were determined. Bending strength and modulus of elasticity testing of the veneered OSBs produced was carried out. The water absorption and thickness swelling resistance of veneered OSB boards produced using PF glue gave better results than those produced using UF glue. It has been determined that gluing the veneers with the fiber directions perpendicular or parallel to each other has no effect on the density. It has been understood that veneered OSBs produced using beech veneers generally exhibit better mechanical properties than veneered OSBs produced using poplar veneers. It can be said that covering the surfaces of OSBs with veneers affects the thermal conductivity value negatively and other physical and mechanical values positively. In order to increase the usage areas of veneered OSBs, it is recommended to conduct new studies using different wood species and glues.

Keywords: OSB; beech, poplar; veneer; thermal conductivity

Kaplanmış OSB Levhaların Fiziksel ve Mekanik Özelliklerinin Belirlenmesi

Öz: Bu çalışmanın amacı, yüzeyleri kaplama levhalar ile kaplanmış OSB levhaların fiziksel ve mekanik özelliklerinin araştırılmasıdır. Çalışmada kavak ve kayın kaplamalar kullanılarak son kalınlığı 18 mm olacak şekilde kaplanmış OSB levhalar üretilmiştir. Levhaların yapıştırılabilmesi için fenol formaldehit ve üre formaldehit tutkalları kullanılmıştır. Üretilen kaplanmış OSB levhaların hava kurusu, tam kuru kurusu ve tam yaş yoğunlukları belirlenmiştir. Diğer yandan 2, 24 ve 72 saatlik su emme ve kalınlığına şişme özellikleri belirlenmiştir. Üretilen kaplanmış OSB'lerin eğilme direnci ve elastikiyet modülü testleri gerçekleştirilmiştir. FF tutkal kullanılarak üretilen kaplanmış OSB'lerin su emme ve kalınlığına şişme direnci değerleri, UF tutkal kullanılarak üretilenlere göre daha iyi sonuçlar vermiştir. Kaplamaların lif yönleri birbirine dik veya paralel olacak şekilde yapıştırılmasının yoğunluğa herhangi bir etkisinin olmadığı belirlenmiştir. Kayın kaplama kullanılarak üretilen kaplanmış OSB'lerin genel olarak kavak kaplama kullanılarak üretilenlere göre daha iyi mekanik özellikler sergilediği anlaşılmıştır. OSB yüzeylerinin kaplama ile kaplanmasının ısıl iletkenliği değerini olumsuz, diğer fiziksel ve mekanik değerleri ise olumlu etkilediği söylenebilir.

Anahtar Kelimeler: OSB; kayın, kavak, kaplama, ısı iletkenliği

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1. Introduction

Making boards from oriented strands dates back to the work of Armin Elmendorf in America and Wilhelm Klauditz in Germany in the late 1940s and early 1950s. Elmendorf received a new patent on this subject in 1965 as a result of the work it carried out in the pilot production facility it established in its research laboratory in 1962. The first facility in Europe was established in 1978. Oriented strand boards (OSB) are produced by adding glue to flakes obtained from small-diameter round woods and by routing these glued strands on the laying line and pressing the cake template obtained under temperature and pressure. (Doğan & Kaymakcı, 2022; İstek et al., 2016; Kaya & Çifçi, 2018; Kaymakcı & Doğan, 2023; Özçifçi et al., 2017; Thoemen et al., 2010).

OSB is a plate-shaped material produced by mixing specially prepared strands with a suitable glue and directing them in the desired direction during laying, and pressing the resulting draft under temperature and pressure. Strands are generally 150mm long, 25mm wide and 0.6mm thick. In order for OSB boards to be used instead of plywood, their physical and mechanical properties and behavior in places of use must be the same or close to those of plywood. Like all wood and wood-based materials, OSB boards swell when exposed to water. But the surface layers expand faster than the middle layer. In this regard, OSB boards should be stored in dry conditions, placed appropriately, adequate roof ventilation and the use of side vapor barriers will help prevent problems that may occur during use on roofs. There are no knots, knot holes, additional openings or overlaps on the surfaces of OSB boards. However, structural plywood may have color differences, overlaps, bends, knots, knot holes, and narrow joint openings (Akbulut et al., 2002; Doğan & Kaymakcı, 2022; Kaya & Çifçi, 2018; Özçifçi et al., 2017; Thoemen et al., 2010).

As an alternative to 1/2-inch-thick plywood sheathing panels, composite wood panels with veneer faces and unidirectionally oriented strand cores have been researched and commercially manufactured. Their initial allure came from the fact that they could be made for the same purpose at a lower cost than standard plywood. They also offered chances to use low density hardwood logs for the core and undersized, low-quality softwood logs. But when OSB for sheathing became commercially available, these benefits appear to have vanished. The properties of commercially available OSB sheathing were found to be sufficient to meet the necessary structural criteria for the intended purpose, although being lower than those of plywood with the same thickness. This has caused a pause in the manufacturing of veneer-overlaid composite panels for use as sheathing in commercial settings. This might only be a short-term issue, as veneer-overlaid composite panels have a wide range of industrial uses where smoother, more robust products are needed than OSB panels (Biblis, 1985; Carney, 1977; Chiu & Biblis, 1973; Koeningshof, 1977; Snodgrass & Saun-ders, 1974).

The potential to create veneer-overlaid composite panel cores is made possible by OSB manufacturing technology, which can orient layers. It is possible to create such composite panels with OSB cores that have specific ratios of stacking thickness and high stressed veneer faces that are both the right thickness and quality. To meet the characteristics and performance requirements of the panel for its intended purpose, this concept calls for unique design criteria. In terms of structural efficiency, OSB is not anticipated to be as good as veneer-overlaid composite panels with same thickness (Biblis, 1985; Biblis & Mangalousis, 1983; Carney, 1977; McKean et al., 1975; Snodgrass & Saunders, 1974).

A review of the literature demonstrates, however, that little is known regarding the extent to which veneer topping OSB would improve its flexural characteristics and dimensional stability. The aim of this study is to investigate the physical and mechanical properties of OSB boards whose surfaces are covered with wood veneer. In the study, veneered OSB boards were produced with a final thickness of 18 mm using poplar and beech veneers. Phenol formaldehyde and urea formaldehyde glues were used as glue. Air dry, oven dry and wet densities of the veneered OSB boards produced were determined. On the other hand, 2, 24 and 72 hours water absorption and thickness swelling properties were determined. Bending strength and modulus of elasticity testing of the veneered OSBs produced was carried out.

2. Experimental

2.1. Materials

In this study, 11 mm and 18 mm thick OSB-2 class boards produced by Kronospan Kastamonu / Turkey were used. Beech and poplar veneers were obtained by specially peeling 1.1 mm thick first-class logs at TKS Veneer Tosya/Turkey. Since the final thickness of Veneered OSBs is 18 mm, the thickness of the OSBs used in the interior was chosen as 11 mm. The veneers were dried in the TKS Veneer factory at a humidity level of 8%. Urea Formaldehyde glue (UF) was supplied from Kronospan company. The amount of solid matter is 65%. NH_4Cl (ammonium chloride) was used as a hardener. The mixture was prepared and used with a hardener ratio of 10%. Phenol Formaldehyde glue (PF) was supplied from Polisan company under the trade name "Polifen 47". The amount of solid matter is 47.50%.

2.2. Production of Veneered OSB

Veneered OSB were produced according to the trial pattern in Table 1.

Table 1. Veneered OSB production models.

OSB code	Veneer wood species	Veneer fiber direction	Adhesive type
A	Poplar	Perpendicular	Phenol formaldehyde
B	Poplar	Parallel	Phenol formaldehyde
C	Poplar	Perpendicular	Urea formaldehyde
D	Poplar	Parallel	Urea formaldehyde
E	Beech	Perpendicular	Phenol formaldehyde
F	Beech	Parallel	Phenol formaldehyde
G	Beech	Perpendicular	Urea formaldehyde
H	Beech	Parallel	Urea formaldehyde

The press temperature for the production of veneers was determined as 110 °C for UF and 140 °C for PF. The gluing process was carried out so that the glue amount was 200 gr/m^2. The press pressure was set to 8 kg/cm^2. Pressing time was set as 13 minutes. A Cemil Usta SSP180T brand laboratory type hydraulic press was used in the production of the veneers. The width of the press table is 60x60 cm^2 and the useful area is 50x50 cm^2. For each group, veneers of 40x40 cm^2 (1 piece), 30x30 cm^2 (2 pieces) and 20x20 cm^2 (5 pieces) dimensions were produced with cleaned edges.

2.3. Determination of Physical Properties of Veneered OSB

Density tests of the samples were performed according to EN 323, water absorption tests according to EN 317 and thickness swelling tests according to EN 318 standard.

Thermal conductivity coefficient was determined in accordance with ASTM C1113-99 standard. The minimum dimensions for thermal conductivity measurement of samples are 50x100 mm. The standard measurement time is 100-120 seconds. Measurements were repeated 10 times. The test samples were conditioned at 20±2 °C and 65±5% relative humidity and measurements were made with the "QTM 500-meter Kyoto Electronics Manufacturing Tokyo Japan" device. Thermal conductivity was measured and the values were recorded as W/m°K.

2.4. Determination of Mechanical Properties of Veneered OSB

Bending strength (MOR) and modulus of elasticity (MOE) tests of the produced sheets were carried out according to TS EN 310 standard.

Test samples were prepared with a length of 400 mm and a width of 50 mm. Accordingly, the distance between the supports was determined as 320 mm. In addition to the produced boards, 18 mm thick OSBs with properties equivalent to the OSBs used in plate production were also tested. The plates in each group were tested 7 times.

3. Results and Discussion

3.1. Physical Properties

Air dry, oven dry and wet densities of the veneered OSBs produced were determined. The density test results of the veneered OSBs obtained can be seen in Table 2.

Table 2. Air dry, oven dry and wet density of veneered OSB groups and neat OSB

Panel type	Density – air dry (g/cm³)	Density – oven dry (g/cm³)	Density – wet (g/cm³)
OSB (18 mm)	0.61 ± 0.03	0.56 ± 0.01	0.72± 0.05
A	0.66 ± 0.02	0.62 ± 0.02	0.78± 0.07
B	0.65 ± 0.04	0.60 ± 0.04	0.75± 0.02
C	0.66 ± 0.02	0.60 ± 0.01	0.76± 0.04
D	0.63 ± 0.04	0.59 ± 0.02	0.74± 0.05
E	0.78 ± 0.02	0.70 ± 0.02	0.82± 0.02
F	0.76 ± 0.02	0.68 ± 0.01	0.81± 0.03
G	0.76 ± 0.03	0.71 ± 0.03	0.80± 0.01
H	0.74 ± 0.02	0.69 ± 0.02	0.80± 0.04

When Table 2 is examined, when air dry, oven dry and wet densities are compared, it is determined that the density values of all OSB boards with wooden surface coatings (veneered OSB) are higher than neat OSB boards of the same thickness. On the other hand, it was determined that the densities of veneered OSBs produced using beech veneers were higher than those of veneered OSBs produced using poplar veneers. In addition, it has been understood that the densities of veneer OSBs produced using PF glue are generally higher than those of veneer OSBs produced using UF glue. No relationship has been detected between the densities of veneered OSBs and whether veneer boards are glued with fiber directions perpendicular or parallel to each other.

The water absorption and thickness swelling test results of the obtained veneered OSBs can be seen in Table 3.

Table 3. Water absorption and thickness swelling values of veneered OSB groups and neat OSB

Panel type	Water absorption 2 hours – (%)	Water absorption 24 hours – (%)	Water absorption 72 hours – (%)	Thickness swelling 2 hours – (%)	Thickness swelling 24 hours – (%)	Thickness swelling 72 hours – (%)
OSB (18 mm)	29.01 ± 1.82	72.27 ± 5.64	84.57 ± 4.53	10.55 ± 0.83	22.83 ± 0.80	24.89 ± 1.00
A	20.62 ± 1.53	61.55 ± 2.31	82.60 ± 3.08	8.25 ± 1.07	20.27 ± 2.39	22.36 ± 2.72
B	19.46 ± 1.21	59.67 ± 3.88	81.94 ± 2.16	7.60 ± 0.82	19.41 ± 1.66	21.59 ± 2.08
C	22.87 ± 1.74	56.29 ± 5.74	85.17 ± 4.05	10.02 ± 0.53	17.97 ± 1.47	19.14 ± 2.07
D	22.44 ± 5.09	55.77 ± 1.86	84.66 ± 2.35	9.57 ± 0.45	17.24 ± 1.80	18.37 ± 2.32
E	16.95 ± 0.87	52.36 ± 5.50	80.54 ± 1.31	5.92 ± 0.58	14.95 ± 3.04	17.55 ± 3.78
F	16.14 ± 1.34	51.73 ± 2.26	79.46 ± 4.78	5.24 ± 0.41	14.13 ± 2.12	16.22 ± 2.64
G	19.00 ± 1.91	69.44 ± 3.00	82.67 ± 5.03	8.14 ± 0.60	18.43 ± 1.76	22.60 ± 1.85
H	18.60 ± 2.73	58.82 ± 4.13	82.04 ± 1.74	7.85 ± 0.92	17.15 ± 1.48	21.04 ± 2.07

When the 2, 24 and 72 hour water absorption values of veneered OSB boards in Table 3 are examined, it was determined that the F group boards showed the best resistance to water, and the neat OSB and C group boards showed the worst resistance. It is thought that the main reason why Group F boards show the best resistance to water is that the PF glue used has better resistance to water than the UF glue, the fiber directions of the veneer boards are glued in opposite directions, and the beech has better resistance to water compared to the poplar. On the other hand, the reasons why neat OSB and Group C boards have the lowest water resistance values are that the water resistance properties on the surface of neat OSB boards are normally low; The use of UF glue, which has less water resistance properties than PF glue, in Group C boards; The fiber directions of the veneers are parallel to each other; and poplar wood has lower resistance to water than beech wood. When the thickness swelling values are examined, it is seen that the trend in water absorption values has not changed. The fact that these situations are parallel to each other reinforces the accuracy of the reasons.

The thermal conductivity values of the obtained veneered OSBs can be seen in Table 4.

Table 4. Thermal conductivity values of veneered OSB groups and neat OSB

Panel type	Thermal conductivity (W/m²K)	
	Mean	Standard deviation
OSB (18 mm)	0.18	0.03
A	0.22	0.01
B	0.24	0.01
C	0.20	0.01
D	0.19	0.00
E	0.26	0.06
F	0.26	0.02
G	0.24	0.02
H	0.25	0.03

When the thermal conductivity results are examined in Table 4, it is seen that the lowest value is obtained in neat OSB and similarly in group D plates, and the highest value is obtained in group E and F boards. The main reason why neat OSBs have the lowest thermal conductivity value may be that they contain more air voids than veneered OSBs and therefore their density is lower. On the other hand, it has been understood that the thermal conductivity values of veneered OSBs obtained using poplar are generally lower than the sheets produced using beech. It is thought that this is due to the density of poplar wood being lower than that of beech wood. In addition, it is understood from Table 3 that gluing the fiber directions of the veneers parallel or perpendicular to each other does not affect the thermal conductivity values of the veneers. Thermal conductivity values of veneered OSBs produced using PF glue were generally higher than those with UF glue..

3.2. Mechanical Properties

The bending resistance and bending modulus values of the veneered OSBs produced can be seen in Table 5.

Table 5. Bending strength and modulus of elasticity values of veneered OSB groups and neat OSB

Panel type	Bending strength (N/mm²)		Modulus of Elasticity (N/mm²)	
	Mean	Standard deviation	Mean	Standard deviation
OSB (18 mm)	23.42	2.53	2,074.55	373.04
A	37.71	3.15	4,721.32	415.57
B	31.79	1.59	4,318.35	106.53
C	27.08	2.10	3,954.57	433.21
D	23.52	3.70	3,207.16	187.20
E	52.33	4.92	8,762.71	228.31
F	54.26	1.48	7,368.13	74.57
G	45.51	3.72	6,738.29	417.34
H	41.97	4.44	5,982.45	264.95

When the MOR and MOE values in Table 5 are examined, it is seen that the highest MOR value is detected in E and F group boards, and the lowest MOR value is detected in neat OSB, C and D group boards. This situation is generally thought to be due to the type of glue used, the type of wood and the fiber directions of the veneers being glued parallel/opposite to each other. It is understood that the same situation occurs in MOE values.

4. Conclusions

In general, it can be said that the following results were obtained in the study;

- The water absorption and thickness swelling resistance of veneered OSB boards produced using PF glue gave better results than those produced using UF glue.
- It has been determined that gluing the veneers with the fiber directions perpendicular or parallel to each other has no effect on the density.
- It has been understood that veneered OSBs produced using beech veneers generally exhibit better mechanical properties than veneered OSBs produced using poplar veneers.
- It can be said that covering the surfaces of OSBs with veneers affects the thermal conductivity value negatively and other physical and mechanical values positively.

- In order to increase the usage areas of veneered OSBs, it is recommended to conduct new studies using different wood species and glues.

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