



INTERNATIONAL  
FOREST PRODUCTS  
CONGRESS



# ABSTRACT BOOK

**ORENKO  
2020** | **INTERNATIONAL  
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CONGRESS**

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**Karadeniz Technical University  
Trabzon, TURKEY**



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## PREFACE

This abstract book contains selected papers of the ORENKO 2020 – International Forest Products Congress held on September 23-26, 2020. The congress, organized by the Forest Industry Engineering Department at Karadeniz Technical University, has received abstracts from different countries including Malaysia, Iran, Portugal, Canada, Slovenia, Serbia, Bulgaria, Bangladesh and Turkey. After an initial review of the submitted abstracts, the 60 abstracts were accepted for oral and poster presentation.

Although given the positive trends related to COVID-19 and easing of restrictions in some countries and regions, there are still some restrictions for domestic and international flights and people are still advised to stay away from crowded places and take necessary measures i.e., using face mask, physical distance and hygiene. Our first priority is always the health and safety of attendees of the congress. Therefore, The ORENKO 2020 Organization Committee has decided to hold the ORENKO 2020 online. Our goal is trying our best to generate an atmosphere where the participants can share their expertise, experience, and resources virtually via webcam and microphone with others.

The purpose of this online congress is to provide an up-to-date discussion in the field of forest products in general. ORENKO 2020 is focused on the theme "Outlining the Forefront Research in The Field of Wood Science and Engineering". The topics that covered in the congress include wood science, technology and engineering, wood and wood-based products, wood anatomy, wood raw materials, wood composites, wood-plastic composites, engineered wood products, wood drying, biomaterials, wood constructions, physico-mechanical properties of wood and wood-based materials, nanotechnology applications in wood science, nondestructive evaluation of wood, sustainable utilization of forest products, wood preservation, wood modification, wood biomass, wood-inhabiting insects and fungi, marine borers, recycle/reuse/disposal of wood and wood based materials, non-wood forest products, wood chemistry, adhesives and bioresins, formaldehyde and VOC emission from wood based panels, pulp and paper, advanced cellulosic products, fiber resources from non-woody plants, furniture design and manufacturing, wood coatings, wood finishing, archaeological wooden structures, industry 4.0 in forest products industry, forest products economics, forest products marketing, production management and operational research, artificial intelligence in forest product industry, forest products ergonomics, environmental and ecological issues in forest products and occupational health and safety in forest products industry.

We would like to thank to all person of the organizing committee who have dedicated their constant support and countless time to organize this congress. The ORENKO 2020 is a credit to a large group of people, and everyone should be proud of outcome.

**ORENKO 2020 Congress Secretariat**



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**KEYNOTE  
ADDRESSES**



**SEISMIC SAFETY OF WOOD CONSTRUCTIONS  
- FROM PAST TO FUTURE -**

**Ario CECCOTTI**  
***Invited Lecturer***

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Turkey*

As a construction material, structural wood (timber) has been used for centuries all over the world in every ambient conditions. Not always with fine results. Learning from the experience – good or bad – is of paramount importance to erect modern wood buildings capable to withstand with success very severe actions, e.g. earthquakes.

In this speech, after a short reminder on key anti-seismic features of wood and wood construction, a global survey on traditional buildings in seismic regions is conducted. Then, a particular emphasis is put on CLT, cross laminated timber, a wood engineered product that provide resistant, rigid and, at same time, capable-to-dissipate-energy constructions.

In fact, without important damages, CLT construction technology does provide People with residential buildings suitable for an immediate occupancy even after a major quake.

Some final statements are provided about the costs of such wooden technology vs traditional reinforced concrete construction.

**Keywords:** CLT, cross laminated timber, immediate occupancy, seismic design, wood construction.



## **THE ENVIRONMENTAL CREDENTIALS OF WOOD AS A CONSTRUCTION MATERIAL**

**Callum HILL**

*NIBIO, Norway; JCH Industrial Ecology Ltd, UK*

Humanity is in the midst of a climate crisis, caused by the emissions of anthropogenic carbon dioxide into the atmosphere. The use of materials in society is linked to wealth creation and global population and the greenhouse gas emissions associated with the creation, use and disposal of materials are a major contributor to global warming. It has not yet been possible to break the link between wealth creation and carbon emissions. However, the use of timber in long-life products can be used as a climate change mitigation strategy and still create wealth. The global warming potential of wood is often quoted as a negative number and the reasons for this will be discussed. The embodied carbon of timber products is the emission of greenhouse gases associated with the production and use of timber products and this impact is exceeded by the sequestered atmospheric carbon that is stored in the products. However, eventually the stored carbon will be released back into the atmosphere and the consequences of this will be explored in the talk. The benefits of the use of timber in construction will be presented, based upon the recent study which was performed for the UK Climate Change Committee.



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## **RENAISSANCE IN WOOD CONSTRUCTION IS UNDERWAY**

**Erol KARACABEYLI**  
***P.Eng. M.A.Sc. Principal Scientist***  
*FPInnovations, Canada*

In Canada, we describe the current efforts to support the greater use of wood in the built environment as a “Renaissance of wood construction”. This is driven by the need to lessen our impacts on the environment while not only meeting the needs of a growing population but also improving the standard of living. After briefly mentioning parts of the world where wood-based construction is gaining more traction, the role of Engineered Wood Products (EWP) and innovative connectors that will make the “Renaissance” a reality will be presented.

Examples of wood-based building systems from the traditional North American light wood-frame, to the new generation of mass timber originated from Europe, and hybrid construction will be highlighted along with how to support and achieve regulatory acceptance.

Finally, types of prefabrication systems and a multi-disciplinary approach which led to the development of some guides and handbooks (with links which will make them available to the audience) will be presented.

**Keywords:** Mass timber, tall wood buildings, engineered wood products



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**“HOW LONG WILL THIS WOOD PRODUCT LAST?” – SERVICE LIFE  
EXPECTANCE AND ITS DETERMINATION METHODS**

**Jakub SANDAK**

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The description of “service life” proposed by International Standard Organization (ISO) seems to be straightforward; however, it is rather hardly applicable when defining limit states. It is especially challenging in case of materials’ aesthetic deterioration and related maintenance actions. Majority of difficulties related to the performance of wood in building applications are related to poor design of construction details, improper choice of materials, or inadequate maintenance. The intensity of materials’ deterioration depends on several factors, including building setting, orientation, architectural details, exposure level, local microclimate, and intrinsic properties of materials used in construction.

Wood as a biological-origin material is vulnerable to diverse biotic and abiotic agents highly affecting kinetics of its deterioration. Consequently, wooden elements may lose their original beauty, functionality of even become potentially harmful. The latest stage is obviously not acceptable but can be affected by the excessive decay or by insect’s infestation. The aesthetical deterioration of the surface appearance is considered as a major trigger to replace or repair building components, as well as a factor for avoiding solutions based on biomaterials. However, wood modification related to both, bulk and/or surface substantially improves durability and aesthetical performance of wood used in architecture. This enables contractors to guarantee longer periods of using buildings without maintenance, as well as to schedule the preventing maintenance activities in advance, allowing precise calculation of the life-long service costs. Nevertheless, a reliable prediction of the real performance for novel materials is always challenging due to lack of consistent reference data collected along their use phase. In this case, prediction of materials’ changes rely on the past experiences with similar materials, usually supported by the artificial weathering tests. Alternatively, numerical modelling approach and simulation are implemented. An example of the pan-European initiative for addressing these issues is the project CLICKdesign: Delivering fingertip knowledge to enable service life performance specification of wood.

This presentation gives a critical review of diverse approaches that can be implemented for prediction of the service life scenario, considering especially wood durability against fungi and insects. A special emphasis is on the aesthetical aspects determining limit states. The theoretical models are confronted with the validation data collected along diverse field studies. A novel methodology for linking human preferences tests with definition of the aesthetical limit state is presented for the first time. Finally, an overview on the further developments in the field of service life performance modelling is provided with a special emphasis on natural and modified biomaterials.

**Keywords:** Deterioration and decay, Service life, CLICKdesign, Biomaterials





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**ORAL  
PRESENTATIONS**



## **TREMA ORIENTALIS PULPING**

**M. Sarwar Jahan**

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Trema orientalis is a native fast growing species in Bangladesh. It grows naturally in all over the country. Recently this species has been planted in experimental forest station for commercial exploitation. It is a diffused porous hardwood consist of fiber (>55%), vessel and ray cells.

The lignin and  $\alpha$ -cellulose content were about 23% and 45%, respectively, consequently produced pulp yield of about 48% at kappa number around 20. T. orientalis pulp showed excellent bleachability with 85% brightness using 25kg ClO<sub>2</sub>/ton of pulp. The papermaking properties of T. orientalis pulp were comparable to tropical hardwood pulp. This species can be a good alternative for pulpwood production in Bangladesh.

**Keywords:** Pulpwood; Trema orientalis;  $\alpha$ -cellulose; Bleachability; Papermaking properties



## **POTENTIAL USAGE AREAS OF IIoT IN FOREST PRODUCTS INDUSTRY**

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The increasing usage of wood materials in the industry necessitates correct, effective and sustainable use of existing raw material resources. In this context, the concept of Industry 4.0, which includes smart production systems, smart objects, and smart management models, stands out. Industry 4.0 is defined by the concept where human, machinery, robotic control equipment, products and all related objects can communicate with each other; thus lines are arranged, and eventually they work as a networked system. IoT (Internet of Things) is defined as the communication of all elements/objects within the industry 4.0 system. In the light of current developments, the use of technology in the routine life activities of people is expanding. The most striking example of this is the progress in the telecommunication sector like smartphones. The aim here is not only to ensure verbal communication between people, but also the communication between objects, and objects with people. This creates the system referred as IIoT. IIoT (Industrial Internet of Things), also called industrial internet, is the use of IoT in industry/manufacturing. This means that the whole supply chain works in interrelation. In this paper, the definition of IIoT concept and its potential in the forest products industry are examined.

**Keywords:** IIoT, Internet of Things, Industry 4.0, Forest Products Industry



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**EFFECTS OF NATURAL NANO CELLULOSE AND ACTIVATED CARBON  
FILLERS ON THE PROPERTIES OF EPOXY BIOCOMPOSITE**

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The functional biocomposite made from epoxy reinforced with natural filler of nano-cellulose and activated carbon were investigated. The commercial nano-cellulose and synthesis activated carbon were made from cotton and rice husk respectively. The epoxy was mixed with 5%, 10% and 15% of nano-cellulose and activated carbon separately. A further epoxy mixed with 10% nano-cellulose or activated carbon was reacted with 1%, 2% and 3% tetrathoxysilane (TEOS) as cross linking agent. The water absorption, thickness swelling, static bending properties were tested according to the ASTM D790 standard. The results revealed that all the properties were significantly different with type of filler. The maximum flexural stress was not significantly different with filler concentration and TEOS for epoxy mixed with activated carbon but not in the case for epoxy mixed with nano-cellulose. The epoxy mixed with 15 % nano-cellulose and activated carbon had the highest modulus automatic. The water absorption was significantly lowest in epoxy mixed with all activated carbon concentrations, except for 15% activated carbon. While epoxy mixed with 5% and 10% nano-cellulose gave the lowest water absorption. The epoxy mixed with 10% nano-cellulose and activated carbon had the lowest thickness swelling. It can be concluded that the epoxy mixed with 10% nano-cellulose or activated carbon without TEOS had an overall optimum property.

**Keywords:** biocomposite, epoxy, natural filler, tetraethoxysilane, properties



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**SOME TECHNOLOGICAL PROPERTIES OF PARTICLEBOARD  
MANUFACTURED FROM PRETREATED SCOTS PINE PARTICLES**

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This study was conducted to increase the efficiency in the particleboard industry. For this purpose, the particles obtained from Scots pine (*Pinus sylvestris L.*) were treated with cold water, hot water, 1% sodium hydroxide, and 1% acetic acid solutions. Then one-layer particleboards with density of 0.650 g/cm<sup>3</sup> were manufactured using urea formaldehyde adhesive. Physical (thickness swelling for 24 h. immersion in the water) and mechanical (modulus of rupture, modulus of elasticity and internal bond strength) properties of the particleboard were investigated. According to statistical analyses of the test results, cold water pre-treatment positively affected the thickness swelling value, while negatively the mechanical properties of test panels. Hot water, 1% sodium hydroxide and 1% acetic acid pre-treatments positively impacted the physical and mechanical properties of particleboard samples.

**Keywords:** Particleboard, scots pine, pre-treatment, mechanical properties, physical properties



**GAS EMISSIONS FROM THE COMBUSTION OF THE PARTICLE BOARDS  
PRODUCED WITH PEANUT HUSK ADDITIVE**

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This study is conducted to determine the amount of CO and NO<sub>x</sub> generating from the combustion of the particleboards produced with peanut husk additive. For this purpose, wood chips consist of red pine (*Pinus brutia Ten.*), Oriental beech (*Fagus orientalis L.*) and Silver poplar (*Populus alba L.*) and mixed with peanut husk in %100 (B1), %75 (B2), %50 (B3) and %25 (B4) proportions, 4 different types of boards were produced. 3 different kinds of glue were used for each type in board production such as %100 UF (G1), %95 UF+%5 MF (G2) and % 95 UF+%5 FF (G3). Combustion properties were determined according to ASTM-E 160-50 principles.

As a conclusion, it was determined that the amount of wood chips increased as the amount of CO and NO<sub>x</sub> decreased. The minimum amount of CO and NO<sub>x</sub> gas in all combustion phases was determined in type (B4) particleboards.

**Keywords:** Particleboard, peanut husk, gas emission, combustion



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**INVESTIGATING THE CHALLENGE OF CHARCOAL PRODUCTION FROM  
THE VIEWPOINT OF SPECIALISTS AND LOCAL COMMUNITIES IN  
ZAGROS FORESTS**

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Charcoal production is one of the major exploits of forests in Lorestan province (especially the middle Zagros). The goal of this study was to investigate the challenges of charcoal production process in the forests of the Bastam area of Aleshtar city. For this purpose, SWAT questionnaire was prepared by forestry expertise in Lorestan province through field surveying. The questionnaires were distributed to the role-makers (12 from the local community and 40 from the expert) and were scored on a Likert scale. The strategic positioning matrix and strategic action matrix were used to guide the coalization strategy. The results showed that the most important strengths, weaknesses, opportunities and threats for the charcoal between experts were considering local livelihoods and increasing household income is deforestation (density reduction, canopy cover and gradual deforestation), reducing rural migration to the city and endangering the sustainability of the forest, respectively. Local role-makers emphasized on weaknesses, opportunities and threats, including respiratory and visual impairment, and bodies burns, Possibility of setting up a collaborative management system, and the presence of people outside the rural custom for charcoal. The position evaluation matrix and strategic action confirmed the defensive strategy (for the whole statistical population and experts) and the conservative (for the local population). It was suggested to optimize forest management and reduce charcoal production, empower local communities and create micro-funds for afforestation and reforestation, and reduce or remove charcoal production from oak trees.

**Keywords:** Questionnaire, Experts, Defensive Strategy, Deforestation, Forest Restoration.



## **CHITOSAN AS WET AND DRY STRENGTH AGENT OF DEINKED RECYCLED PULP**

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Paper recycling increased during the last decades due to different economical, technical and environmental issues. Writting and printing waste papers are of the most valuable waste biomaterilas which are usually deinked and used as hygiene papers. On the other hands, application of the hygiene papers increased both in developed and developing countries, mainly based on the deinked recycled fibers, traditionally using petrochemicals like polyamide epichlorohydrin (PAE). Effects of chitosan biopolymer as a biobased chemical and its performance compared to the common synthetic PAE on the wet and dry strengths, whiteness, brightness and water absorbency of the handsheets prepared from deinked pulp of mixed office waste paper were carried out at 0.5, 0.75 and 1% addition levels of the bio and oil-based chemicals. SEM images proved the sedimentation of additives and higher advent of chitosan fibers than PAE. Higher dry tensile, burst and wet tensile strengths, lower rate and content of water absorption of treatment with chitosan were determined mainly caused due to creation of cross linkages among the paper ingredients during the drying. Due to the high similarity between the cellulose and chitosan structutres and also plenty of amine and hydroxyl functional groups of the chitosan, the bonding increased while water uptake sites decreased and blocked simultaneously. Extensive bonding resulted in lower flexibility and higher bending stiffness, which was higher in PAE than chitosan treatments at 0.5%. In spite of declining trend, variations in whiteness (111%) and brightness (86%) of chitosan reinforced handsheets were insignificant. Generally, 0.5% of the chitosan compared to 1% of PAE, provided higher strengths values and minimum reduction in water absorption (-10%) and optical properties while higher flexibility donated to the paper. Also an improvement in the wet strengths of the fibrous network could be resulted in better machine runnability.

**Keywords:** Wet and Dry strength, Water absorption, Chitosan, Polyamide epichlorohydrin. Deinked Pulp.





## **CHITOSAN APPLICATIONS IN LIGNOCELLULOSIC INDUSTRIES: A BRIEF REVIEW**

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In Lignocellulosic products industries, various chemicals are usually used reaching to different and mandatory purposes like controlling and improving of process and product properties, reduction of pollution issued by waste streams of waters and solids etc. Petrochemicals like Polyacrylamides, formaldehyde adhesives (PF, UF), Poly amid amine epichlorohydrine, are of the mostly and widely used chemicals in lignocellulosic mills. But the various sections of lignocellulosic industries could benefits from bio based chemicals instead of the petrochemicals. Chitosan as abundant and nearly available biopolymer from aqua systems all around the world could provide a better alternative compared to the other biopolymers like starches and gums with huge and vital applications in food and feed applications. Close similarity to cellulose chemical structures and intrinsic cationic charge of aminated chitosan are the key motivating factors toward anionic lignocellulosic fibres. Biodegradability, biocompatibility and biodegradability is going to be forced and obliged in any future products, too. Then, in this brief review, chitosan reported applications and potentials in the lignocellulosic industries will discuss and the structure, reaction mechanisms, affected properties and reported results will also be addressed.

**Keywords:** Lignocellulosic Industries, Chitosan Application and Potentials.



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**FORESTS AND WATER: FROM QUANTIFICATION OF CANOPY WATER  
BALANCE TO WATER FOOTPRINT OF WOODY PRODUCTS**

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The challenges of feeding the world's population using the limited water resources have been compounded by population growth, socio-economic development, climate change and global warming. Deforestation and afforestation affect hydrological processes in a way that may directly influence water availability, among which forest evaporation accounts for 45–58% of the total vapour flow from land to atmosphere. Although precipitation is renewable, it is limited in time and space, and so are its subsequent pathways as green (which refers to precipitation on land that is stored in the soil or temporarily stays on top of the soil or vegetation, and also refers to the rainfall incorporated into harvested crops or wood) and blue water flows (which refers to surface and groundwater). This review tries to summarize our current understanding of forest canopy water balance and water footprint quantification of woody products using recent case studies and examples. The water footprint of a product can contain green, blue and grey (which refers to the volume of polluted ground- and surface water) components and is defined as the total amount of freshwater that is needed to produce it. Large amounts of freshwater are required throughout the supply chain of a product until the moment of consumption. For quantifying this amount, the water footprint concept can be used. The literature review illustrates that during different stages in the production process, from growing wood to processing pulp into the final consumer product, most of the water is consumed in the forestry stage, where water consumption refers to the forest evapotranspiration. The differentiation of intra- and inter-temporal variability of meteorological and evapotranspiration data at the global grid would improve the accuracy of green water footprint assessments and should be a matter of future research.

**Keywords:** Canopy water balance, Evapotranspiration, Forest products, Water footprint



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## **ESTIMATING THE SPATIAL DISTRIBUTION OF WOODY BIOMASS IN HYRCANIAN FORESTS**

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Forest biomass has regarded as a key factor in carbon cycles of forest ecosystem, which affects carbon emission through forest harvest, burning, growth, and expansion. Precise estimates of forest biomass spatial distribution are important for reducing uncertainty in estimating carbon emissions due to deforestation and forest degradation associated with selective logging and fires. In the present study, aboveground biomass was estimated by applying allometric regression equations previously developed locally that only require tree diameters. The data used was collected from 246 plots with an area of 1000 m<sup>2</sup> in Gorazbon district of Kheyroud forest, north of Iran. The performance of kriged map results for the interpolation of field data was assessed by cross-validation. Our geostatistical analyses revealed that diameter at breast height, height, and biomass distribution are spatially structured and autocorrelated up to 1.5, 55, and 6.8 m, respectively. Ordinary kriging was performed to predict aboveground biomass at unsampled locations. The total estimates of aboveground biomass and root mean squared cross-validation errors (RMSCVE) were 178 ton/ha and 8/7%, respectively.

**Keywords:** Forest biomass, Geostatistics, Hyrcanian forests, Kriging



## **INCREASING THE OUTDOOR DURABILITY OF UREA FORMALDEHYDE PARTICLEBOARDS WITH NEW GENERATION WATER-BORNE ACRYLIC COATINGS**

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In general, urea formaldehyde glue has a low moisture resistance ratio and therefore, particleboards produced with urea formaldehyde are suitable for use in closed areas. However, melamine formaldehyde glue moisture resistance is relatively higher than urea formaldehyde glue moisture resistance. Particle board products produced with melamine formaldehyde can be used in semi-open outdoor conditions and indoor structures, except for common usage areas, where there may be hot-cold water leaks, moisture deposits or steam, such as bathrooms, showers, sinks, cellars or sinks (kitchen sinks).

In this study, it is aimed to increase the resistance of urea formaldehyde particle board to semi-open outdoor conditions (temperature and humidity) by applying water-borne acrylic coatings. The outdoor durability of urea formaldehyde particleboards (test samples) prepared with in two different water-borne acrylic coating formulations was compared with urea formaldehyde and melamine formaldehyde particleboards (control samples). For the test and control samples, artificial weathering test was applied for 12 days (288 h). After the weathering test, some mechanical (flexural strength, modulus of elasticity, tensile strength) and physical (surface roughness, water absorption, moisture and density) of the test and control samples were determined.

After the outdoor test, the change in the mechanical and physical properties of the test samples were found close to the control on melamine formaldehyde particleboards. However, it was determined that the semi-open outdoor durability of the test samples was quite higher than urea formaldehyde particleboards without coating applied. The results of this study showed that in semi-open outdoor conditions, urea formaldehyde particleboards can be preferred instead of melamine formaldehyde particleboards.

**Keywords:** Urea formaldehyde, melamine formaldehyde, particleboard, acrylic varnish, outdoor durability, mechanical properties, physical properties



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**THE PROBLEMS OF FURNITURE SECTOR AND SUGGESTIONS FOR SOLUTIONS (A CASE STUDY OF VAN)**

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This study was carried out in order to identify the problems experienced by SME enterprises operating in Furniture Industry Site in Van city center. For this purpose, it was randomly selected from the enterprises registered in Van Chamber of Carpenters. Businesses with a number of employees ranging from 1 to 10 produce furniture and wooden doors and windows. Businesses were visited and face-to-face question-answer technique was applied. Thus, data on establishment date, area, number of employees, type of production, existing machines, sales method, problems experienced and supports received were collected. As a result, it was determined that the problems were insufficient demand, lack of capital, lack of qualified personnel, transportation and social and physical facilities. The problems of small-scale furniture enterprises operating in the province of Van have been identified and examined and solution suggestions have been included.

**Keywords:** Furniture, industry, business, Van.



**PRODUCTION OF *PLEUROTUS OSTREATUS*, *PLEUROTUS CITRINOPLEATUS* AND *PLEUROTUS DJAMOR* IN DIFFERENT CONTENTS AND SOME PHYSICAL ANALYSIS**

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In this study, some physical analysis of oyster mushroom (*P. ostreatus*), yellow oyster mushroom (*P. citrinopileatus*) and pink oyster mushroom (*P. djamor*) were investigated. Waste sawdusts of beech, alder, chestnut and walnut wood were used as substrate. After sterilization of sawdusts, %3 micelle and %1 calcitic lime were added to the sawdusts and placed in the nylon bags. There was only one type of sawdust in each nylon bags. The temperature of the cultivation room was  $15\pm 2$  °C, the humidity was 80 - 90%, and ventilation was made at certain intervals. *A. bisporus* is used as control and purchased from local. In the study, *P. citrinopileatus* was the fastest micellization mushroom type at the beech sawdust substrate, Mushrooming was the slowest in the *P. djamor* type at the chestnut sawdust substrate. Growing in chestnut sawdust substrate, the *P. djamor* is generally considered to be the lowest width-length measure mushroom. For *P. ostreatus* growing in beech sawdust compost, the fungus produced can have the highest width-length dimensions. The lowest yield was 19.77% in the *P. djamor* at the chestnut sawdust substrate. The highest yield was *P. citrinopileatus* species grown in beech substrate with 31.02%. Following this, *P. ostreatus* growing in beech sawdust substrate was very close with 30.99% yield. The lowest biological activity rate was 38.22% at the *P. djamor* which grown in chestnut sawdust substrate. The highest biological activity rate was *P. citrinopileatus* growing in beech sawdust substrate with 70.93%.

**Keywords:** *P. ostreatus*, *P. citrinopileatus*, *P. djamor*, Physical analysis, Wooden substrate, Micellization, Mushroom quality and yield, Biological activity



## **METAL AND RADIONUCLIDE ACCUMULATION IN SOME CULTIVATED MUSHROOM SPECIES**

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Heavy metals and radionuclides, which include potential hazardous substances, occur naturally or artificially produced in nature. They accumulate in plants, animals and fungi over a period of time. In particular, some fungal species have a high capacity to absorb radionuclides. Their excessive accumulate can be damaging to the other living organisms. In this study, metal and radionuclide accumulations in some culture mushroom species such as *Pleurotus eryngii*, *Pleurotus citrinopileatus* (cultivated on alder and walnut tree sawdust, separately) and *Pleurotus djamor* (cultivated on beech and walnut tree sawdust, separately) were investigated. Metal accumulations were determined by using Inductively Coupled Plasma – Mass Spectrometer (ICP-MS). Radioactivity measurements were performed by using High Purity Germanium (HPGe) detectors. Among the studied mushrooms, *Pleurotus citrinopileatus* had drawn attention with the highest 52Cr, 55Mn, 60Ni, 63Cu, 66Zn, 204Hg, 206Pb contents. 232Th and 238U content were not detected in any mushroom species. 137Cs was not detected in any mushroom except *Pleurotus citrinopileatus* cultivated on alder tree sawdust ( $15 \pm 3$  Bq/kg.). Also, the highest 40K radionuclide content was determined in *Pleurotus eryngii* cultivated on alder tree sawdust ( $947 \pm 32$  Bq/kg.) It was concluded that the metal and radionuclide content of mushrooms were affected by mushroom type and cultivation conditions.

**Keywords:** Cultivated mushrooms, metal, *Pleurotus spp.*, radionuclide



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**WOOD AND WOOD DERIVATIVES IN URBAN FURNITURE USED IN  
LANDSCAPE DESIGN PROJECTS**

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Wood material is used in many different areas in the historical process, and today it is frequently used in urban furniture within the scope of landscape applications. It is very important that these materials are compatible with the environment and suitable for the design. In this study, different urban furniture made of wood and wood-based materials were examined in order to improve existing designs. In the examples examined, urban furniture designed in accordance with the general design principles was handled; Determinations were made within the framework of elements such as aesthetics, size, form, ergonomics, functionality, construction, material, robustness, security, layout and economy. In addition, different suggestions and suggestions were made for the development of urban furniture, which is a part of landscape applications, and for the emergence of new designs in harmony with nature by examining the visual and material types on the sample wooden reinforcements.

**Keywords:** Urban Furniture, Wood, Landscape, Design.





**DETERMINATION OF FORMALDEHYDE/UREA MOLE RATIO EFFECTS ON SOME PROPERTIES OF PARTICLEBOARD MANUFACTURED WITH MIXTURE OF MELAMINE IMPREGNATED PAPER WASTES (MIPW) AND NEAT UREA-FORMALDEHYDE RESIN**

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In this study, the effects of formaldehyde/urea ratio in the mixture of MIPWs and neat urea-formaldehyde resin on the FE values, mechanical and physical properties of particleboard were investigated. Two different urea-formaldehyde resin (UF) mole ratio (1 mole and 1.25 mole) was used. UF was used for both core and surface layers. The resin was reduced in equal rates from both layers and MIPWs were added to equal to the reduced ratios. Three different rates of MIPWs (0% for both layers, 1.9%SL-1.4%CL and 3.8%SL-2.8CL) were studied. Formaldehyde content was examined by perforator method according to EN 120. Moreover, mechanical and physical properties including bending strength, modulus of elasticity, internal bond strength, surface soundness, screw withdrawal strength, thickness swelling and water absorption of the samples were determined according to EN 310, EN 319, EN 311, EN 320 and EN 317 standards, respectively. Based on the results obtained, UF mole ratios and MIPWs using rates were statistically effective on the FE values, mechanical and physical properties of the produced boards. FE value was decreased with decline of UF mole ratios and strength values were also reduced as expected. However, all the particleboard groups, manufactured with UF 1 mole ratio resin were satisfied the standard requirements for FE values, mechanical and physical properties except thickness swelling. In spite of the fact that particleboard groups produced with UF 1.25 mole ratio resin were provided higher mechanical and physical properties than UF 1 mole ratio resin groups, they showed higher FE values than standard requirements and they did not provide desired properties for FE values. With the rising of MIPWs using rates FE values were slightly getting worse. Although the mechanical properties were shown vary according to the resin mole ratio, all the manufactured groups were satisfied standard requirements for mechanical properties. In addition, all the tested boards had satisfied the standard requirements for water absorption but not for thickness swelling.

**Keywords:** Urea-formaldehyde resin; mole ratio; formaldehyde emission; melamine impregnated paper waste; mechanical and physical properties.



**UTILIZATION OF UREA POWDERS WITH DIFFERENT SIZES AS A  
FORMALDEHYDE EMISSION SCAVENGER IN THE PARTICLEBOARD  
MANUFACTURING**

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In this study, the effects of different size and rate of urea powder usage in particleboard manufacturing on the formaldehyde emission of the boards were investigated. In addition, the effect of the urea powder usage method (mixing with adhesive or separately) on formaldehyde emission was also investigated. Two different sizes (Large, Small) and five different rates of urea powder (1, 2, 3, 4 and 5%) were used for particleboard manufacturing. Urea formaldehyde (1.35 moles) adhesive was used for production of three-layered particleboards. Formaldehyde emission properties were examined by perforator method according to EN 120. Furthermore, mechanical and physical properties including bending strength, modulus of elasticity, internal bond strength, surface stability, thickness swelling and water absorption of the samples were determined according to EN 310, EN 319 and EN 317 standards, respectively. Formaldehyde emission values was decreased with the mixing of the urea powder with chips prior to gluing and the produced boards had E0 grade in terms of formaldehyde emission. The size and rate of the urea powder were statistically effective on the mechanical and physical properties of the produced boards. In addition, all of the boards in this group satisfied the required standards. It should be noted that slight decrease of mechanical and physical properties was observed. The usage method of the urea powder also has a significantly effect on particleboards properties (formaldehyde emission, mechanical and physical properties). As a result, it was determined that mixing of the urea powder passing through the 0.2 mm sieve with the chips before gluing provided better results.

**Keywords:** Formaldehyde emission, carcinogenic substance, particleboard, urea formaldehyde adhesive, urea powder.



## **EFFECT OF NANOCELLULOSE AND BORAX ON FORMALDEHYDE EMISSION OF PLYWOOD PANELS**

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Nanoscience and nanotechnology represents a major opportunity for enhancing the properties of wood-based composites. Wood-based composites fall into two categories from the end application. Panel applications, such as particleboard, medium density fiberboard, plywood and oriented strand board; and beam or header applications, such as laminated veneer lumber, parallel strand lumber, oriented strand lumber and glue laminated timber. One of the most important wood products for structural use is plywood. It is used for furniture, construction, roof and floor sheathing and more. Urea formaldehyde, phenol formaldehyde and melamine-urea formaldehyde adhesives are most commonly used binders in production of wood-based composites and due to formaldehyde in their chemical structure creates a major environmental and health issues. Developing low formaldehyde-emitting plywood panels as environmentally friendly wood-based composites by nanotechnology was the major goal of this study. The melamine-urea formaldehyde (MUF) adhesive that were used to produce plywood panel, respectively, were reinforced with various nanocellulose (NC) and borax (BX) at different loading levels. Formaldehyde emission tests were carried out according to standard TS 4894 EN 120. The results acquired in this work indicated that nanocellulose and borax reinforcement significantly affected the formaldehyde emission properties of the plywood panels. Formaldehyde emissions of the plywood panels decreased after reinforcement with nanocellulose and borax at proper loading levels. Therefore, using nanotechnology, it is possible to produce environmentally friendly furniture components, structural and building materials.

**Keywords:** Nanocellulose, Borax, Plywood, Formaldehyde emission, Wood-based composite panels



**INFLUENCE OF THERMAL MODIFICATION OF ASH WOOD  
(*Fraxinus excelsior* L.) AND MACHINING PARAMETERS IN CNC FACE  
MILLING ON SURFACE ROUGHNESS USING RESPONSE SURFACE  
METHODOLOGY (RSM)**

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The objective of this research was to analyze the effect of thermal modification of ash wood (*Fraxinus excelsior* L.) at moderate temperature of 160°C and three processing parameters: spindle speed, feed rate and depth of cut in CNC face milling operation on surface quality, expressed by arithmetic surface roughness parameter (Ra).

In order to determine material properties, moisture content (MC), density, swelling, anti swelling efficiency (ASE) and contact angle for both untreated and thermo-treated ash wood have been measured.

Highly effective, incomplete 3<sup>3</sup> Box-Behnken factorial design was made, with three levels of spindle speed: 8.000, 12.000, and 16.000rpm; three levels of feed rate: 1.000, 1.500 and 2.000 mm/min; and three levels of depth of cut: 2, 4, and 6 mm. According to the above design matrix, all groups of 50x50x30mm samples have been machined with two machining strategies: *raster* and *offset*. Surface roughness parameter Ra was measured per each run. Response - surface analysis (RSM) was applied to the parameter Ra for all sets of samples. The 3-D response surface plots, polynomial equations and ANOVA tables have been obtained per each observed input variable, for both machining strategies (*raster* and *offset*).

The results indicated that the thermal modification of ash wood at 160°C improved it's physical properties: decreased MC, improved wood density, improved ASE and increased wood hydrophobicity.

Polynomial equations and ANOVA tables showed different behavior of untreated and treated ash wood regarding changing of machining parameters in experimental space. *Offset* processing strategy, gave better results in the quality of wood surface, than *raster* processing strategy for all types of samples. Thermal modification of ash wood at 160°C improved surface quality after machining for both processing strategies.

**Keywords:** ash wood, thermo-wood, surface roughness, response surface methodology (RSM), design of experiment (DOE), CNC face milling



## **INVESTIGATION OF THE EFFECT OF BUILDING MATERIAL SELECTION AND DESIGN STYLE ON KILN THERMAL PROPERTIES IN SOLAR KILNS**

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Natural and technical drying methods are generally applied in timber drying. Although energy is not used in natural drying, the drying time is long and timber cannot be dried until the desired humidity for interior spaces. Despite the fact that timber can be dried up to the degree of humidity desired in technical drying, drying costs are high. In the timber industry, 70% of the energy is spent during the drying phase. Depending on the tree type and timber thickness, the energy spent varies between 600-1000 kWh for 1 m<sup>3</sup> of timber. In recent years, the drying of timber with solar energy is being studied as an alternative drying method in order to reduce energy costs in drying. For this purpose, various types of solar energy timber drying ovens are designed and drying trials are carried out. In most of these studies, it was concluded that solar furnaces can be used economically if fuel prices increase and solar collectors' costs can be reduced. In these studies, the effects of wall building materials on the temperature regime have not been evaluated. In terms of drying quality, drying temperatures appropriate for the characteristics of the dried timber should be applied. During the sunbathing period, the temperature rises first, it drops again after reaching the maximum value between 12:00 and 14:00. The specific heat and heat conduction coefficients of the wall materials also have important effects on the change of the oven temperature. The negative effects of intense energy consumption on costs and environmental pollution in timber drying have strengthened the tendency to benefit from solar energy in recent years. Although drying of timber in flat collector solar ovens takes more time than conventional drying, energy costs are low and there are no negative environmental effects.

In this study, the selection of building materials and design type to be used in the design of solar furnaces are evaluated in terms of thermal properties. Materials with different thermal capacities create different thermal features in different designs. Therefore, it is possible to control the course of the temperature distribution throughout the solar timber drying ovens by choosing different building materials and design types.

**Keywords:** Solar kilns, timber drying, drying economy, furnace design



## **A SCALE DEVELOPMENT STUDY TO EXAMINE THE APPLICATION OF TOTAL QUALITY MANAGEMENT**

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The total quality management approach is a management style in which the human factor stands out, continuous development and improvement is adopted, group work is emphasized in the enterprise, and quality responsibility spreads to all of the employees. The goal of total quality management is to provide continuous and excellent service to the customer with well-trained and motivated employees.

Within the scope of this study, some features (customer orientation, management leadership, full participation, systematic process analysis and human understanding first) of total quality management activities implemented in forest products industry are examined. For this purpose, 377 engineers and foremen working in 14 large-scale companies with ISO 9001 Quality Management System Certificate were reached through a survey method. The questionnaire used consists of two parts. In the first part, some demographic features of the employees were evaluated with 13 questions. In the second part of the survey, the management system applied in the enterprises was researched with 50 questions. The survey data were evaluated with the Structural Equation Model (SEM) prepared in SPSS and AMOS statistical package programs and the results were revealed.

As a result, a statistically acceptable scale has been put forward for researchers who want to examine the total quality management studies in the forest products industry.

**Keywords:** Total quality management, scale development, forest products industry, Quality management



## **MULTICRITERIA EVALUATION OF STRUCTURAL COMPOSITE LUMBER PRODUCTS**

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In this study, laminated veneer lumber, parallel strand lumber, and laminated strand lumber were evaluated via multicriteria decision-making methods. Within the model, nine evaluation criteria were defined: moisture content, density, bending strength, modulus of elasticity, compression strength parallel to grain, dynamic bending strength, tensile strength parallel to surface, tensile strength perpendicular to surface, and screw holding capacity. The weights of the criteria were computed using the fuzzy analytic hierarchy process (FAHP). The evaluation based on distance from an average solution (EDAS) and the technique for order preference by similarity to an ideal solution (TOPSIS) were employed to determine the ranking of the alternatives. After the borda count method was used, an integrated ranking was obtained. According to the results, the first three important subcriteria were density, bending strength, and modulus of elasticity. Furthermore, laminated veneer lumber was determined as the best alternative. Consequently, this study can present a road map to evaluate wooden materials.

**Keywords:** Structural composite lumber, Multicriteria decision-making, FAHP, EDAS, TOPSIS



## **LOCATION SELECTION FOR THE FURNITURE INDUSTRY BY USING A GOAL PROGRAMMING MODEL**

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The location of a facility plays a significant role in minimizing costs and maximizing the utilization of resources. Therefore, in this study, a goal programming model was proposed to determine an appropriate location for the furniture industry. Seven provinces in the Western Black Sea Region of Turkey were considered as candidate places. The objectives of this study were identified as follows: proximity to raw materials, the number of qualified people, proximity to markets, population, and distances to other provinces in the region. The proposed model was solved using an optimization tool. The results demonstrated that Karabük was the best choice. Consequently, the model proposed in this study can be used as a guideline for furniture firms.

**Keywords:** Goal programming, Facility location problem, Furniture industry, Western Black Sea Region, Turkey





## **ANALYSIS OF FOREST INDUSTRY SECTOR IN SOUTH SUDAN AND TURKEY**

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The forest estate of South Sudan represents a key national asset for generating significant sources of revenue for the developing nation. As such its proper management is essential for promoting social and economic development. However, the opposite is proving true since challenges in the sector are not well addressed. The study analysed the Forest Industry Sector, associated challenges and potential opportunities in the case of South Sudan and how Turkey can help develop South Sudan Forest Industry Sector. Secondary sources of data were used for the study; internet webpages, Government and Private institutes documents. South Sudan is well endowed with diverse natural forests and woodlands: out of its total land area, forests cover approximately 30% (191,667 km<sup>2</sup>). Among the most valuable tree species found, Teak makes up roughly 2-3% of overall forest area and yet has an extremely important role in generating revenue from exportation with the rising global demand. However, the development of a viable industry has been slow due to the lack of a legal framework and regulatory clarity in the sector; lack of Technical and Management capacity; and lack of infrastructure. Considering the total forest land cover 28.6%, in Turkey, Broadleaves Forest is 33%, Needle leaves Forest 48% and mixed forest is 19%. And the most widely used species are Pine, Beech, Oak, chestnut Firs and Spruce. Given that Turkey is a major player in the sector with some known brands worldwide, investing in South Sudan forest estate would witness a desirable development in the sector, help Turkey satisfies its Teak and other tropical tree species demand, and would generate a huge revenue which would benefit both countries and open South Sudan forest industry to the world.

**Keywords:** Forest Industry, plantation, natural forest, Teak, Mahogany and Bamboo trading, forest products import and export.



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**ALTERNATIVE SOLUTIONS FOR DECREASING FORMALDEHYDE EMISSION  
FROM WOOD-BASED PANELS**

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Formaldehyde emission is one of the important issues in wood-based industry due to its harmful effects to humans and environment. Thermosetting resins are the main source of formaldehyde emitted from wood-based panels such as medium density fiberboard (MDF), particleboard, plywood, oriented strandboard. Among the formaldehyde based thermosetting resins, the most used resin is urea-formaldehyde in the wood-based panel industry due to its significant advantages, such as low-cost, easy-supply, low pressing temperature and duration, good mechanical properties in dry conditions. The regulations of governments focused on the decreasing of the formaldehyde emission from wood-based panels. The companies decreased formaldehyde/urea ratio, and adding natural and synthetic formaldehyde catchers into the resin. There are many factors on the formaldehyde emission from wood-based panels. In this study, the recent studies on the formaldehyde emission from wood-based panels were summarized.

**Keywords:** Formaldehyde emission, resin, wood-based panels, additives, formaldehyde catcher



**TECHNOLOGICAL PROPERTIES OF MDF PRODUCED WITH UREA-FORMALDEHYDE RESIN CONTAINING PLUG-SCREW WATER OF DIGESTER IN MDF PLANT**

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The physical and mechanical properties and formaldehyde emission of medium density fibreboard (MDF) produced with urea formaldehyde (UF) resin containing plug-screw water of digester. The 5 wt%, 7,5 wt%, and 10 wt% plug screw based on the oven-dry weight of water were added into the UF resin used in the core and face layers. The gallic acid (GC-MS analysis) and total phenolics (Folin Ciocalteu method) were determined as 40,68 mg/L and 244,99 mgGAE/100 g, respectively. The MDF panels were produced under laboratory conditions. The bending strength, bending modulus, screw withdrawal resistance, water absorption and thickness swelling of the MDF panels produced with plug-screw showed higher bending strength and bending modulus and as compared to the control group. However, above 5wt% plug screw, the internal bond strength and surface soundness of the MDF panels decreased. As for the formaldehyde emission, the MDF panels produced with 10wt% plug screw showed lower formaldehyde emission (10,29 mg/100 g) than the control group (13.2 mg/100 g). The results showed that the plug-screw water could be successfully used in the urea-formaldehyde resin for producing of MDF panels.

**Keywords:** Plug-screw water, MDF, urea-formaldehyde-resin, formaldehyde emission, technological properties



## **DECAY RESISTANCE OF WEATHERED BEECH WOOD**

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Wood expose to photo-degradation in outdoor applications, and deformations occur on its surface such as micro or macro cracks, color changes etc. Especially, cracks make wood material more vulnerable to biotic attacks. In this study, decay resistance of natural and accelerated weathered beech samples was investigated by a brown (*Coniophora puteana*) and white rot (*Coriolus versicolor*) fungi. For this purpose, beech samples exposed to natural weathering (NW) for 393 days, and accelerated weathering (AW) for 1512h, and then subjected to decay test in malt extract agar medium for 2 and 4 weeks. After 2 weeks of decay testing, weight loss of samples by *C. versicolor* was found to be 22% for controls, 11% for AW samples and 20% for NW samples. In the case of *C. puteana*, it was found as 21%, 21% and 26% for controls, AW samples and NW samples, respectively. Weight loss of samples by *C. versicolor* was found to be 62% for controls, 28% for AW samples and 41% for NW samples, after 4 weeks of decay testing. The weight loss by 4 weeks exposure of *C. puteana* was found to be 21%, 24% and 31% for controls, AW samples and NW samples, respectively. Natural weathering caused more weight loss than accelerated weathering test in the laboratory.

**Keywords:** White rot, brown rot, natural weathering, accelerating weathering, beech.



## **WATER ABSORPTION, DIMENSIONAL STABILITY AND DECAY RESISTANCE OF TREATED WOOD BY SILICA BASED SOLUTIONS**

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In this study, the effect of two different silica (SiO<sub>2</sub>) based solutions on water absorption, dimensional stability and decay resistance of Scots pine wood was studied. Sol-gel process was used in order to prepare SiO<sub>2</sub> based solutions. One of the SiO<sub>2</sub> based solutions (Sol 1) was prepared by using tetraethoxysilane (TEOS), ethanol and de-ionized water (TEOS:H<sub>2</sub>O=1:1/2). The same precursors was used for preparing the other solution (Sol 2) but with a different molar ratio of TEOS:H<sub>2</sub>O=1:4. Scots pine wood samples were first vacuum impregnated with the solutions and then cured. The level of water absorption and dimensional stability were determined with cyclical wetting tests, total of 14 days. Samples were exposed to brown rot fungus, *Coniophora puteana* attack according to EN 113 standard to determine the best SiO<sub>2</sub> based solution for sufficient decay resistance. Leached samples were also suspected to decay test in order to evaluate any loss in effectiveness in decay resistance due to possibility of silica leaching. Both solutions had similar weight percent gains in wood, around 25%. SiO<sub>2</sub> treated samples decreased water absorption of wood as 20% in comparison with untreated controls. Dimensional stability of wood was found as 39% for Sol 1 solution and 48% for Sol 2 solution at the end of the test. Decay resistance of treated samples was in the range of 63-91% in comparison with controls. Sol 2 solution were found efficacious in suppressing *Coniophora puteana* attack when no leaching prior the decay test was used, however, Sol 1 solution seemed to be ineffective against fungus attack that exhibited more than 3% weight loss. Leached samples had higher weight loss than un-leached samples. The remained silica inside leached wood supposed to be not sufficient enough to prevent brown rot fungus attack on wood. Results clearly showed Sol 2 solution had better water absorption and dimensional stability rates, and decay resistance than Sol 1 solution.

**Keywords:** Scots pine, sol-gel, decay resistance, dimensional stability, water absorption.



**PREDICTION OF RETENTION LEVEL AND MECHANICAL STRENGTH OF PLYWOOD TREATED WITH FIRE RETARDANT CHEMICALS BY ARTIFICIAL NEURAL NETWORKS**

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The treatment with fire retardant chemicals is the most effective process to protect wood and wood-based products from fire is. Therefore, use of fire-retardant chemicals has been increased. However, the fire-retardant chemicals have an effect on other physical, mechanical and some technological properties of the materials treated with them. In this study, firstly, the retention level prediction model was developed with the artificial neural network (ANN) to examine the effects of wood species and concentration aqueous solution on the retention levels of veneers. Then, the effects of wood species, concentration aqueous solution and retention level on the mechanical properties of plywood were investigated with the mechanical strength prediction model developed with ANN. The prediction models with the best performance were determined by statistical and graphical comparisons. It has been observed that ANN models yielded very satisfactory results with acceptable deviations. As a result, the findings of this study could be employed effectively into the forest products industry to reduce time, energy and cost for empirical investigations.

**Keywords:** Artificial Neural Network, Fire Retardant, Plywood, Concentration, Retention Level, Mechanical Properties



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**THE EFFECTS OF WOOD SPECIES, NAIL SIZE, GRAIN DIRECTION AND LAYER NUMBERS ON LATERAL NAIL STRENGTH OF STRUCTURAL PLYWOOD PANELS**

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In the use of solid wood and wood-based composite materials in wooden structures, metal elements such as nails, screws and bolts are used as fasteners. The strength of the connection points depends on many factors. In this study, it was aimed to determine effects of wood species, nail size, grain direction and layer numbers on lateral nail strength of structural plywood panels. Scots pine, black pine and spruce were used as wood species for structural plywood production. Five and seven-ply plywood panels, 10 mm and 14 mm thick, were manufactured by using phenol formaldehyde glue resin. Lateral nail strength test was performed according to ASTM D1761. The specimens were oriented so that the load was applied parallel and perpendicular to the grain of the main axis of plywood panel during the test. Also, nail size was chosen as 6d and 8d for test. As a result of the study, it was seen that the Scots pine plywood gave the highest lateral nail strength values among other wood species. Lateral nail strength values of seven-ply plywood was found higher than five-ply plywood. Lateral nail strength value of the samples using 8d nails was found to be higher than those using 6d nails. Also, it was determined the lateral nail strength values in perpendicular to grain were higher than those in parallel to grain.

**Keywords:** Lateral Nail Strength, Structural Plywood, Nail Size, Grain Direction, Layer Numbers



**AN ASSESSMENT OF CARBON FOOTPRINT IN MDF MANUFACTURING:  
A CASE STUDY OF WOOD BASED PANEL PRODUCTION IN TURKEY**

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Nowadays, carbon footprint (CF) is became an important topic closely related to the ecological production of goods and services. Energy use and subsequent emissions of greenhouse gases (GHGs) in all human facilities affect the World's climate in the form of Global Warming in recent decades. The dominant greenhouse gas arising from human activities is carbon dioxide (CO<sub>2</sub>). Carbon footprint is CO<sub>2</sub> and other GHGs that is released per unit product for a specific period. The main purpose of this study is the determination of most important critic processes about that contribute to the CF problem during medium-density production with Pareto analysis method. Medium-density fiberboard is a kind of composite panel product which is typically containing of cellulosic fibers with the combination of synthetic resins and additives becoming under heat and pressure. For this purpose, a wood-based panel company is selected to examine CF for its production processes. As a conclusion this study makes an important contribution to the panel-based industry to see the emission problems with the help of Pareto analysis and to perform an environmental oriented production. Moreover, two scenarios are built up to decrease of total carbon footprint in the selected plant. So, the analysis results are supported with two scenarios. Also, this study shall provide a general view and perception for the importance of the carbon footprint in the industrial sector.

**Keywords:** Carbon footprint, Medium-density fiberboard, Pareto analysis, Scenarios.





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**EVALUATION PRODUCT DEVELOPMENT, PRODUCT DESIGN FOR THE  
FURNITURE-WOOD INDUSTRY VIA QUALITY FUNCTION DEPLOYMENT  
AND PARETO ANALYSIS**

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Product Development, product design is often discussed from a strategic perspective by industry experts. A common view is that product development is necessary, and companies are advised to focus their efforts on it. In this study, the product development processes of companies in this industry are examined. The literature and concepts of product development, user friendly design, the state of innovation research in the furniture-wood industry and implementations of these concepts in the system, marketing strategy for the industry are presented in order to support the objective of this study. One purpose of this research is also to define the fundamental concepts and properties of the span of activities leading to products that are new to the firm, product development process and its key success factors but not necessarily new to the market perception, to present the literature of the resource-based view of the firm and the organizational capabilities approach approaching and to discover the principles towards the framework for furniture-wood industry. The study shares common ground with several of the perspectives described above. This study aims to further the knowledge about product development in the furniture-wood industry and to provide insights that can help management, make their business' product development process more effective. According to this objective, the research is to demonstrate a general overview and assessment of product design-development in terms of management, quality management, and furniture products with the customer and market-business requirements via Quality Function Deployment (QFD) and Pareto Analysis (PA) for the wood-furniture industry.

**Keywords:** Furniture Industry, Pareto Analysis (PA), Product Development, Product Design, Quality Function Deployment (QFD)



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**EVALUATION FOR THE USAGE OF PLANER SHAVINGS OF SOME FRUIT TREES AS ADDITIVE MATERIALS FOR FIBERBOARD PRODUCTION**

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This study aimed to investigate some selected physical and surface properties of fiberboard prepared from commercial fibers and planer shavings of the sapwood of *Diospyros lotus* L., *Eriobotrya japonica* Lindl. and *Olea europaea* L. woods. In the panel preparation, the planer shavings were introduced into the fibers with the rate of 10, 20, 30 %. The mixtures of fibers and wastes were glued using by urea formaldehyde (UF) resin and made panel mats. Then, the mats pressed at 180 °C and 7 min. The water absorption (WA), thickness swelling (TS) values for 2, 24 h and surface roughness parameters of these panel samples were determined using related standarts. As a result of tests, it was found that, the water absorption, thickness swelling and surface roughness values changed depending on the experimental parameters such as addition rates of planer shavings, and wood species. Statistical evaluations also showed that these parameters had an important effect on the panel properties.

**Keywords:** Fiberboard, *Diospyros lotus*, *Eriobotrya japonica*, *Olea europaea*, sapwood.



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**MECHANICAL PERFORMANCE OF GREEN COMPOSITES MANUFACTURED FROM FURFURAL WASTES/PLA**

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This study aims to fabricate an eco-friendly wood plastic composite with poly lactic acid (PLA) biodegradable matrix reinforced by furfural waste powder derived from agricultural waste. Poly lactic acid samples were compared to the samples made by other researchers used synthetic plastics, to evaluate the results of this study. Also, to achieve the best properties of green composite such as mixing percentage, different ratios of furfural waste powder and poly lactic acid polymer in three levels of 70:30, 60:40 and 50:50 and Maleic anhydride grafted with polypropylene (MAPP) as a coupling agent at a constant level of 6% were used. In this study mechanical properties of test specimens including tensile strength and modulus and impact resistance were measured. The results showed that with increasing the amount of poly lactic acid, tensile strength and impact resistance increased and there was a significant improvement. On the other hand, by reducing the share of PLA and increasing the amount of furfural waste powder, it increased the tensile modulus. In general, the results showed that the use of poly lactic acid polymer along with furfural waste powder in the construction of green composite has desirable mechanical properties and even higher than expected.

**Keywords:** Eco-friendly, Wood Plastic, Poly lactic Acid, Mechanical Properties.



**DEVELOPING FURNITURE DESIGNS INSPIRED BY THE BADGE IN THE  
CANKIRI DARUSSIFAS**

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In this research, inspired by a hexagon shaped rosette in relief on the Darülhadis sentence door in Cankiri Darussifa (Stone Masjid), 8 different furniture designs were realized in the form of this rosette. With the designs realized, it has been tried to establish a connection between the past and the present, and to include historical badges in today's designs and to contribute to the furniture designs that reflect our culture and the historical awareness of the new generations.

**Keywords:** Interior architecture, furniture, design



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**DETERMINING THE CHARACTERISTICS REQUESTED IN KITCHEN  
FURNITURE SELECTION**

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In this research, it has been tried to determine the most wanted features in kitchen furniture selection. For this purpose, 100 randomly selected kitchen furniture produced and designed by a furniture design-production company operating in the center of Adiyaman (between 20.07.2019 - 20.07.2020) was considered and the features preferred by the customers were determined. According to this; the most preferred cabinet door color is white, the cabinet door material is lacquered, the cabinet door model is plain models, the counter color is white, and the color between the upper cabinet and counter is white. It has been determined that customers generally prefer white colors in their preferences, and it has been determined that white color has an important place in kitchen designs from past to present.

**Keywords:** Interior architecture, furniture, furniture choice



## **STRUCTURAL PERFORMANCE ANALYSIS OF CROSS LAMINATED TIMBER (CLT) PRODUCED FROM PINE AND SPRUCE GROWN IN TURKEY**

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Wooden buildings with many advantages such as being lightness, durability, earthquake resistant, healthy, insulating, and esthetic are suitable for all kinds places especially earthquake zones. Cross-laminated timber (CLT) has increasingly become a viable alternative to other structural materials, mainly because of its excellent properties related to sustainability, energy efficiency, and speed of construction. This has resulted in the recent emergence of a significant number of CLT buildings constructed around the world. This is a study on determining the properties of CLT panels manufactured from wood species grown in Turkey and investigating of the structural behaviour and seismic resistant performance of them. Lumbers of 100 mm (width) x 50 mm (thickness) x 2400 mm (length) used in CLT manufacturing were obtained from eastern spruce (*Picea orientalis* L.) and scots pine (*Pinus sylvestris*) logs. Two replicate three-layered CLT panels of 2400 mm x 2400 mm x 150 mm in size were manufactured for each group. Density of the CLT panels was determined according to EN 323. The seismic resistant performance of the CLT shear walls was determined according to ASTM E 72 standard. In addition, artificial neural networks (ANN) model has been established and the CLT wall groups in the scope of the study have been optimized. CLT panels manufactured from scots pine gave higher seismic performance than those of CLT panels manufactured from spruce. The maximum load capacity of the walls increased with increasing the density values of the CLT panels.

**Keywords:** CLT (Cross Laminated Timber), Structural behaviour performance, Artificial neural network, Scots pine, Spruce



## **INVESTIGATION OF HIGH STRENGTH COREBOARD PRODUCTION POSSIBILITIES**

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Some problems may arise from raw materials in packaging paper production factories used as waste paper raw materials. As waste paper fibers that are not primary fibers are recycled many times, the fibers can be shortened and cut. This situation causes a decrease in the strength properties of the produced paper. The aim of this study is to improve the strength properties of coreboards produced from waste papers using commercial cationic starches (Cargill (Charge120), Roquette (Hi-Cat c643a), ADM (Meribond 166)). Coreboards with 400 (gr/m<sup>2</sup>) grammages were produced by using certain proportions of cationic starch. Tensile and burst strength tests were carried out on the obtained coreboards, and the effect of cationic starches and dosage amounts on the strength was investigated. Based on the obtained results, it was observed that the coreboards produced using Hi-Cat cationic starch gave the best strength values. It was found that 40 kg/ton of Hi-Cat cationic starch gave the best values in cationic starch dosages such as 10-20-30-40-50 kg/ton. The breaking lengths (cross and machine directions) and burst strength of these coreboards were found to be 1900 m, 3893 m and 8 kg/cm<sup>2</sup>, respectively.

**Keywords:** Coreboard, cationic starch, waste paper, strength



**EFFECTS OF SANDING AND SURFACE SMOOTHING PROCESSES ON SURFACE ROUGHNESS AND VARNISH ADHESION OF BEECH, OAK AND PINE MASSIVE PARQUETS**

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The objective of this study was to determine effects of sanding and various surface smoothing processes on surface roughness and varnish adhesion of beech, oak and pine massive parquets. First of all, the parquet samples were classified into four groups. Fifteen parquet samples were used for each group. Parquet samples in first group were processed on thickness machine, samples in second group were processed on plane machine, and samples in third group were sanded with 60 grit sandpaper while the parquets in fourth group were sanded with 180 grit sandpaper, parallel to grain direction. The surface roughness of the samples was determined according to DIN 4768. After surface roughness measurements, parquet samples were coated with cellulosic varnish by using a spray gun at a spread rate on 120 g/m<sup>2</sup>. The adhesion strength of the parquet samples were determined according to ASTM D 4541. According to the study results, the highest surface roughness values were obtained in oak, and there was no statistical difference between beech and pine. The adhesion strength values of beech parquets were higher than pine and oak parquets. Processing of sanding with lower grit sandpaper resulted in increased surface roughness while improved adhesion strength characteristics between the coating and the substrate.

**Keywords:** Surface Roughness, Adhesion Strength, Parquet, Sanding, Varnish





**CELLULOSIC SUPERABSORBENT PRODUCTION WITH CITRIC ACID  
CROSS-LINKING METHOD**

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In this study, it was aimed to determine water absorption capacity of cellulosic superabsorbents that were produced by using citric acid crosslinking method. Cellulosic superabsorbents were prepared with mixing cellulose and carboxymethylcellulose at different ratio. The highest water absorption capacity in water was determined 2616% at pH:7 for cellulosic superabsorbent which was produced with cellulose (10%) and carboxymethylcellulose (90%). Absorption capacity of cellulosic superabsorbent in salt solution was calculated 984% for  $\text{NH}_4\text{Cl}_2$  solution. It was concluded that carboxymethylcellulose had an affirmative effect on water absorption capacity of cellulosic superabsorbents.

**Keywords:** Superabsorbent, absorption, cellulose, carboxymethylcellulose, citric acid.



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**BRICS COUNTRIES AND TURKEY'S COMPETITION COMPARATIVE  
ANALYSIS OF THE FURNITURE INDUSTRY SECTOR**

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Economic problems driven by global crises have led to an increase in the power of developing countries against the economies of developed countries and created global economic unions. The economic union (BRIC), which was established by Brazil, Russia, India and China, which are considered to be the four biggest economies of the 21st century together with the United States, and represented by 5 countries with the inclusion of South Africa in 2011 and named as BRICS countries. It has taken a leading position for developing economies.

Our country in the evaluations made at the level of the foreign trade balance, which has a positive position BRICS. Under the subgroup of the furniture sector (Brazil, Russia, India, China and South Africa) countries in the face of how competition works include the 2010-2019 year performed to determine whether to position Turkey and the BRICS countries. The levels of competition and specialization were calculated with the help of the Revealed Comparative Advantages Approach. Study results are seen in the presence of intense competition among all subgroups level in Turkey and China.

**Keywords:** BRICS, Furniture Sector, Turkey, Competition Comparative Analysis



**A STUDY ON THE EFFECT OF STARCH TEMPERATURE CHANGES ON  
PACKAGING PAPER PRODUCTION IN SIZE PRESS MACHINE**

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In this study, effect of temperature on the use of starch in packaging paper production and to find optimum use of starch, the properties of starch such as dry matter amount, viscosity and pH value were evaluated by continuously measuring. Fluting (90 gr/m<sup>2</sup>), NSSC (120 gr/m<sup>2</sup>) and Test liner (110 gr/m<sup>2</sup>) paper types using waste paper as raw material were selected as the most common production types and their strength values were measured. All production conditions were kept constant and measurements were made by changing the starch temperature in the size press equipment. Starch obtained from natural corn was used in the size press. According to obtained data, it was measured that as a result of the increase in starch temperature from 70°C to 75°C, strength values such as burst, CMT and SCT increased by 6% in all paper types. When the temperature was increased to 80°C, it was determined that there was an 18% increase compared to 70°C. In addition, porosity values of the papers decreased by 7-10% with increasing temperature. At temperatures above 80°C, it occurred defects in the paper and problems with sticking to the felts in the machine became difficult to control.

**Keywords:** Starch, temperature, packaging paper, strength



**THE EFFECT OF LEACHING CONDUCTED IN NATURAL AND LABORATORY CONDITIONS ON SOME PHYSICAL AND MECHANICAL PROPERTIES OF ANATOLIAN CHESTNUT (*Castanea sativa* Mill.) WOOD**

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It is a classic procedure that has been applied in our country for a long time to leave the chestnut wood under the effect of rain water for a while before it is used. In this study, the effect of leaching process conducted under outdoor and laboratory conditions in Anatolian chestnut (*Castanea sativa* Mill.) wood on some physical properties of the wood was investigated. The effect of leaching process on oven-dried density, water uptake and water repellency properties, swelling and anti-swelling efficiency properties, and compression strength parallel to the grain were determined on the wood samples taken from two different locations in Eastern Black Sea Region. The results showed that leaching process resulted in an increasing of water uptake and swelling ratios of wood, but no effect on oven-dried density values. While the leaching process conducted in laboratory condition decreased compression strength, the conducted in natural condition increased it.

**Keywords:** chestnut wood, leaching, water uptake, swelling, compression strength



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**THE EFFECTS OF POLYSTYRENE SPECIES AND FIBER DIRECTION ON  
THERMAL CONDUCTIVITY OF PLYWOOD**

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Thermal conductivity of wood material is superior to other building materials because of its porous structure. Thermal conductivity is used to estimate the ability of insulation of material. Thermal conductivity of wood material has varied according to wood species, direction of wood fiber, specific gravity, moisture content, resin type, and additive members used in manufacture of wood composite panels. The aim of study was to determine the effect of polystyrene species and fiber direction on thermal conductivity of plywood panels. In the study, two different wood types (black pine and spruce), two different fiber directions (parallel and perpendicular to the plywood fiber direction), two different types of insulator (expanded polystyrene and extrude polystyrene) and phenol formaldehyde glue were used as the adhesive type. Thermal conductivity of panels was determined according to ASTM C 518 & ISO 8301. As a result of the study, the lowest thermal conductivity values were obtained in the perpendicular fiber direction of the spruce plywood using extrude polystyrene as insulation material. The use of extrude polystyrene as an insulation material in plywood has given lower thermal conductivity values than expanded polystyrene.

**Keywords:** Thermal conductivity, Polystyrene, Fiber direction, Black pine, Spruce



## **MECHANICAL PROPERTIES OF WOOD MEMBERS IN SANTA MARIA CHURCH**

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Wood is one of the oldest building materials used on earth. Wood as a building material; It has been evaluated in different ways according to the socio-economic, cultural and natural resource structures of the countries. In addition, wood is a building material used in the construction of places of worship such as mosques and churches according to the belief structures of the societies. Our country, which has a deep-rooted culture and history, is also rich with its places of worship, houses, architecture and use of houses. It is possible to come across some of these building examples in the Black Sea Region. One of them is the Santa Maria Church, which was built between 1869-1874 in the Merkez Kemer kaya District in Trabzon, and is a religious center where foreigners who visit the city still worship. The aim of this study is to evaluate the performance of the wooden materials of the Church of Santa Maria by testing them with damaged and undamaged test methods. In this way, it is aimed to determine the current bearing properties without damaging the structural materials in a wooden structure built in our country and surviving for many years. For this purpose, the damage, defects and resistance properties of the building's bearing elements were tried to be determined with undamaged test devices. The results obtained were compared with the values specified in the EN 338 standard. It has been determined that most of the wooden elements in the said structure still maintain their load-bearing properties and provide the minimum mechanical resistance properties specified in the standards.

**Keywords:** Nondestructive Tests, Mechanical Tests, Santa Maria Church



## **SITUATION OF FOREST CARBON PROJECTS IN CARBON MARKETS**

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It has been recognized that human activities increase the density of greenhouse gases in the atmosphere, increase the natural greenhouse effect, increase the average temperature in the earth, and that natural ecological systems and humanity will be exposed to harmful effects, and that climate change is the common problem of mankind. For this reason, there has been a need for an intergovernmental global effort to address the climate change problem. Global cooperation activities are being carried out within the framework of United Nations Framework Convention on Climate Change, Kyoto Protocol and Paris Agreements to stabilize the increasing greenhouse gas emissions in the atmosphere. Forests that play a key role in combating climate change are among the most important issues discussed during the climate change negotiations. There are two important pillars of the forestry sector in climate change. One is mitigation and the other is adaptation. Issues related to forestry interviewed in the scope of mitigation Land use is land use change and forestry (LULUCF) and REDD +. The mechanism for mitigation is carbon markets. The rate of forestry projects in carbon markets is low. Turkey is traded on the voluntary carbon market is achieving very low income according to the mandatory carbon market. However, the carbon credits that are traded are provided by the renewable energy sector. These loans are in Turkey need to combat climate change in forestry activities both actively involved in the negotiations for the benefit of the mechanisms created in this context and should maintain this attitude. Turkey must make changes in the organizational and technical infrastructure except negotiations.

**Keywords:** Climate change, Kyoto protocol, Carbon credit, Forestry



## **A STUDY ON THE BIOMASS ENERGY POTENTIAL OF TURKEY: EXAMPLE OF WOOD PELLETS**

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Today, with the increasing population, the pressure on natural resources varies in terms of quality and quantity in parallel with the developments in the living standards of people. In addition to being the natural resource that experiences this pressure most severely, forests play an important role in the production of sustainable and clean energy, especially within the scope of combating global climate change, together with the technological developments. In addition to energy forestry, the use of trunk parts and bark, roots, branches and leaves that remain idle in forests as a result of production activities has gained importance today. "Wood Pellet", one of the biomass fuels in renewable energy sources, stands out among all renewable energy sources with its ease of production technology, environmental friendliness and similar features. Wood pellets, which are fuel pellets of 6-10 mm diameter, which are obtained from the drying of wood waste, milling it into sawdust and then compressing it with high pressure, have become economically comparable with fossil fuels today. Wood pellet trade worldwide increased by more than 21% in 2018 compared to the previous year, reaching a trade volume of 22.3 million tons. The biggest pellet exporter countries in the world since 2012 are USA, Canada, Vietnam, Latvia and Russia respectively. These countries accounted for approximately 69% of the world export volume in 2018. Except for five countries, they continue to work on alternative energy sources and especially the production, technology, use and properties of wood pellets in China. In Turkey, there are studies on the production of wood pellets and the economy. However, these studies need to be updated both in terms of production and economics. In the study, analyzed the current data with the potential that Turkey has developed proposals for the use of this potential.

**Keywords:** Forestry, Economy, Biofuel, Energy demand





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**PAPER AND PAPER PRODUCTS AND WOOD AND WOOD PRODUCTS  
SECTORS COMPETITION ANALYSIS: BRICS COUNTRIES AND TURKEY**

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Financial crises on a world scale cause the emergence of new economic structures and powers. While the financial efficiency of developed countries decreases, developing countries are increasing their positions. BRIC (Brazil, Russia, India and China), which emerged as an alternative economic power after the financial crisis in 2008, started to be known as BRICS countries with the addition of South Africa in 2011 and became an important economic structure. Its economic and demographic strength of thanks and wishing to take part in the active position in the world Turkey is willing to take part in the BRICS. Determination of Turkey's infrastructure sector as competitive with these countries is extremely important.

In this study of the important sectoral groups of Turkey Paper and Paper Products and Wood and Wood Products Sector is intended to determine whether a location opposite of how the BRICS countries. Revealed Comparative Advantages approach was used in the study covering the years between 2010-2019. As a result of the study, countries were compared at year level and superior sectoral structures were determined.

**Keywords:** BRICS, Turkey, Paper and Paper Products, Wood and Wood Products, Revealed Comparative Advantages



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**MECHANICAL PERFORMANCE OF WOOD COMPOSITES BY LIGNIN  
REINFORCED UREA FORMALDEHYDE ADHESIVE**

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Lignin is the second most abundant naturally occurring biopolymer on Earth, after cellulose. Due to its aromatic structure, it is more chemically stable than cellulose. Every year, approximately 50 million tons of lignin are produced annually as a by-product of the pulp and paper industry. Lignin is of vital significance as a structural material in wood composites and has a critical effect on the mechanical properties of wood composites. The major goal of this study was to develop lignin reinforced plywood panels with enhanced mechanical properties. Urea-formaldehyde (UF) adhesive used to produce plywood panels was reinforced with different types of lignin at loading level of 0%, 1%, 3%. To obtain mechanical properties modulus of rupture (MOR), modulus of elasticity (MOE), and internal bonding strength (IB) tests were carried out to acquire of the plywood panels. Mechanical properties were tested on both parallel and perpendicular to grain samples. The findings obtained in this study revealed that lignin reinforcement significantly affected the mechanical performance properties of the plywood panels. It was determined that using 1% lignin in the plywood panels had the best results in the modulus of rupture, modulus of elasticity, and internal bonding strength tests. It was concluded that the mechanical performance properties of the plywood panels could be enhanced by using proper lignin loading levels.

**Keywords:** Lignin, Plywood panels, Wood composites, Urea formaldehyde, Adhesives



**EFFECT OF PRE-TREATMENTS ON WEAR INDEX OF VARNISHED WOOD  
PLASTIC COMPOSITES (WPC) WITH PIGMENTED**

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The utilization and usage areas of the wood plastic composites (WPC) have increased over the years. In addition, the importance of wood plastic composites produced by adding pigments has increased in terms of usage area. To be able to increase the coating ability of plastics, different pre-treatment had been used and some improvements were achieved. It is the purpose of this study to determine the wear index in abrasion of the WPC with pigmented using various coating and pre-treatments. For this purpose, it was used 2 different coating types (acrylic and cellulosic based) and 4 different pretreatments (sanding, acid treatment, UV, microwave). WPC with pigmented were manufactured and samples after various pretreatment and coating were prepared. The adhesion strength values were determined after coating. The results showed that pre-treatments used in this project affected the wear index. Acrylic based coating gave the best results of wear index in abrasion.

**Keywords:** Wear index, Coating properties, Wood plastic composites, Acrylic varnish



## **WOODLOVERNESS AS A PATHWAY TO CIVILIZATION CONNECTED WITH NATURE**

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Woodloverness, although is a vast subject that has been well known throughout the world for a long time in terms of learning based on experiences that emerge with its reflections in every phase of life with its behavioural dimension that integrates attitudes and behaviours and combines feelings and thoughts, is a term that has been named and defined almost very recently in the field of wood science and technology with the focus of woodlover approach with its inherentness that complements people whose geography is far from each other by keeping them together around the same purpose in terms of being a harmonious part of nature, and is a universal phenomenon that embraces all humanity. In a more general sense, woodloverness, in Usta's words (Usta, 2019), is a thematic issue that contributes to the development of civilization and plays an important role in the progress of humanity, and is considered in the focus of the woodlover approach that aims to integrate human with nature. Obviously, with its deep and comprehensive presence, woodloverness is an interdisciplinary phenomenon that stands out clearly in the development of civilization by integrating with nature in the company of science and technology, together with art and literature, and it is a preliminary reinforcer of the effort to identify with nature and the environment, which constitute the essence of all humanity with its cultural dimension. In this study, woodloverness is presented as a deep and comprehensive phenomenon that provides endless benefits to humans through the integration of nature on the way to civilization, focusing on the woodlover approach.

**Keywords:** Wood, Woodlover Approach, Woodloverness, Human-Nature Interactions, Civilization



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**CHEMICAL CHANGES IN HISTORICAL WOODEN STRUCTURES IN RİZE-FIRTINA VALLEY**

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Studies conducted to determine the factors that cause damage in historical wooden buildings in our country are quite limited. Rize-Firtına Valley, with a climate index higher than 65, is one of the regions with the highest rainfall in our country. The risk of decay in historical wooden buildings in this region due to the high climate index is quite high. As a result of this situation, the resistance properties of wood are negatively affected. Within the scope of the research, samples were taken from wooden mansions which are at least 150 years old in the region. Cellulose, lignin, and hemicellulose contents were determined in order to detect chemical changes occurring in the chemical structures of the wood samples. Thanks to the obtained results from this study, intervention/restoration methods may be suggested for the protection and sustainability of wooden materials in historical buildings.

**Keywords:** Firtına Valley, Historical wooden structures, Chemical analysis, Cellulose, Lignin



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**DETERMINATION OF DAMAGE AND DEFECTS IN HISTORICAL WOODEN STRUCTURES USING NONDESTRUCTIVE TEST DEVICES**

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The rich accumulation of historical and cultural mosaic of Anatolian geography can be found in Rize. The examples of civil architecture in the region have survived to the present day, largely without deteriorating their original qualities. The preservation of the historical urban texture in the region where the historical wooden structures that defy the centuries are intense are of great importance in terms of transferring to future generations and maintaining the cultural memory. There are not many studies in the forest industry engineering literature to determine the damage and defects in historical wooden structures and to protect the original texture of these defects. Within the scope of the study, a research was conducted in Cinan mansion, a 200-year-old wooden mansion in Rize Pazar district. In this study, the damage and defects in the historical wooden structure were determined by non-destructive test methods. In addition, screw holding, shear and elasticity modulus of the wooden carrier beams in the structure were determined. With this study, it is aimed to determine the defects and damages in historical wooden structures and to develop appropriate protection techniques that can contribute to the solution of the problems encountered. In addition, it is aimed to be able to intervene without damaging the texture of the wooden structure and to ensure the sustainable use of historical wooden structures for many years.

**Keywords:** Historical wooden structures, Nondestructive Tests, Deterioration and decay



## **EMISSIONS FROM DRYING IN THE WOOD-BASED BOARD INDUSTRY**

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The reason why wood-based boards are preferred in many areas of use, especially in furniture, is that they can be produced in desired properties and are cheap. In addition, wood defects such as different work in three dimensions, differences in resistance values, internal stresses and physical changes seen in solid wood are not encountered in wood-based boards. Volatile organic compound (VOC) emissions from wood-based boards occur from the raw materials of the boards and during production stages such as gluing, storage, pressing and drying. Most of the VOCs from wood raw materials are formed during the drying process. VOCs contribute to the formation of nitrogen oxides and photo-oxidants in the presence of sunlight. Photo-oxidants are harmful to humans as they irritate the respiratory and sensitive parts of the lungs. It also disrupts photosynthesis and damages forests and crops. The aim of this study is to evaluate the factors affecting the emissions that occur during the drying process in wood-based boards and the processes applied to reduce the emission.

**Keywords:** VOC, Drying process, Emission of wood based board



## **MECHANICAL PROPERTIES OF MYCELIUM BASED MDF**

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Mycelium composites have been popular recently worldwide in terms of research interest and commercialization. Mycelium composites are biodegradable, produced renewable materials, environmentally friendly and show low density, good insulation properties, both related to acoustic and thermal aspects. However, mechanical properties of mycelium composites are obviously lower than alternative materials such as expanded polystyrene. In this study, hardwood and softwood fibers were inoculated with a white rot fungus and incubated in a climate chamber at 25 °C and 65% relative humidity for 15 and 30 days. Mycelium based medium density fiberboards were produced either without using any adhesive or with using 6% urea formaldehyde adhesive. The MOE, MOR, IB, thickness swelling and water absorption percentage of the mycelium based MDF were determined. The results showed that the MOE, MOR and IB values of the mycelium based MDF were low and did not meet the minimum required strength values given in the standards. However, these boards may still be used as insulation materials.

**Keywords:** Mycelium composites, MDF, White-rot fungi, Mechanical properties, Physical properties.





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**ECONOMIC ANALYSIS OF TOY INDUSTRY TODAY AND THE  
IMPORTANCE WOODEN TOY IN TURKEY AND ITS COMMERCIAL  
VOLUME ECONOMY**

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Human's most precious assets are his children. While families want their children to be happy, they also take into consideration their health. With the effect of the organic life and ecological approach that has become widespread in the world, the use of wooden materials in the production of toys, which are the most important equipment and entertainment elements of children's rooms, has been increasing day by day. This study, which was carried out in order to emphasize the meaning, quantity and value of the wooden toy industry, to determine its share in the total toy industry and to evaluate its commercial volume, has the quality of meeting the deficiency in the field.

As of 2018, 46.27 billion dollars of exports and 124.9 billion dollars of imports have been carried out worldwide in the toy industry. In Turkey in the same year, despite the production of 97.6 million dollars in the toy industry, by 34% decrease in import of was 262.9 million dollars, by 21% decrease in export was 32.8 million dollars.

In the wooden toy industry; In our country, a production of 23.7 million worth of 3.1% was realized in 2014, and imported toys received 77% and domestic toys received 23% share from domestic market consumption. EU countries appears to be the most important foreign market for Turkey and aims. Production and world trade volume, which is a very low market share of wooden toys in the toy industry in terms of being open to investment and development of a sector in Turkey is the leading cause of research.

The aim of the study is to determine the development capabilities and factors that trigger production by analyzing the 2014-2018 economic data of the Turkish toy industry. It is also a first wooden toy industry in the field of economic data by examining the industry's development and create favorable investment conditions, the second objective of the study is to establish the principles to be taken into account in Turkey. In parallel with these aims, Turkey's wooden toy industry has been assessed, solutions will be developed in order to improve the creation of awareness and market conditions are considered.

**Keywords:** Toy, Wooden Toy, wooden reinforcement, Economic Analysis



INTERNATIONAL  
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**BIO BASED INDUSTRIALLY ADHESIVES FOR WOOD AND WOOD  
COMPOSITE INDUSTRIES: A BRIEF REVIEW**

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During the last decades, wood and wood composite applications are increased due to the historic and intrinsic willing of human and the several benefits derived from the woody products instead of metals, plastics and other petrochemical products. Synthetic adhesives are usually used for mainly strength improvements purposes in all wood and wood composite products, which are posed with several drawbacks. Environmental and health concerns about the adhesive production and application during the woody products manufacturing and also in services, price fluctuations originated from oil expense, public awareness toward the petrochemicals etc., are motivating and driving forces to substitute bio adhesive instead of traditionally synthetics ones like phenol formaldehyde and urea formaldehyde adhesives. In this paper, an overview was conducted on the most reported bio-based adhesives for woody products to enhance the mechanical and physical properties of manufactured products. The strength and weak aspects of bio adhesives applications were addressed and bio adhesives originated from the bio wastes were also included.

**Keywords:** Bio adhesives, Synthetic Adhesives, Wood Products, Wood Composites.



## **WOOD LOSS AND DAMAGE OF LOGGING IN HYRCANIN FOREST**

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It is important to study the amount of wood loss in terms of volume and economy. Damage to the wood of the trees harvested during the operation is one of the most important things that forestry planners and wood producers must pay attention to. Large volumes (about 30 to 40 percent) of standing trees are lost during forest logging. Hyrcanin forest is the only economic forest of Iran that play key role in environmental issue. Therefore, increasing productivity and reducing tree harvesting in this ecosystem is essential. It is essential to determine the amount of wood damaged during the cutting and pruning process and to provide solutions to prevent and reduce the effects of wood damage during logging in hyrcanin valuable forest.

**Keywords:** harvesting, wood, forest, damage.



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## **PULPING BLACK LIQUOR APPLICATIONS IN BIOREFINERY APPROACH: A BRIEF REVIEW**

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Recently, Biorefinery is highlighted due to several reasons like cleaner production, biomass waste valorisation, environmental concerns, and public willing on bioproducts. Pulping is defined as a chemical and semi-chemical process converting lignocellulosic raw materials into the liberated fibres with lignin and hemicelluloses removal from the fiber cell walls into the cooking liquor called pulping black liquor (PBL). Then the PBL comprise huge amounts of degraded valuable biopolymers such as lignin, hemicellulose and also cellulose to some extent. Traditionally, the PBL is burnt after the mineral chemicals recovery to produce energy from the valuable biomass combustion in the recovery boilers. The biomass conversion into the energy is not reasonable in some region like Iran due to ease availability to other sources of energy like fossil-based fuels. Pulping processes of agro-residuals is mostly in small scale and in low technology plants which could not allow the recovery boilers presence. Then usually the highly content biomass liquor is discharged into the environment which cause severe hazardous situation. Biorefinery concept focus on the maximum utilization of biomass into the bio-byproducts. Therefore, the concept is gradually being mandatory from several points of view which also comprises several benefits. With this respect, the present study the reported application and potentials of PBL is reviewed with emphasis on non-woody lignocellulosic raw materials pulping which mainly suffer from the cooking liquors and its difficulties. The novel bio based byproducts of conventionally pulping process are introduced, too.

**Keywords:** Biorefinery, Pulping Black Liquor, Lignocellulosic Raw Materials, Bio Value Added Byproducts.



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**LAND USE EVOLUTION OF MARITIME PINE IN THE CONTEXT OF LIFE  
CYCLE ASSESSMENT: A PORTUGUESE CASE STUDY**

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In a climate change scenario, the forestry sector faces important challenges globally and particularly in mainland Portugal, resulting in increased incidence of fires and the action of pathogens, which puts the sustainability of forest resources at risk.

Between 2005 and 2015 the forest area occupied by the maritime pine tree in mainland Portugal decreased by about 172000 hectares which is equivalent to -19.4% and the existing volume decreased by about  $17.7 \times 10^6 \text{ m}^3$  which corresponds to -20.7%.

Due to economic, social and environmental importance of maritime pine forest, the objective of this work is to study the evolution of its "land use" environmental impact in mainland Portugal between 2005 and 2015.

The SimaPro software was used and the ILCD 2011 Midpoint+ method was chosen to assess the "land use" environmental impact.

Despite the high variation in land occupation and forest production during the study period, results show that land use impact category increases slightly (1.6%) between 2005 and 2015. The most contribution for land use is from forest land transformation to forest road followed by the forest occupation and forest road occupation.

**Keywords:** Forest, Land use, Life cycle assessment, Maritime pine



## **PSEUDOTSUGA BARK SUBERIN LIQUEFACTION IN POLYALCOHOLS**

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Douglas-fir (*Pseudotsuga menziesii*) outer bark is called a suberin-rich bark due to a significant amount of cork tissue. Although this cork tissue cannot be used for cork stoppers of other structural cork products since it is mixed with phloem, there is also the possibility of using this material by chemical conversion and use it as a source of chemicals. One of the most used chemical processes in the last years has been the liquefaction at moderate temperatures using a mixture of polyalcohols.

This work studies the possibility of using polyalcohol liquefaction to liquefying Douglas-fir bark and mainly its suberin fraction by alkaline catalysis. Liquefaction of bark was done in a reactor using glycerol/PEG (50/50) mixture catalysed by 0.9 g potassium hydroxide (KOH) at 180°C during 2 h. The reactor charge was 10 g of dried sample, bark/solvent ratio was 1/10. Suberin was extracted from a bark sample by use of methanolysis.

FT-IR ATR spectra of normal bark, desuberized bark, liquefied bark and solid residue were taken in a PerkinElmer UATR Two, FT-IR Spectrometer, Beaconsfield, UK. A resolution of 4.0 cm<sup>-1</sup> was applied with seventy two scans recorded in the range 4000-400 cm<sup>-1</sup>.

Results showed great differences in FT-IR spectra between the initial material with and without suberin. The main differences were found to be the nearly disappearance of the peaks at 2919 cm<sup>-1</sup>, 2854 cm<sup>-1</sup> and 1749 cm<sup>-1</sup> (non-conjugated aliphatic esters) for the material without suberin. However, there was also a decrease in the peak at 1600 cm<sup>-1</sup> (conjugates) and 1515 cm<sup>-1</sup> (lignin) and at 1450 cm<sup>-1</sup> and 1223 cm<sup>-1</sup>. In the solid residue after liquefaction we could observe a similar decrease in the suberin peaks, indicating that most of the suberin was liquefied.

**Keywords:** Alkaline catalysis, FT-IR spectra, Pseudotsuga bark, Suberin liquefaction



## **LAND USE EVOLUTION OF EUCALYPTUS GLOBULUS IN THE CONTEXT OF LIFE CYCLE ASSESSMENT: A PORTUGUESE CASE STUDY**

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The eucalyptus globulus forest in Continental Portugal has shown a systematic increase over the last 50 years. In 20015 it was the species with the highest forest land occupation (845,000 hectares) representing 26.2% of the total Portuguese forest area. Although between 2005 and 2015 the occupation of the soil by eucalyptus globulus had grown about 14.2%, the existing volume decreased by 4.5%. The wildfires had a strong impact on this with a total burnt area of 1.1 million hectares during this period.

Due to its economic value (national leader in exports of high added value) and social (contributes to the generation of thousands of jobs) this study aims to assess the evolution of the environmental impact of eucalyptus globulus in terms of land use between 2005 and 2015.

Life cycle inventory and life cycle impact assessment were done with the help of SimaPro software. The ILCD 2011 Midpoint+ method was chosen to assess the "land use" environmental impact.

Results show that land use impact category of 1 m<sup>3</sup> (functional unit) of eucalyptus globulus trees increased about 19.7% between 2005 and 2015. Transformation to forest road (from forest) is the process that most contributes for this impact category with approximately 78%. Forest occupation is the second most important process representing about 19.5% of the total impact category and forest road occupation represents only 3%. Transformation from forest is a process with a slightly beneficial contribution (-0.4%) to the total impact category.

**Keywords:** Forest, Land use, Life cycle assessment, Eucalyptus globulus





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**BIOCELLULOSIC MATERIAL IN PEELS OF *IPOMOEA POTATO* AND  
*MONALISA POTATO***

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Sweet potato (*Ipomoea potato*), island potato, jatica or jetica is a plant of the family of *convolvulaceae*, of the order of *Solanales* (the same of potato, tomato, peppers, etc.) originating in the Andes and spread throughout the tropics and subtropics of the world. It has a good percentage of nutrients, is rich in vitamins A, C, E, B6, B12 and D and minerals such as calcium, iron, magnesium and potassium. The common potato (*Monalisa potato*) was used as a comparison enabling a better knowledge about the different benefits of each one. The main types of common potato are: monalisa, asterix, yacon, baraka, bintje, àgata, markies, cupid, caesar and mondial and sweet potato: purple, white sweet potato. The potato has a low amount of fat and contains B and vitamin C vitamins, phosphorus (in good quantity), iron, potassium, calcium and is an important source of starch.

This work aims to characterize the chemical composition of the peel from *Ipomoea potato* and *Monalisa potato* in order to understand the possible benefits of the peel from these products,

Regarding the chemical composition, ash content, extractives (in dichloromethane, ethanol and in methanol- water), proteins, cellulose, tannins, lignin and hemicelluloses were determined in triplicate using the 40-60 mesh fraction following Tappi T 264 om-97.

The studies carried out for the chemical composition of the common potato peel allowed us to conclude that the peel consists mainly of proteins (31.62%), tannins (21.45%) and extractable in methanol: water (17.39%), also presenting hemicelluloses (13.38%), ash (5.77%), lignin (5.91%) and cellulose (2.42%). Relative to the sweet potatoes peel allowed to conclude that the bark consists mainly of tannins (30.33%), proteins (19.45%) and extractable in methanol: water (16.26%), also presenting cellulose (9.85%), ash (7.27%), lignin (6.90%) hemicelluloses (6.06%).

**Keywords:** *Ipomoea potato peel, Monalisa potato peel, chemical composition, biocellulosic material.*



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