

## Effect of press closing speed on stress relaxation and set recovery of densified alder wood

### Abstract

One of methods to overcome the problem of the set recovery in densified wood is decreasing the press closing speed which leads to stress relaxation during densification. In the present study, the effect of press closing speed (at three levels of 0.2, 0.4 and 0.6 mm/min) at constant compression ratio of 45% was investigated on stress relaxation behavior and set recovery of alder wood. Results showed that with increasing press closing speed, stress created in densified wood was increased and the reason was attributed to the breakage of covalent hydrogen bond and relaxation of stress at lower press speed which led to decreasing of the set recovery. Two stages were observed in stress relaxation curves. At the first stage, the relaxation rate was high, attributed to the slippage of wood molecules and breakage of intermolecular hydrogen bonds. At the second stage, the stress relaxation curve became flat, represented the decrease of the stress relaxation rate. The Results of time-press closing time superposition showed that the master curve was able to predict the stress relaxation behavior to almost 380 hours (380 times of test time). Since a smooth master curve was not achieved by just horizontal shift and a vertical shifting was also required, it can be state that regarding high temperature and moisture content of woods, the material showed a complex thermorheological behavior. With increasing press closing speed from 0.2 to 0.6 mm/min, the set recovery value increased up to 20%. A linear relation was found between the residual stress after one hour of stress relaxation and set recovery.

**Keywords:** set recovery, press closing speed, time-loading rate superposition, densification.

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## The product of pulp from hornbeam with alkaline sulfite- AQ process

### Abstract

The objective of this study was to investigate the modification of neutral sulfite semi chemical (NSSC) pulping liquor by applying changes in the percentage of chemicals, increasing alkalinity and changing the pulping duration for the production alkali sulfite (AS). Among the pulps, the best combination was acceptable with respect to the residual alkalinity ( $\text{pH} > 11$ ) and the acceptable kappa number (about 17) and the lowest amounts of so-called undercooked wood (or “rejects”) was selected. Pure AS pulp and also the mixing of different percentages of AS pulp with NSSC pulp were compared. The results showed that the overall strength of the modified pulp compared with the initial NSSC pulp increased. So that the alkali sulfite (AS) and NSSC is about 66.2 and 32.4 N.m/ g, respectively. By adding more amounts of this pulp in furnish, by increasing the required strength of the paper, the consumption of pulp from the imported long fiber could be reduced while maintaining the paper's strength properties.

**Keywords:** alkali sulfite (AS), modification of pulping liquor, NSSC pulp, strength properties.

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## Fabrication and properties evaluation of three layered transparent nanocomposite reinforced with cellulose and chitin nanofibers

### Abstract

In this study, three-layered transparent nanocomposite containing wood cellulose nanofibers (WCNF), bacterial cellulose nanofiber (BCNF) and chitin nanofibers (ChNF) individually as core layer and epoxy as top and bottom layers has been fabricated and characterized. The WCNF, BCNF and ChNF, prepared from Nano Novin Polymer Co. (Iran), were first converted to nanofilms, followed by solvent exchanging by ethanol and acetone and then immersed into epoxy resin. The impregnated nanofilms with epoxy was cold pressed followed by drying in an oven to get three layered nanocomposites. FE-SEM, transparency and tensile test showed that epoxy could penetrate into the core layer (nanofilms) positively affected the transparency and mechanical properties. The crystallinity index of nanocomposite was lower than that of pure nanofilms. ATR-FTIR confirmed the peaks of nanocomposites were similar to those of epoxy. The mechanical and transparency properties of nanocomposite were higher than those of pure nanofilms. Nanocomposite containing BCNF and ChNF showed highest tensile strength and transparency, respectively.

**Keywords:** transparent nanocomposite, cellulose nanofiber, chitin nanofiber, epoxy.

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## The effect of dimensional changes of flange and web in I-joist on its bending strength

### Abstract

This study evaluated the effects of flange thickness to depth of web ratio at three levels (1:2, 1.5:3.5 and 2:5) as well as thickness to depth of web ratio at three levels (0.5:2, 0.5:3.5 and 0.5:5) and width of flange at three levels (3, 3.8 and 4.6 cm) as independent variables on some mechanical properties e.g. modulus of rupture (MOR) and modulus of elasticity (MOE) of I-joist manufactured from ash wood (*Fraxinus* sp.). For this purpose, response surface methodology (RSM) was applied to evaluate the effects of independent variables on MOR and MOE of I-joist based on a three-level, three-variable central composite rotatable design (CCRD). In this survey, bending test was done according to the ASTM D-5055. Mathematical model equations were derived from computer simulation programming to find significant differences and the most effective variables. According to the results, predicted values were found to be in agreement with actual values ( $R^2$  values of 0.99 and 0.98 for MOR and MOE, respectively). The study showed that RSM can efficiently be applied in modeling bending properties of I-joist. It was found that all independent variables had direct effect and significant effect on responses; in a way that flange thickness to depth of web ratio, thickness to depth of beam web ratio and width of flange maintained the MOR and MOE at maximum levels up to 2:5, 0.5:5 and 4.6cm, respectively. Simultaneously, some quadratic and interaction terms of variables had significant effects, too. Generally, increment in flange thickness to depth of web ratio, thickness to depth of web ratio and width of flange increased MOR and MOE of I-joist. Besides, flange thickness to depth of web ratio had the strongest effect on bending strength of beams

**Keywords:** I-joist, elm, bending strength, response surface methodology.

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## Mechanical properties of light weight sandwich panel made from sawdust and waste rubber

### Abstract

In current study, the sandwich panels were made by using the urea/melamine formaldehyde resin/with different ratio (90:10, 80:20, and 70:30). In addition, the sawdust and rubber waste with the ratio of (100:0, 90:10, 80:20) were added to produce final composite. The press temperature was used at 160, 170 and 180 °C respectively. Populous layers with 2 mm thickness were also pressed on the surface of the panels. Flexural strength, modulus of elasticity, internal bonding, and compression parallel to the grain tests were characterized in accordance with the ASTM standard C393, D1037 and C364, respectively. The results of the mechanical properties were investigated by analysis of the variance and averages of groups with Duncan's multiple range tests with 95% confidence level. The results showed that the sandwich panels had highest mechanical properties at temperature of 170 °C. Furthermore, by adding the 30% of melamine formaldehyde resin the mechanical properties of sandwich panels were improved. Increasing the rubber waste up to 10% percent illustrated a maximum increase in compressive strength, flexural strength, and internal bonding while the samples without rubber waste increased the maximum modulus of elasticity.

**Keywords:** sandwich panel, light weight panel, sawdust, waste rubber.

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## The effect of kaolinite on the properties of lignocellulose superabsorbent from old corrugated container fiber fines

### Abstract

An instance for high added value applications of fines and fiber fractions of old corrugated containers can be production of super-absorbents. As high water gain in super-absorbents leads to a loss of mechanical resistance, and meanwhile addition of chemical cross-linkers increases the costs and environmental problems, therefore, in this research it was tried to improve super-absorbent properties by using mineral additives such as kaolinite. Accordingly, electron microscopy images, X-ray spectra and water absorption tests were conducted. The results showed that the natural super-absorbent structure without any other chemical could absorb water more than 30 times its own weight. Eventually, it was found that although high amounts of kaolinite decreased the water absorption, but adding appropriate less amount (5%) of kaolinite improved the mechanical properties of the super-absorbent without significant decrease in the water absorption amount.

**Keywords:** super absorbent, kaolinite, fines, old corrugated container.

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## The effect of residual xylan on cellulose nanofiber production through electrospinning from wheat straw

### Abstract

In this research, wheat straw as one of the important and available agricultural residues was used for preparation of cellulose nanofibers through electrospinning process. Wheat straw was pulped and bleached to produce cellulose fibers through soda-AQ and DED bleaching sequences. Trifluoroacetic acid (TFA) and dichloromethane (DCM) were employed to dissolve the cellulose fibers of dissolving pulp (purified with NaOH alkaline extraction) and xylan-rich pulps for preparation of electrospun cellulose nanofibers. SEM images proved that long and homogenous cellulose nanofiber with diameter less than 100 nm can easily be obtained from wheat straw cellulose fibers. Interestingly, average diameter and beaded electrospun nanofibers prepared from xylan-rich cellulose fibers are lower than those lacking xylan. The results of this research corroborated the pivotal role of xylan into the electrospinning process of wheat straw cellulose fibers.

**Keywords:** cellulose Fiber, electrospinning, crystallinity, trifluoroacetic acid, wheat straw.

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## Chemical treatment of bagasse by oxalic acid-choline chloride and lactic acid-choline chloride deep eutectic solvents

### Abstract

Bagasse carbohydrates, which are mainly consist of cellulose and hemicelluloses, are important raw materials in chemical industries; because they can be easily prepared from biomass in large scale, their application is simplified in large scale. Derivation and purification of biomass chemicals are difficult, costly and require the use of complex methods with environmentally dangerous chemicals and solvents. Therefore, researchers are looking for simpler, cheaper, safer and environmentally friendly compounds and processes. The use of deep eutectic solvents has been reported as one of these methods in biomass processing. In this study, the use of new oxalic acid-choline chloride and lactic acid-choline chloride deep eutectic solvents for bagasse treatment was investigated. Results indicated that these new solvents were effective in the solubilization and extraction of short-chain and amorphous carbohydrates, especially hemicelluloses; as the final processing yields were respectively reduced to about 50 and 59%, and the main part of degradation belonged to the hemicelluloses. Cellulose to holocellulose ratio was increased in all treatments to about 90%. The lactic acid-choline chloride solvent was effective in lignin solvation, as the lignin content was reduced to 6.2%, while oxalic acid-choline chloride solvent did not have an ideal efficiency toward lignin removal, and the least amount of lignin in treated product was about 11%. Also, the viscosity drop of cellulosic pulp in lactic acid-choline chloride solvent-treatment was much less compared to oxalic acid-choline chloride solvent-treatment, as the cellulosic pulp viscosity for these treatments were 11.1 and 4.3 cp., respectively.

**Keywords:** bagasse, deep eutectic solvent, oxalic acid, lactic acid, choline chloride, lignin.

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## The possibility of designing and constructing standard tables and chairs with palm trunk

### Abstract

In this research, the possibility of designing and constructing standard tables and chairs using palm tree trunk tissue for use in the furniture industry was evaluated. For this purpose, samples were cut to standard dimensions of 200×40×7 cm from dried palm (*Phoenix dactylifera* L.) and dried into a conditioning room (T = 25 °C and RH=65%) for about 15 days to reach a moisture content of 12%. Then, to make the table and chair, the lumber was first cut into smaller boards and was made using two joints of mortise and tenon and wooden dowel of the structures. In addition, for assessing the profile edges, surface finishing, bending moment resistance, stability and durability of furniture, respectively, roughness test, mechanical testing, and furniture testing were conducted in accordance with Iranian national standards. The results of the roughness test showed that palm trunk tissue has ability to be well finished and with the increasing number of sanding, the number of surface roughness decreases. The highest resistance to bending moment capacity was related to the mortise and tenon joint and showed a 73% more resistance than the wooden dowel. Also, the results of the furniture test indicated that the tables and chairs made and designed and using palm has the strength, durability and safety requirements of the seat in accordance with national and international standards. Therefore, palm tissue can be used to make furniture; however, the used joints should be of mortise and tenon.

**Keywords:** furniture, joints, mortise and tenon, wooden dowel, palm trunk.

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## Investigation of performance and fracture monitoring of dowel-welded joint by micrographs of scanning electron microscopy

### Abstract

The aim of this study is to investigate the performance and fracture monitoring of dowel-welded joints by micrographs of scanning electron microscopy (SEM). In this regard, joints with hornbeam (*Carpinus betulus*) and fir (*Abies alba*) members were constructed by using hornbeam smooth and grooved dowels with diameter of 10 and 12 mm. The joint members were cut according to EN 326-1 standard and after assembling, the joints were subjected to the tensile test according with EN 319 standard. The results showed that effects of independent variables on tensile strength was significant. The investigation of the scanning electron microscope images from the fracture zone of the welded joint member demonstrated that not only the fracture at the joint zone was not occurred, but also the welded area between the dowel and the joint member exhibited greater strength in comparison with wooden members during tensile loading. Also, the investigation of the image obtained from the SEM showed that the components of the welding line did not remain on the dowels with smooth surface, and the dowel surface was also affected by micro cracks, but the surfaces of grooved dowels were sound and part of the welding line was observed on the dowels. According to the results of this study, compared to conventional adhesives, using of welding in making joints with small diameter and smooth dowel, not only provides a joint with the proper structural performance, but also it provides optimum utilization of wood in making joint. This leads to raw materials savings, cost reduction of raw materials preparation and reduction of jointing time which altogether cause to reduce production costs.

**Keywords:** wood welding, dowel joint, tensile strength, polyvinyl acetate.

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## Effect of cationic polyDADMAC-based fixing agent on strength properties of OCC pulp

### Abstract

Stickies are one of the main challenges in the papermaking industry, especially in recycling process of old corrugated containers (OCC). Application of a fixing cationic polymer is one of the main approaches to control these harmful substances. However, it is obvious that these agents besides fixing characters could also influence the final product properties. Therefore, in this study, the effect of using an industrial cationic polymer i.e. GL (Trade name), as a stickies control agent on mechanical properties of hand-sheets made of OCC fibers, was assessed at three levels of 0.4, 0.8 and 1.2% (based on pulp dry weight) and at two pH ranges of 4 and 7. The characterization of the GL by FT-IR spectroscopy demonstrated that it was synthesized based on poly (diallyldimethylammoniumchloride). The results showed that use of the cationic polymer enhanced the strength properties of the hand-sheets by influencing formation and inter- fiber bonding through fixing and flocculating the stickies and fines into the fibers network. These respective enhancements were measured at pH ranges of 4 and 7 as follows: Tensile strength of 35 and 30%, burst strength of 12 and 10%, ring crush test (RCT) of 29 and 21%, Concora medium test (CMT) of 19 and 32% and tear strength of 10 and 13%. It can be concluded that 0.4 % GL cationic fixing agent could be proposed as optimum value at pH =7 for industrial applications.

**Keywords:** stickies, polyDADMAC, OCC pulp, strength properties.

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## Effect of cationic polyDADMAC-based fixing agent on strength properties of OCC pulp

### Abstract

Stickies are one of the main challenges in the papermaking industry, especially in recycling process of old corrugated containers (OCC). Application of a fixing cationic polymer is one of the main approaches to control these harmful substances. However, it is obvious that these agents besides fixing characters could also influence the final product properties. Therefore, in this study, the effect of using an industrial cationic polymer i.e. GL (Trade name), as a stickies control agent on mechanical properties of hand-sheets made of OCC fibers, was assessed at three levels of 0.4, 0.8 and 1.2% (based on pulp dry weight) and at two pH ranges of 4 and 7. The characterization of the GL by FT-IR spectroscopy demonstrated that it was synthesized based on poly (diallyldimethylammoniumchloride). The results showed that use of the cationic polymer enhanced the strength properties of the hand-sheets by influencing formation and inter-fiber bonding through fixing and flocculating the stickies and fines into the fibers network. These respective enhancements were measured at pH ranges of 4 and 7 as follows: Tensile strength of 35 and 30%, burst strength of 12 and 10%, ring crush test (RCT) of 29 and 21%, Concora medium test (CMT) of 19 and 32% and tear strength of 10 and 13%. It can be concluded that 0.4 % GL cationic fixing agent could be proposed as optimum value at pH =7 for industrial applications.

**Keywords:** stickies, polyDADMAC, OCC pulp, strength properties.

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## Investigation the effect of nanographene particles on physical and mechanical properties of high density polyethylene-rapeseed stalk flour composites

### Abstract

The purpose of this study was to investigate the effect of graphene nanoparticles (NG) on mechanical properties of composites made from rapeseed stalk flour (RSF) and high density polyethylene (HDPE). To meet this objective, the RSF and HDPE at 50 wt%, coupling agent (3phc) and various amounts of NG (0, 0.5, 1, 1.5 and 2 phc) were mixed via hake internal mixer, and then the specimens were prepared using injection molding. The morphology of samples was characterized using field emission scanning electron microscope (FE-SEM). The physical and mechanical characterization including water absorption, thickness swelling, tensile, flexural strength, and unhocked impact resistance were performed. In addition, the field emission scanning electron microscope (FE-SEM) was used to study the distribution of graphene nanoparticles in the composite. The results showed that by increasing the amount of nanographene the tensile modulus, flexural modulus, tensile strength, and flexural strength of the composite were increased while the impact strength, water absorption and thickness swelling of the samples decreased. FE-SEM micrographs showed that the using of 1 wt% NG improved the adhesion between the filler and the polymer matrix. However, in the higher amount contents (>1%), nanographene particles tend to accumulate.

**Keywords:** rapeseed stalk flour, nanographene, mechanical strength, morphology.

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