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Design of a Topological Waveguide Using Two Types of Rhombic Unit Cell Structures Mutually Shifted by Half-period

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Abstract

Topological waveguides are waveguides based on the concept of the mathematics topology [1]–[3] and are constituted on the zigzag boundary between two structures whose topology is different. The waveguides have characteristics that reflected waves from waveguide bends or junctions are not generated, and it will be expected for applying those to technologies of high density, high functionality, and low loss ICs. In the conventional design methods, we must adjust the frequencies of the bandgap of two types of unit cell structures as those agree with each other. Therefore, there is an issue that many numerical simulations are required and this makes the constitution of topological waveguides difficult. In this paper, we establish the easier constitutive method for the topological waveguides than conventional ones. Firstly, we propose two types pf rhombic unit cell structures mutually shifted by half-period. Secondly, we calculate the frequency dispersion characteristics by eigenvalue analysis in order to confirm that the structures have the same frequency bandgap. Finally, we constitute an electromagnetic topological waveguide by periodically arranging the proposed structures (see Figure 1) and verify the operation by full-wave simulation. The results show that the incident electromagnetic wave propagate along the constituted topological waveguide (see Figure 2).

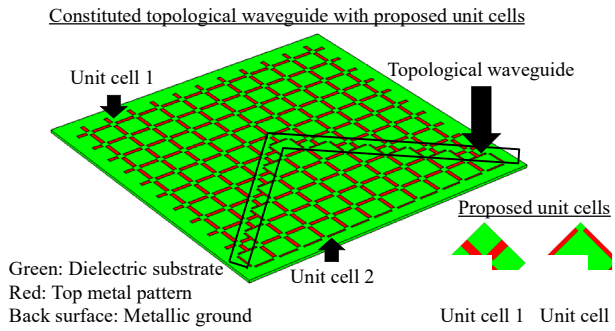

Figure 1 Topological waveguide constituted by the proposed two types of unit cell structures.

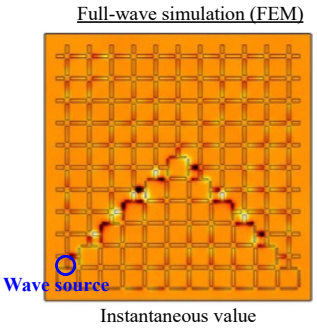

Figure 2 Complex electric field distributions at 6.101 GHz. COMSOL Multiphysics is used as simulator.

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The 17th Asian Textile Conference (ATC-17)
17-19 December 2024, Taichung, Taiwan

Synthesis of Amorphous Cellulose Derivatives by Means of Michael Addition to Hydroxyalkyl Acrylates

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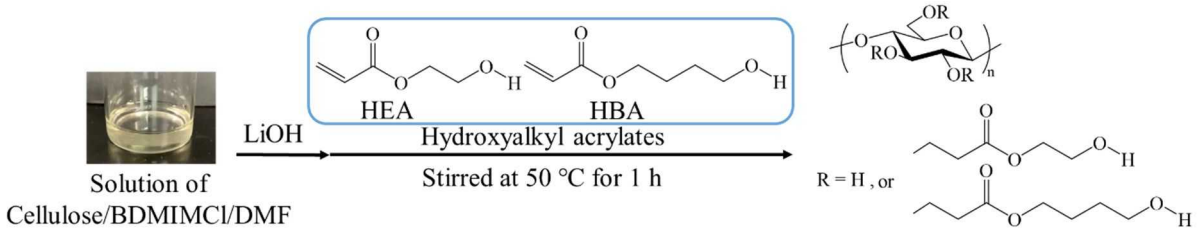
Abstract

Cellulose, which is a consisting of a chain of β(1→4)-glycosidic bonds, is one of the most abundant polysaccharides on the earth. However, cellulose has highly crystallinity because of strong intra- and intermolecular hydrogen bonding, resulting in quite poor solubility and processability. Derivatizationis effective in the utilization of cellulose, because the methods reduce crystallinity and improve solubility and processability. This study investigated synthesis of cellulose derivatives by means of Michael addition reaction to 2-hydroxyethyl acrylate (HEA) or 4-hydroxybutyl acrylate (HBA) under basic conditions in a homogeneous solution (Scheme 1). The derivatives had amorphous nature and form thermoplastic films, combined with an ionic liquid, 1-butyl-3-methylimidazolium chloride (BMIMCl).[1)] A solution of cellulose/1-butyl-2,3-dimethylimidazolium chloride (BDMIMCl)/DMF was first prepared according to the previous method.[2)] After treatment of cellulose with LiOH in the solution to generate alkoxides, Michael addition reaction was carried out in the presence of HEA or HBA at 50 °C for 1 h with stirring (Scheme 1). The ^{1}H NMR spectra of the products in NaOD/D_2O supported the progress of Michael addition. From the ^{1}H NMR analysis, degrees of substitution were calculated to be 0.6 (HEA) and 0.3 (HBA), respectively. The XRD profiles of the products indicated disruption of cellulose crystalline structures. The products were swollen with high polar organic liquids, such as DMF, and further, those from HBA were dissolved in DMSO. A thermoplastic film was successfully prepared by casting its DMSO solution containing BMIMCl, followed by drying under reduced pressure (Figure 1).



Scheme 1. Synthesis of cellulose derivatives by Michael addition reaction

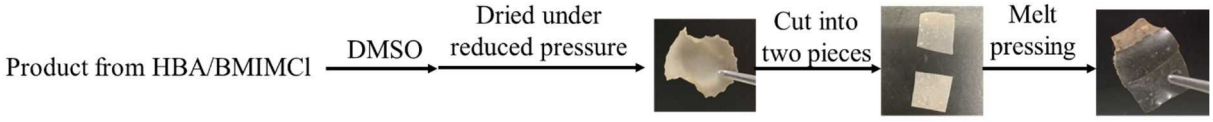


Figure 1. Procedure for preparation of thermoplastic film via casting method

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Etherification of chitin in ionic liquid

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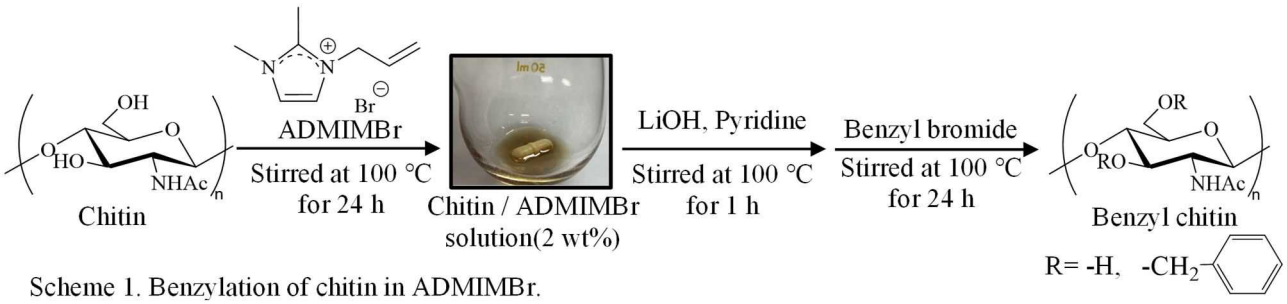
Abstract

Although structural polysaccharides, such as cellulose and chitin, are abundant biomass on the earth, they show poor processability and solubility due to their strong crystallinity. Derivatizations, such as acylation and etherification, are known to be effective for the utilization of cellulose,[1)] because the methods reduce crystallinity and improve solubility and processability. Acylation of chitin has also been investigated for its functional materialization,[2)] however, etherification of chitin has scarcely been performed compared to acylation. Ionic liquids have increasingly attracted much attention as reaction solvents for poorly soluble polysaccharides, such as chitin. Based on the fact, that an ionic liquid, 1-allyl-2,3-dimethylimidazolium bromide (ADMIMBr), is a good solvent for chitin, in this study, we investigate benzylation of chitin, as the represent etherification, in ADMIMBr. Chitin was first dissolved in ADMIMBr by heating a mixture at 100 °C for 24 h (2 wt%). Because etherification had generally been carried out under alkaline conditions, the present benzylation of chitin was conducted using benzyl bromide in the presence of LiOH in the resulting solution. The reaction was examined by stirring the chitin/ADMIMBr solution in the presence of LiCl (5 equiv. with hydroxy groups) at 100 °C for 1 h, and subsequently, stirring with benzyl bromide (10 equiv. with hydroxy groups) at 100 °C for 24 h. However, the reaction did mostly not proceed, probably due to heterogeneous condition of the present system. After the benzylation of chitin was attempted by the same operation under various conditions, we found that addition of pyridine (3 equiv. with hydroxy groups) in the reaction mixture resulted in progress of the benzylation (Scheme 1). The ^{1}H NMR spectrum of the isolated product in DMSO-d_6/D_2O/LiCl showed signals derived from both chitin and benzyl groups. From the integrated ratio of the aromatic signal to the acetamido signal, the degree of substitution was calculated to be 1.73. In this reaction system, pyridine has an ability to react with benzyl bromide in-situ to form benzylpyridinium bromide, which can act as a phase-transfer catalyst for progress of the benzylation.



Scheme 1. Benzylation of chitin in ADMIMBr.

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The 18 th World Conference on Earthquake Engineering (WCEE2024)

June 30 th to July 5 th , 2024, Milan, Italy

STEEL BAR-TIMBER COMPOSITE BEAM-COLUMN CONNECTION ADOPTING STEEL DAMPER

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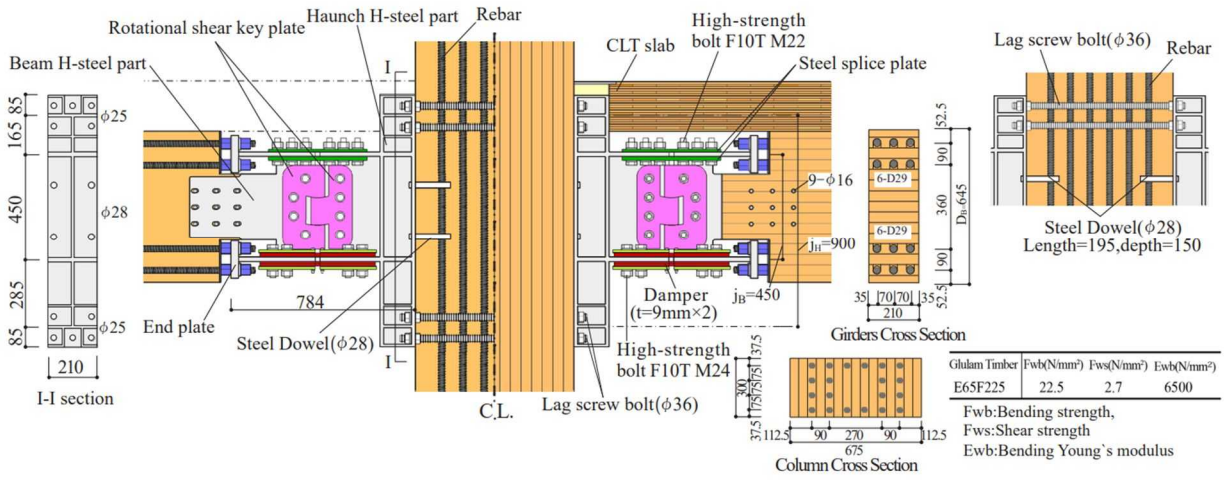
ABSTRACT

We have been developing a frame system consisting of steel bar-timber composite members which can perform better than those of reinforced concrete structure. The steel bar is deformed bar, which is embedded near outer in cross-section of the composite member and bonded with epoxy resin adhesive. Bending stiffness of the composite member is estimated to be approximately five times as much as conventional glulam timber for beam and approximately twice for column. Also, the bending capacity of the composite member is estimated to be approximately three times for beam and approximately twice for column. We developed wet and dry method for connecting column and beam, and now we have been improving the latter method. The improvements include a new manufacturing process for the composite timber, a change to threaded steel bar, a change in the shape of the steel parts used for the connection, and a change to steel damper. This paper presents the improvements, those advantages, and a loading test to investigate the performance of the improved connection.

SUMMARIES

In order to investigate the mechanical performance of the improved method of dry connection of rebar-timber composite beam and column, which was developed in the past, a reversed cyclic loading test was conducted on one specimen with full-size dimension under the assumption of major earthquake. Through making the specimen for the test, modifications of the process for manufacturing the steel bar-timber composite beam were attempted, for the new proposed connection of column and beam.



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CLT-SHEAR WALL CONNECTED WITH STEEL BAR-TIMBER COMPOSITE COLUMN DISSIPATING HIGH-ENERGY

T. Suyama[1], R. Kawasaki[1], R. Kamimakise[1] & S. Shioya[1]

ABSTRACT

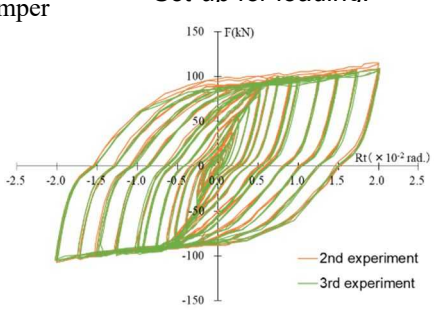
In light of the current climate crisis, there has been much recent interest in using timber structural members in large buildings, since timber is as renewable natural resource. Moreover, in severe earthquake prone zones, such as Japan, they are more desired on the grounds of light weight of timber members. We are developing a frame system formed by steel bar-timber composite members strengthened by deformed steel bars (i.e., rebars) using epoxy resin adhesive. We are also developing Cross Laminated Timber (CLT)-shear wall for the frame. One of the most excellent mechanical characteristics of CLT is its high shear stiffness and shear capacity. It is most advisable to use one long CLT panel as one continuous wall without cutting it at floor levels. This paper presents the application of the rotational shear key plate concept to the CLT wall and experiment of the shear wall dissipating high-energy amount by damper installed in a frame consisting of steel bar-timber composite columns and timber beams.

SUMMARIES

In this paper, we proposed a shear wall system in which CLT panels are incorporated into a rigid-frame structure of steel bar-timber composite members, which authors have been developing, and revealed mechanical characteristic of the shear wall subjected to reversed cyclic loading by a specimen scaled as 40.

Set-up for loading.

A friction damper so as to be installed between the CLT wall and the column and its connection method were proposed, and then it was confirmed that the damper can be easily joined. Although yield capacity of the damper increased with amount of its sliding deformation and the number of loading iterations, the capacity gradually converged to a constant value as the deformation increasing. Sliding deformation occurred in the joint between the damper and the CLT wall and in the joint between the damper and the column owing to clearance of holes in the drift pin or holes in self-taping screw, but the amount of deformation was almost negligible in the deformation of the shear wall.



Lateral force-deformation

2.The rotational shear key plate was proposed to transfer the shear force as the bottom of the CLT wall rotating, and it was confirmed that the plate could be easily jointed to the CLT wall and the incorporated CLT-shear wall allowed the rotation angle as planned.

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