IRG/WP 05-40294

THE INTERNATIONAL RESEARCH GROUP ON WOOD PROTECTION

Section 4 Processes and Properties

A Preliminary Investigation of the Properties of Engineered Wood Composite Panels Treated with Copper Naphthenate

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Paper prepared for the 36th Annual Meeting
Bangalore, India
24-28 April 2005

IRG Secretariat
SE-100 44 Stockholm
SWEDEN

A Preliminary Report on the Properties of Engineered Wood Composite Panels Treated with Copper Naphthenate

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ABSTRACT

This paper reports on our preliminary investigation of the properties of randomly oriented strandboard which had waterborne or powdered copper naphthenate (CuN) incorporated into the board during manufacture. When compared to zinc borate-treated controls (ZnB), the mechanical properties of strandboard (MOR, MOE, work-to-maximum load, internal bond strength) were not adversely affected by treatment with either form of copper naphthenate. In general, values for mechanical properties followed the trend untreated controls > waterborne CuN = powdered CuN > ZnB. Water absorption and dimensional properties followed a similar trend. This preliminary study suggests that CuN is a viable alternative treatment for engineered wood composites.

Keywords: copper naphthenate, strandboard, static bending, internal bond strength, thickness swelling, water absorption, linear expansion, zinc borate, modulus of rupture, modulus of elasticity, southern pine

INTRODUCTION

The need for durable engineered wood composites (EWC) has seen an increase in the last thirty years. These building products often are used in demanding exposure environments, especially in the high-risk regions of the southern and southeastern U.S. (Short 1984). They are commonly used in buildings as the principal structural elements for interior as well as exterior applications. Biological agents to which these materials are susceptible to include: decay fungi, stain fungi, mold/mildew fungi and wood-destroying insects. Decay fungi and subterranean termites, particularly the Formosan subterranean termites (FST) in the southern United States, pose the highest risk. They often encounter exposure to wetting and associated decay as well (Barnes 1993). While one of the simplest approaches to preventing decay is keeping wood dry in use, this is often not possible with exterior use EWCs. Schmidt (1993) noted that their use in a variety of exposures with potential for moisture ingress was increasing without adequate laboratory or exposure and service tests to predict their durability. The next step to preventing decay then is treating wood with chemicals toxic to biological decay agents (Haygreen and Bowyer 1996). As recently as 2002, Laks noted a gap in our understanding of the biological deterioration resistance of

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composite materials in interior applications and an even greater need to understand their biological performance in exterior applications.

Many studies have been conducted examining durability enhancement of EWC by preservative addition (Boggio 1982, Jeihooni 1994, Jones 2002, Knudson 1990, Laks 1990, Muin 2002, Myles 1994, Murphy 2002, Nieh 2004, Roos 1993, Schmidt 1991). Industry, however, is currently limited to only a few commercially viable preservative choices. At present, the commercial systems use zinc borate treatments, an ammoniacal copper complex (Potlatch Corp. 2004), or IPBC + isothiazolone treatment (Martco Ltd. Partnership 2004). Zinc borate treatments offer durability in protected environments, although leaching of borate treated products during building construction is a valid concern. This leachability of zinc borate limits applications to above ground protected environments. Other viable treatments registered for use with the EPA include propiconazole, methylenebisthiocyanate, tebuconazole, and chlorpyrifos.

Oriented strandboard (OSB) is a structural panel widely used in building construction that now outsells plywood (APA 2004). It can also be found as webstock in I-joists, in structural insulated panels, and as rim-board, as components making complete stair systems, combined with overlays in a siding products, combined with overlays in concrete forms and as other specialty products (Anonymous 2004), but the bulk of OSB is used as wall and roof sheathing and as floor underlayment. The long-term use of OSB in exterior exposures, however, is restricted due to low durability to decay fungi, dimensional instability from excessive moisture, and strength loss resulting from dimensional changes (Goroyias 2000). Interior use OSB may still be susceptible to intermittent wetting as well as insects. The widespread use and low durability led to the decision to use OSB as the EWC model in this study. Additionally, Shupe (2000) noted that little research is available in the public domain regarding treated southern yellow pine OSB. Waferboard panels were chosen for this study rather than OSB due to simplicity in manufacture. Waferboard panels feature homogenous, randomly aligned flakes as opposed to OSB which has strategically aligned flakes in layers. This study examines several new preservative formulations for use in engineered wood composites using waferboard models.

MATERIALS AND METHODS

Panel Manufacture--Panels were manufactured under laboratory conditions and made with one of three preservative treatments or no treatment (control). Waterborne copper naphthenate and powdered copper naphthenate treatments were added at a retention of 0.96 kg/m^3. A commercial formulation of powdered zinc-borate was added at a retention of 0.9% (w/w basis). All preservative treatments were added during panel manufacture. The powdered preservatives were added during flake blending using a modified agricultural type duster. The aqueous preservative solution was mixed with binder prior to addition to flakes. Single batches of flakes were blended for each preservative treatment to make a total of four panels per treatment.

Dried flakes were obtained from a cooperating commercial OSB manufacturer and stored in drums until used. Flakes were comprised mainly of southern yellow pine (SYP) with less than 4% mixed hardwoods. Mean flake size was 86.4 x 10.1 x 1.8 mm. A standard OSB commercial-type phenol-formaldehyde (PF) resin was used at loading of 4% resin solids. A particleboard-type liquid emulsion wax was used at a loading of 1% solids. This emulsion wax was chosen over slack wax normally used in OSB manufacture due to ease of use in manufacture. Mats were hand-felted in a forming box and hot-pressed for 300 s at 200°C. Finished panels measured 610 x 560 x 11 mm and had a target density of 672 kg/m^3.

<u>*Sample Testing*</u>--Panels were trimmed and cut into appropriate specimen sizes to examine physical and mechanical properties. Physical properties examined were: water absorption (WA), thickness swell (TS), and linear expansion (LE). Mechanical properties examined were internal bond (IB), modulus of elasticity (MOE), and modulus of rupture (MOR). MOE and MOR testing included dry specimens and separate wet (accelerated aging) specimens. The cutting pattern is seen in Figure 1.

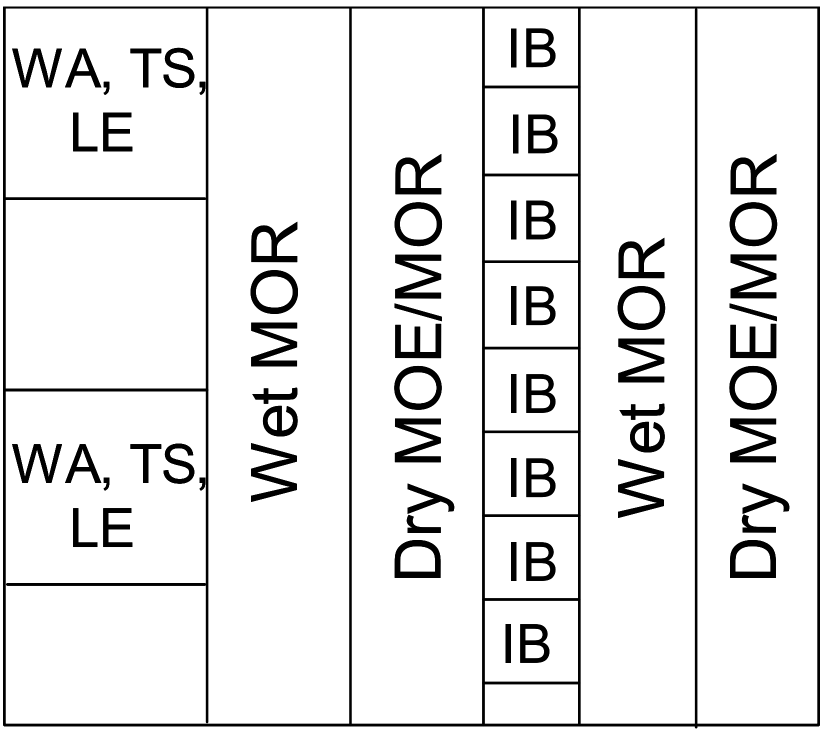

Figure 1. Panel cutting pattern.

Tests were performed in accordance with ASTM D 1037 (ASTM 1998) with modifications. Instead of the prescribed sample size (76 x ≥304 mm), linear expansion was determined on the square TS/WA samples. TS/WA samples measured 102 mm square rather than 152 mm square samples specified in the standard. The PS2-92 (APA 2002) moisture cycle for delamination and strength reduction (six-cycle test) was used as an accelerated aging cycle rather than the cycle specified in the standard. Properties were compared against Canadian Standard O437 for R-1 grade (randomly aligned) panels (CSA 2001).

RESULTS AND DISCUSSION

Panel manufacture was not negatively influenced by the treatments, but each treatment affected the appearance of finished panels differently. The copper naphthenates had a brown color, with the waterborne treatment being the darkest. Zinc borate treated panels were almost identical in color to controls. All panels had good surface finish and adequate consolidation throughout the edge thickness.

MOE results (Figure 2) show both copper naphthenates and untreated controls exceeded the minimum standard (CSA 2001). Zinc borate-treated panels did not meet the standard and were statistically lower than other treatments. No statistical difference between MOE of copper naphthenate treatments existed, though they were statistically lower than controls.

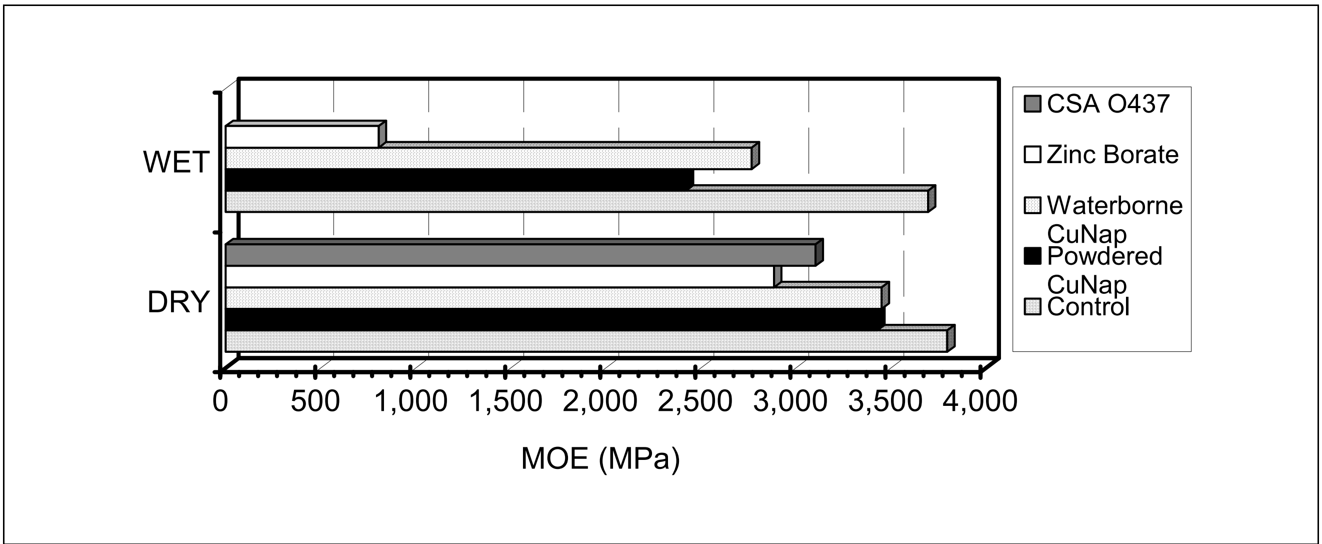

Figure 2. Effect of treatment on modulus of elasticity (MOE) results for waferboard.

MOR results (Figure 3) indicate the same findings, although all treatments met the minimum standard. IB results (Figure 4) showed all treatments meeting the minimum standard. Zinc borate had the poorest IB performance, with the control and copper naphthenates showing no statistical difference among them. Interestingly, waterborne copper naphthenate IB performance was superior to all treatments.

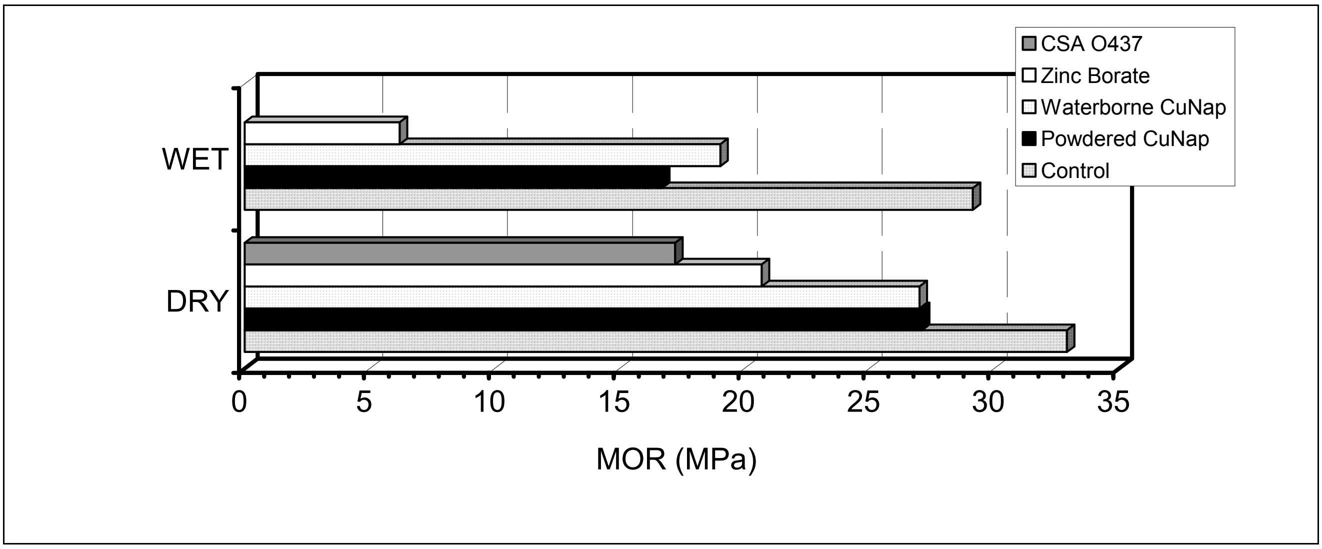

Figure 3. Effect of treatment on modulus of rupture (MOR) results for waferboard.

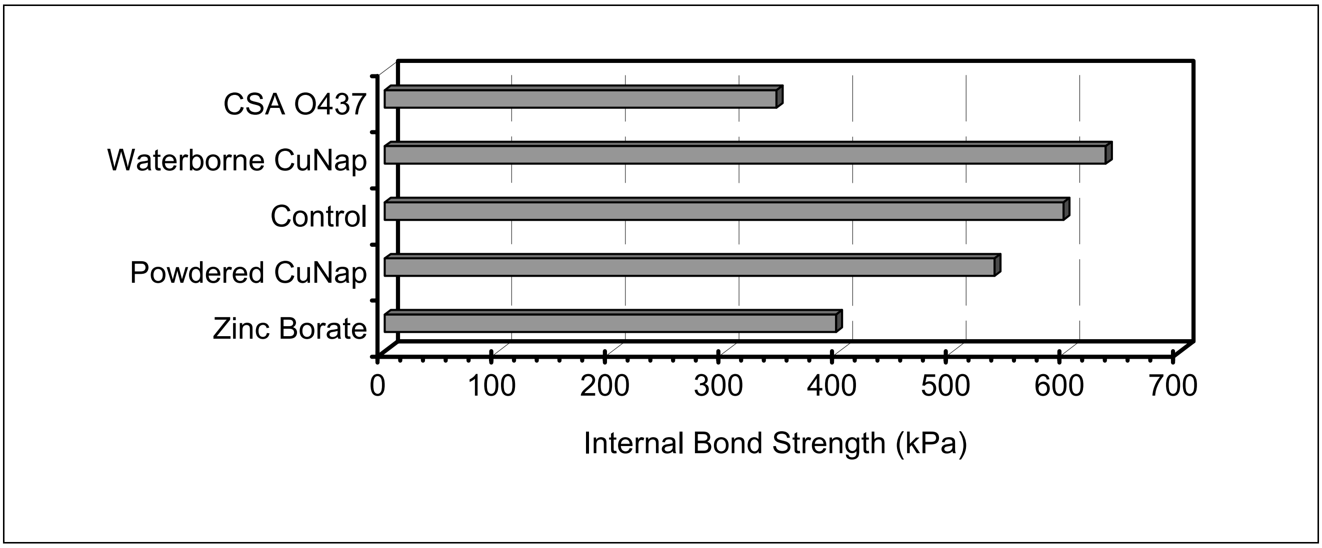

Figure 4. Effect of treatment on internal bond strength.

Physical properties were examined on 125 mm square specimens. TS results (Figure 5) did not meet the minimum standard and zinc borate treatment results were significantly poorer than other treatments. LE results (Figure 6) and WA results (Figure 7) also indicate that panels treated with ZB had poorer performance than the waterborne copper naphthenate or powdered copper naphthenate. Controls outperformed all other treatments in the TS, LE, and WA tests, although not always significantly.

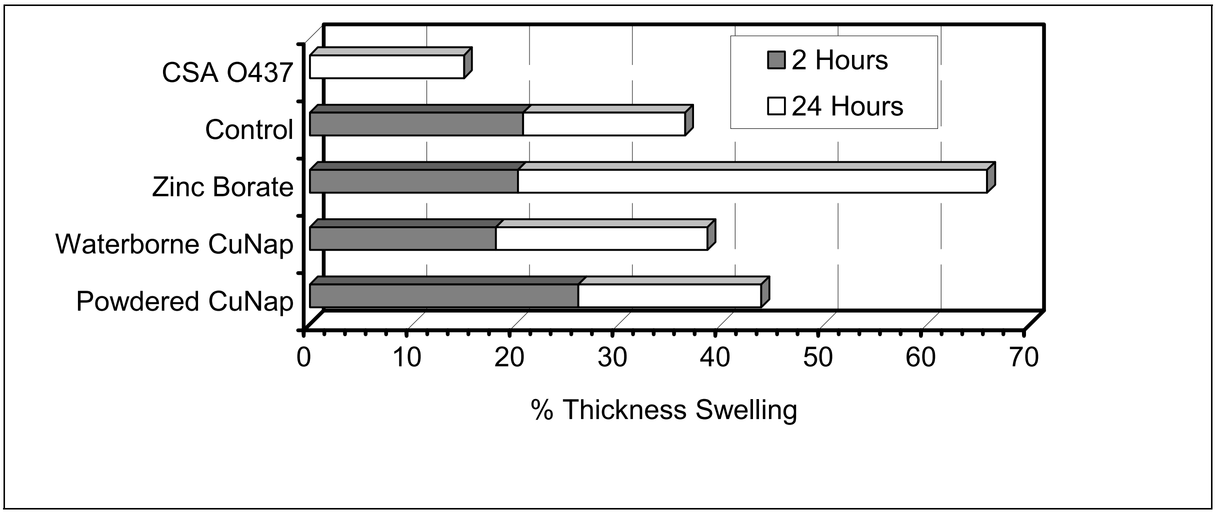

Figure 5. Thickness swelling results for treated waferboard.

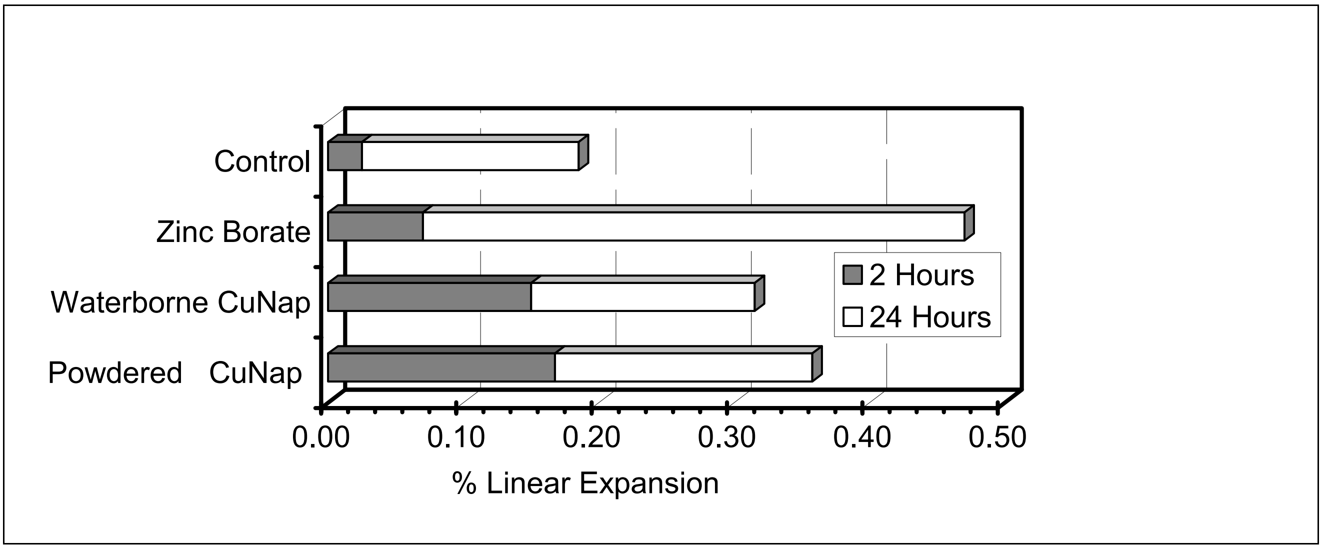

Figure 6. Linear expansion results for treated waferboard.

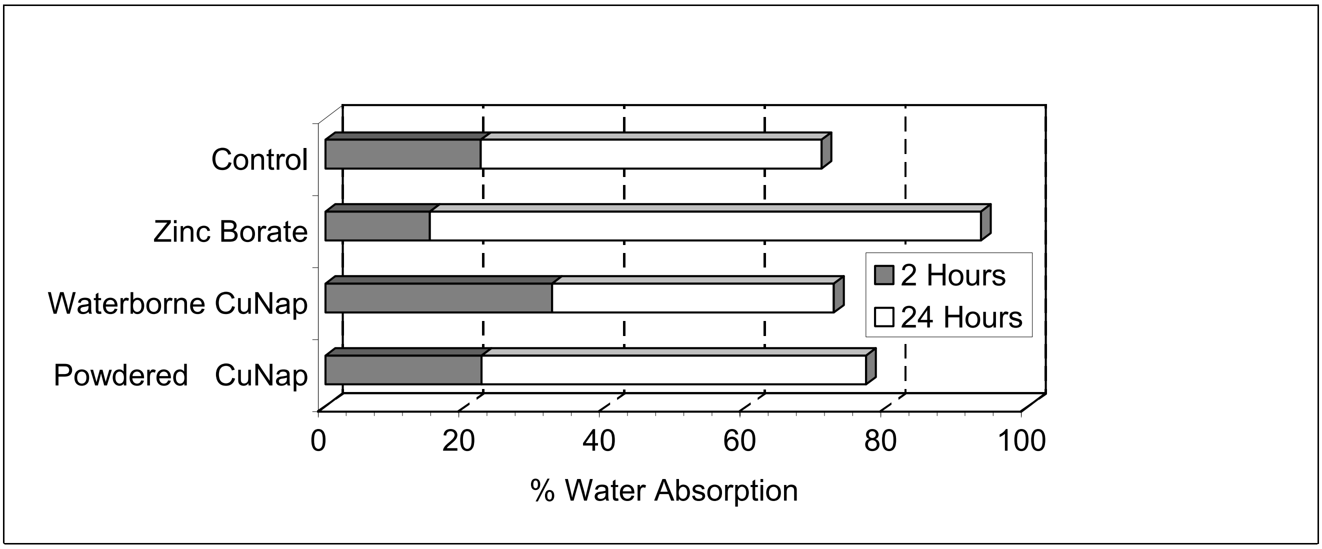

Figure 7. Water absorption for treated waferboard.

CONCLUSIONS

Preliminary findings of copper naphthenate addition to waferboard warrant further investigation. Adequate mechanical properties were attained, although some strength reduction in comparison to untreated controls was evident. Further work is needed to obtain required physical properties. The poor performance of zinc borate-treated panels was surprising. The method of zinc borate addition used in this study must be modified before any valid comparison to other treatments can be made. Additionally, due to the low number of replicates in this initial study, valid conclusions cannot be stated until more extensive studies are completed.

Further work is being done with the preservatives used in this initial study as well as additional new proprietary waterborne treatments. Multiple retentions and more replicates will be used in the larger study to ascertain the resistance to termites and fungi.

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