Weathering Test of Coatings for Wood Panel Boards

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ABSTRACT

Protection that coating gives to wood based boards exposed to weathering, depends on multiple factors such as: substratum, application, properties of the product and conditions of weathering. The decision on the utilization of a given protector is based on requirements of use and durability. The evolution through time of the substratum-protector system is studied in long-term experimental weathering test field.

Coatings in service are submitted to high and low temperatures, rain effect, solar radiation and wind, which are variable in different climatic zones, causing different effects when dampness is excessive or dryness is extreme. They are formulated for particular end-use conditions and, it is necessary to check their efficiency for the conditions that the manufacturer stipulates.

In this work the behaviour in service of pigmented varnish, varnish with filter UV, insecticides and fungicides, paintings and stains, solvent-borne and water-borne, is studied These products were tested to weathering in the Metropolitan Region, Santiago, La Pintana. Tests were made according to the ASTM D D1006-73 standard. Materials for test were oriented strand board (OSB) and plywood. Evaluations are realized until 24 months of weathering. cracks, spots, erosion, discoloration, sheen, shelling, humidity absorption, and swelling in thickness were evaluated.

Results indicate that none of the superficial protectors offers a completely efficient protection due to the severity of the exposition which caused visual unsightly effects such as loss of color, sheen, and fluctuations in the evaluated properties. After 24 months of weathering, coatings are still present on the substratum without loss of adherence, but with important appearance of superficial cracks. According to these results, the appearance and useful life decreases, lessening its competitiveness, corroborating the importance of the maintenance of the substratum-protector system.

Key words: Weathering, Plywood, Oriented strand board, Finishes, Varnish, Stain, Paint.

INTRODUCTION

Weathering is the general term used to describe the degradation of materials on the surface of all organic materials, including wood, as well as finishes used on wood, such as paints and stains. The process occurs through photo oxidation of the surface catalyzed by ultraviolet (UV) radiation, and it is augmented by other processes such as washing by rain, changes in temperature, abrasion by windblown particles, and changes in moisture content. (R.S. Williams et al 2000).

Although the weathering process can take many forms depending on the exposed material, in general, the process begins with a color change, followed by slow erosion (loss of material) from the surface. The surface initially develops slight checking. With some materials, deep cracks may ultimately develop. Weathering is dependent on the chemical makeup of the affected material. Because the surface of a material may be composed of many different chemicals, not all materials on the surface may erode at the same rate. (R.S. Williams et al 2000).

The protection of wood and boards weathering is a world-wide preoccupation. Feist (1988), Dieguez (1997), Beall (2002), Deglise (2005) have studied during years this thematic one. Effective products in their duration in front of degradation agents have been used; nevertheless these became highly toxic and little friendly with the atmosphere. At the moment the search concentrates in less toxic and equally efficient products.

The coatings durability on the weathering of wood depends essentially on three main factors that degrade and destroy these coatings. The wood superficial instability, the actions by atmospherics agents and the mechanism of aging (Dieguez, 1994)

The humidity fluctuation in the atmosphere and the wood cause dimensional and volume variations in the wood pieces which later are translated in superficial cracks. The liquid water crosses pores of the superficial layer and reaches the substrate gives rise to blisters, cracks, spots, erosion and discoloration. The frontal attack of water against the organic coatings can be avoided using special pigments and waterproof vehicles (Dreyse, 1979).

The ultraviolet light transmitted initiates photochemical reactions in wood surface being a change from color and failure in the adhesion between wood and the coating (Garmendia, 2003)

The effect of the exhibition of solid wood to high temperatures has incidence in the degradation of the wood components and the changes in its physical properties (color, density, shrinkage and permeability) and mechanical properties (Beall, 2002).

According to Garmendia (2003) the protection against the effects of the ultraviolet light can be reached with the use of absorbents of UV light, antioxidants, amine light stabilizers (Hals), and pigments.

In the technical information of wood paintings, varnishes and stains is described its protective action against the outside, blockade against UV radiation, waterproof capacity. For stains it is indicated that it reduces the aqueous vapor passage between the interior and outside of wood. In some products like fungicides and insecticides are gotten up (Garay, 2008). These protective properties need to be corroborated by means of field tests.

Around of 30 kinds of elastomer stuccos, varnishes and paintings were applied on radiata pine structural plywood, native plywood, humidity resistant particleboard, hardboard and MDF. Were installed in weathering test field for two years. None of these products showed good results in the protection against exhibition conditions especially on plywood (Garay, 2006).

In another research about wood protectors (Garay, 2007), its observed the nonfilm-building coating with pigments (stains or lasur) showed minor damage in the wood impregnated with CCA salts.

Later, two new experiments were realized in field test. In the first one it was tried to show if the nonfilm-building coating type stain without pigments, but with additives, applied in faces and edges protects the board indeed the weathering plywood and OSB board. In the second experiment it was looked for superficial protectors that protect OSB boards efficiently. The results of both experiments appear in this technical paper.

The objective of this study is to compare the service life of OSB and Plywood boards protected with stain-non forming coating and painting-forming coating only in OSB boards. This finishes were applied to severely weathered boards without doing an extensive surface preparation prior painting. Finishes included Test Group 1: Two stain – solvent base (P1 and P2); Test Group 2: Three kinds of finishes, polyurethane lacquer, oleo - elastomer stucco and marine varnish were applied to OSB boards.

MATERIALS AND METHOD

Materials

Experiment Group 1: Stain nonfilm-building coating.

Substrates: Plywood and OSB boards. Coatings: Two type of stain without pigments, with additives.

Experiment Group 2: Film -building coatings without additives, with pigments.

Substrates: OSB boards. Coatings: high gloss acrylic polyurethane lacquer of two component, marine varnishes based in high strength modified alkyd urethane and oil painting- elastomer stucco.

Method

Experiment Group 1 and 2

Protectors were applied according to engineering specifications of the manufacturers in faces and edges of boards and were prepared (20º C of temperature and 65% relative humidity) for two weeks. The painted boards samples were dimensioned at 0.25x2.44 m and weathering in a weathering test field in Santiago according to standard ASTM D1006-73.

The measurements were realized in T0 (beginning of the test), T1 (1 year of exhibition) and T2 (2 years of exhibition). After each period, the samples were retired from the test field for being evaluated. A statistical analysis show the influence of the exposure time

(T0, T1, T2), type of protection (P1 and P2 - F1, F2 and F3) and type of exhibition (North, South) factors on the esthetic properties.

The panels were evaluated annually according to American Society for Testing and Materials (ASTM) standards for erosion, cracking, flaking, and mildew growth. The panels were also evaluated for discoloration and general appearance using an appearance scale similar to that in the ASTM standards. Each board was rated individually to give four observations for flaking, cracking, mildew growth, etc. annually for two years. A rating of 10 indicates no observable degradation and 1 indicates complete failure of the specimen. A rating of 5 indicates medium degradation.

RESULTS AND DISCUSSION

Experiment Group 1 Stain with additives and without pigments:

Physical Properties:

In the Figure 1 it is observed thickness swelling and moisture absorption for both non film buildings with additives and without pigments (P1 y P2), north and south exhibition. The highest values of thickness swelling (14%) and moisture absorption (35%) were reached about P2 South exhibition. The lowest values were observed in P1 North exhibition for thickness swelling (smaller than 8%) and moisture absorption (smaller than 30%).

Figure 1 Thickness Swelling and Absorption (%) in OSB.

Aesthetic properties

In Figure 2 it is observed the experiment of group 1, stain-nonfilm building with additives and without pigments applied on plywood and OSB at the beginning of test (T0)

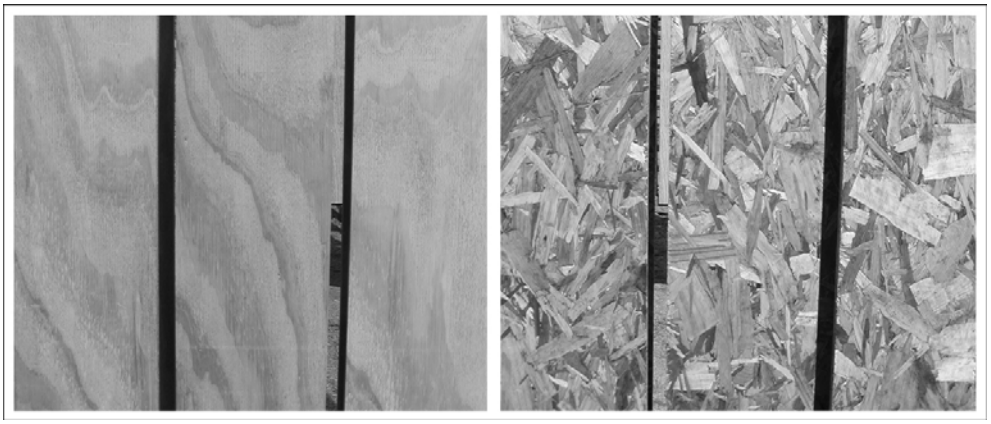

Figure 2 Test general states in initial time (T0).

After one year of exposition the boards were totally unprotected. P1 north protected less for cracks and spot fungi than P2 north. In south exhibition the fungi spot were very aggressive and the protectors didn't work well. Strong erosion in plywood was observed. For OSB there was erosion and edges deformation. Dimensional instability and superficial cracking were observed in north plywood exhibition. In OSB north exhibition erosion and loosening of strands were verified (Fig.3).

A protector which does not form film cannot be evaluated according to the properties of the paintings such as blistering and cracking, however it can be evaluated by the substrate condition, i.e. cracking, discoloration and erosion in the same substrate.

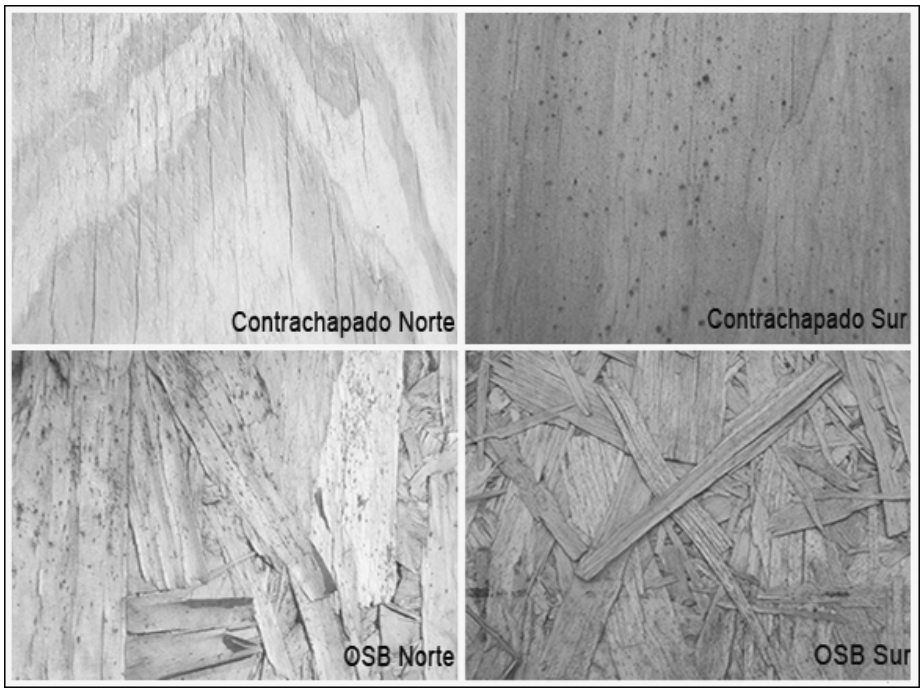

Figure 3 Visual aspects of boards after one year of exhibition

In Figure 4 the damage severity is showed when OSB and Plywood boards were protected with stain and exposed in weathering test field during two years.

There was superficial loosening of strands; there were not signs of the applied protector. The board surface was completely exposed outdoors and the erosion reaches degree 2, according to ASTM standard. For the plywood the main defect observed was the severe superficial cracking (degree 2) and erosion (degree 2). In addition was strongly discolored. This severe damage demonstrates the inefficiency of stain with additives and without pigments to protect severely exhibited substrates (Fig. 4).

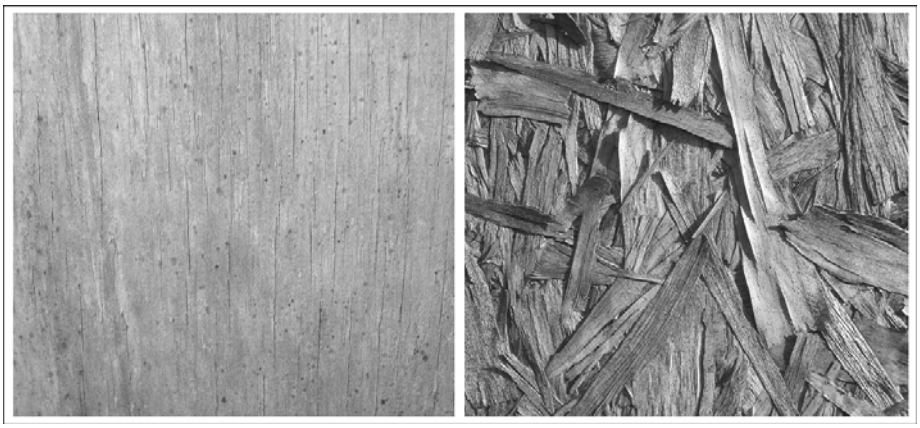

Figure 4 Boards Plywood and OSB protected with Lasur with additives and without pigments after two years of exhibition.

Experiment Group 2: Acrylic polyurethane lacquer, marine varnishes, oil-elastomer stucco.

Esthetic properties

The Figure 5 is a general view of the weathering test field, from which already the samples of year one and two for evaluation of the esthetic properties have been retired.

Figure 5 General View of the test field Group 2 after two years of exhibition.

After two years of exhibition in weathering (fig 6). The general state of the substrate (board OSB) still protected by the coatings.

Detachment and cracking of paint was observed in medium degree (degree 5 to 6) in lacquer polyurethane. This coating is excellent on MDF in humidity condition; however it didn't have the same results for OSB.

The marine varnish corresponds to a commercial product acrylic based and alkyd resin with high pigment content, reason for which has conserved its appearance and presented slight cracking (degree 8).

The best treatment for finishes was oil-elastomeric stucco, wasn't observed superficial damage of cracking, erosion or detachment (degree 10), and only was appreciated the accumulation of superficial dirt.
The application of oil as it bases previous to stucco was excellent, since it avoids the leaching of extractable towards the surface and therefore it don't appear undesirable spots. In addition the board stays stable dimensionally. The seal of the edges turned out helpful to maintain the adhesion of the coatings and the dimensional stability of the board.

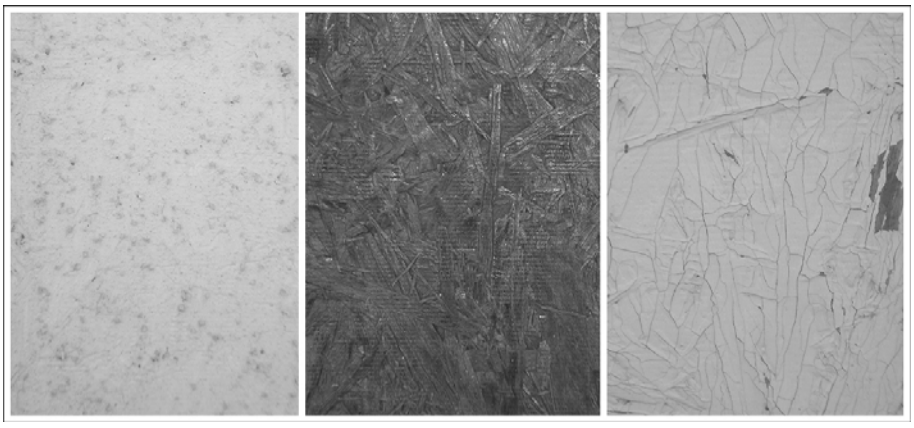

Figure 6 Esthetic aspects of coatings after two years of exhibition

CONCLUSIONS

In the group of test 1 (lasur with additives and without pigments) the physical properties of thickness swelling and moisture absorption were seen much influenced by the weathering, was unacceptable the moisture absorption according to standard test. The protectors type lasur with additives and without pigments did not offer suitable protection and the esthetic damages were severe. The esthetic properties of cracking and erosion were very affected by the lack of protection; there wasn't influence of the type of protector, being bad the result in both protectors. In the group 2 (specific tests for OSB) the protector which presented the best result was oil - elastomeric stucco. Marine varnish was satisfactory, and lacquer polyurethane wasn't adequate.

REFERENCES

ASTM D 1006-73. Test Methods for Conducting Exterior Exposure Tests of Paints on Word. (1973).

Beall, F. Termal degradation preservation. Forest Products Laboratory, University of California, Richmond, CA. Primer Congreso Chileno en Ciencias Forestales. Universidad de Chile. (2002)

Deglise, X. 2005. Superficial Protection of Wood: Present, Future and Tendencies. http://www.cidemco.es/congress/htm. accessed August 2nd, 2005

Dieguez, M. J. 1994. Lasures, protectors of the wood. Interbimall magazine. Technical bulletin of AITIM (Spain). 47-51p.

Dieguez, M.J. 1997. Finished of wood. Duration to the outside and vitreous transition temperature. AITIM 186. March /April.60-64.

Dreyse, C. 1979. Deterioration and aging of coverings in the construction. Thesis Engineer. Universidad de Chile. 216p.

Garay, R. 2006. Superficial coatings for outer use. Protecma 29. Spain. February. 16- 22.

Garay, R. 2007. Impregnants type lasur for the protection of the wood and boards. Agro-Ciencia 23(1): 25-36

Garay, R.; Poblete, H.; Karsulovic, T. Evaluation of oriented strandboards and plywood subjected to severe conditions of relative humidity and temperature. *F P J* (Submitted January (2008).

Garmendia, I. 2003 Mechanisms of Degradation and Systems of Protection in Varnishes and Paintings In front of External Agents. (Summary). Revista PROTECMA Nº 5. available in www.esinal.es.

UNE-EN 317. Thickness swelling and moisture absorption (1993).

Williams, R. S.; C. Jourdain; G. I. Daisey; R. W. Springate. 2000. Wood Properties Affecting Finish Service Life. V Journal of Coatings Technology Vol. 72, No. 902, March 2000.