The Use of Exterior Plywood for Small Signs
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THE USE OF EXTERIOR PLYWOOD FOR SMALL SIGNS

INTRODUCTION

Statement of the problem:

Plywood mills have greatly expanded in the Northwest during the past year. There are now twenty-two mills in Washington and eight mills in Oregon. Three of these plywood mills started in Washington, and five started in Oregon in the past year. Plywood has definitely established itself in the eyes of the public as a useful product, and new outlets for its uses are continually being revealed.

Since our country has been involved in the World War No. 2, there has become an increasing scarcity and priority on metal products. The following article appeared in the March 27 issue of the Oregonian. Along with this a need for some product to take the place of metal signs has originated. An example of this shortage has occurred right here in our own state. The state had difficulty
in securing enough metal to supply license plates for 1942. This problem brings up the question, "How about plywood being used in place of metal for small signs?"

The development of successful water-resistant glue and other adhesives have contributed largely to the increase in the use of Douglas-fir plywood for many exterior uses. Plywood has also proven relatively inexpensive in relation to its competing materials. The alternating direction of the grain of plywood, with each contiguous layer of veneer minimizes the shrinkage and warping coefficient of the product and prevents splitting or checking. Since wood is much stronger and stiffer along the grain than across the grain, plywood by having longitudinal grain in both directions possesses great strength and stiffness in all directions. From these facts it would seem evident that plywood could adequately take the place of metal for use in small signs.

Study to be made on "Keep Oregon Green" and "Oregon License Plate" signs:

The study of the possible and practical use of plywood for small exterior signs has been made on, "Keep Oregon Green" and "Oregon License Plates". The lumber industry is the chief industry in Oregon, and the state could greatly advertise its chief product by using plywood for its small signs. Especially for "Keep Oregon Green" signs, the plywood sign would serve a dual purpose by not only
educating the people to refrain from setting forest fires but also to educate the people as to the possible uses and value of wood which can be maintained only by the preservation of our forests.

PROCEDURE

The procedure of preparing the samples for testing will be broken down into selection of plywood, cutting of plywood, treating of plywood, and printing letters on plywood.

Selection of plywood:

An exterior grade of one-quarter inch, three-ply plywood glued together with an adhesive called Phenol-resin, Resin-Pressed, was selected on which to make the tests. This is a waterproof glue and is greatly adapted to outside use. The plywood used in making the "Keep Oregon Green" tests was an excellent grade of plywood, but the plywood used in making the license plate tests did not have a good finish and had numerous fine checks in its surface. This poor grade of plywood had a decided influence on the outcome of the license plate tests.

Cutting of plywood:

With a small jig-saw the plywood for the "Keep Oregon Green" signs was cut in the shape of the metal signs that are now being used for this educational campaign. The plywood used for license plates was cut in blocks the size of a standard size license plate, five and one-half
inches by twelve inches.

**Treating of plywood:**

The small plywood signs were dipped into a solution of waterproofing mixture which would further adapt the plywood to outside use. Three different types of solutions were used.

**Types of solutions used:**

Three different solutions were selected for use in minimizing the shrinking and swelling of the plywood due to the absorption of moisture. Woodtox and Woodfix are toxic water repellents, consisting of plain water repellents, consisting of plain water repellent formulas with five per cent or more of some effective toxicant added. This type of solution tends to reduce dimensional changes in wood and also protects the wood against stain and decay organisms. White Re7 is the third type of solution and consists of natural resins, synthetic resins, and similar materials dissolved in suitable solvents to form mixtures of varnish consistency into which wood products are dipped so as to form, upon drying, a moisture resisting coating over the wood surfaces. These mixtures, known as sealers, rarely penetrate deeply into the wood as do the penetrating water repellents but form a thin varnish-like layer over the surfaces and thus produce a satisfactory priming layer for subsequent paint coatings.
Woodtox:

"Woodtox is a clear amber-colored liquid, oily but not sticky. Its toxic element (5% by weight) is Monsanto Chemical Company's powerful pentachlorophenal: 15% consists of water repellent ingredients; 80% is a special light petroleum "carrier" oil. Thus, 20% of the ingredients are active fungicides, insecticides, and water repellents and 80% consists of clean light oil which penetrates quickly and deeply and spreads the active agents through the fine cells of the wood. Within 48 to 72 hours the "carrier" oil evaporates even the odor disappears. Pentachlorophenal is practically insoluble in water---won't leach out. Woodtox not only controls decay insect attack, and moisture content, but stays put indefinitely."^5

Woodfix:

Woodfix contains the same or similar ingredients as that of Woodtox except it does not contain any toxic. Woodtox contains five percent of pentachlorophenal, a toxic, which is not contained in Woodfix. The exact contents of Woodfix is a trade secret, and I was unable to secure data of its contents for this report.

Effects of treating plywood:

We should know that absolute water proofing of wood cannot be accomplished with any of the known treatments. "It is difficult to obtain an anti-shrink efficiency as high as 70% when wood is saturated with certain resin-forming solutions to a point where the weight of the resins added nearly equals the weight of the wood. It is the cell walls which shrink and swell with the removal or addition of moisture and the mere plugging of the cavities does not insure against the penetrating of moisture. The exchange of moisture by the cell wall material at the
surfaces of piece of wood, and, in the minute spaces which develop between the cell wall surfaces and the films or plugs of water repellent material in the cell cavities, account for the dimensional changes which take place. 

Dipping of "Keep Oregon Green" signs in Woodtox:

No. 1 and 2 of the "Keep Oregon Signs" were dipped into a mixed solution containing 300 cc. of Woodtox and 450 cc. of Stoddard's solvent. These signs were dipped for a period of ten minutes and during this time absorbed 30 cc. of the solution. A third sign was dipped in this same solution for a period of thirty minutes and during this time absorbed 16 cc. of the solution. This third sign was dipped for thirty minutes in order to determine if there would be a noted increase in absorption for a longer dipping period; however, since only one additional cc. was absorbed per sign, the added time does not prove to be of any particular value as far as absorption of the solution is concerned.

Dipping of "Keep Oregon Green" signs in Woodfix:

No. 4 and 5 of the "Keep Oregon Green" signs were dipped into a mixed solution containing 100 cc. of Woodfix and 700 cc. of Stoddard's solvent. These signs were dipped for a period of ten minutes and during this time absorbed 35 cc. of the solution. A sixth sign was dipped in this same solution for a period of thirty minutes and
during this time absorbed 16 cc. of the solution. This sixth sign absorbed less solution than the signs dipped for ten minutes and indicates that ten minutes is sufficient time in which to acquire maximum absorption.

Dipping of "Keep Oregon Green" signs in White Rez:

No. 7 and 8 signs were dipped in White Rez, a synthetic resin sealer and primer. This test was taken to see if the White Rez would serve not only as a water resistant but also as a white background for painting. After the White Rez had dried on the plywood signs, it caused the outward surface of the plywood to check and left a poor finish. On account of the effect the White Rez had on the plywood, no further testing of this solution was carried out.

All the preceding mentioned signs that were dipped had been placed in a drier at a temperature of 85°F. in order to assure drying of the solution within a weeks time.

Dipping of license plate signs in Woodtox:

No. 1, 2, 3, 4, 5, and 6 of the license plate signs were dipped into a mixed solution containing 605 cc. The solution was made up of 1 cc. of Woodtox to $\frac{1}{2}$ cc. of Stoddard's solvent. Before the signs were dipped this time they were heated until warm in order that the signs would absorb an additional amount of the solution. These signs
were dipped in the solution for a period of fifteen minutes and during this time absorbed 156 cc. of the solution, an average of 26 cc. per sign.

Dipping of license plate signs in Woodfix:

No. 7, 8, 9, 10, 11, and 12 of the license plate signs were dipped into a mixed solution containing 645 cc. The solution was made up of 1 cc. of Woodfix to every 7 cc. of Stoddard's solvent. The plywood signs were heated until warm in order to prepare the signs to absorb more of the solution. These signs were dipped in the solution for a period of fifteen minutes and during this time absorbed 145 cc. of the solution, an average of 24 cc.

The last 12 signs were placed in a small oven for overnight at 140°F. to hasten the drying period to one day.

Lettering of signs:

The next step to be done was to find a color combination and a method of printing the color design on the signs. This experiment was greatly curtailed because of the inability of the printing shops in Corvallis being unequipped to print on plywood. Printing the letters on the signs was determined the only practical and economical method of applying the color design on the plywood signs. Since the printing could not be accomplished in Corvallis, the signs were painted and printed by hand. These signs were lettered in order that the lettering might be tested along with the testing of the plywood.
Painting of the "Keep Oregon Green" signs:

No. 1 and 3 of the "Keep Oregon Green" signs were first painted on the face with an aluminum paint. After the aluminum paint had dried, the signs were lettered with green paint. The signs were lettered by copying the same letter and tree background as found on the metal "Keep Oregon Green" signs. The green lettering paint was a decor enamel put out by Fuller paints. The No. 1 sign after being painted was sent to Weyerhouser Lumber Co. in Longview, Washington in order to obtain an approximate cost for printing this sign; however, the Weyerhouser Lumber Co. was unable to submit any information of value.

Printing of the license plate signs:

The lettering on the license plates was printed with a small toy printing set having three-quarters of an inch type. Black India and green India ink was used in printing. This ink is waterproof and is similar to ink used by printers. Oregon Centennial was printed across the top of the plate, Oregon printed across the bottom, and 1943 was printed along both sides. No. 1, 3, and 5 license plates were printed with green ink. No. 2, 7, and 13 signs were printed with black India ink.

Testing of the samples:

Both the "Keep Oregon Green" and the license plate signs made of plywood were ready for testing. Since
Fig. 1.
A comparison of two different types of "Keep Oregon Green" plywood signs with a metal "Keep Oregon Green" sign. The letters on the plywood signs were painted with a green decorat enamel paint with a high gloss varnish over the top.
very little time remained for actually testing the signs to outside use, a method of testing was needed that would speed up the operation. Boiling the samples was the severest test that could be determined from which could be secured immediate results.

Boiling the "Keep Oregon Green" signs:

No. 1 and 3 samples of the "Keep Oregon Green" signs were held in boiling water for one hour. The signs were then taken and placed in room at natural room temperature to dry. After the signs had dried, numerous small checks appeared through the painted face surface. Both signs gave similar results. The paint was only very slightly dulled and did not materially injure it. Despite the slight checks in the plywood, the sign as a whole was still good and would stand a much severer test.

Boiling the license plate signs:

No. 3 and 5 plywood signs printed with green ink, No. 2 printed with black ink, and No. 13, a control without preservative, printed with black ink were held in boiling water for one hour. The signs were then taken out and placed on the table at a natural room temperature to dry. After the signs had dried, they were compared as to the different affects the boiling test had on them. The black ink on No. 2 and No. 13, the control, stood up extra well and did not appear to have been damaged at all by the boiling test. The green ink faded out con-
siderably, and proved that it was not as permanent an ink as the black ink. As was noted in the first of this report, the plywood used in the license plate tests was of a poor grade and had slight checks in it before testing was begun. The result of the test on checking the surface of the samples turned out with similar results on all samples. The surface appeared fairly severely checked, although not enough to hinder the sign from continuing to be used for the purpose intended. The falacy of the test and the reason for the similar answer between treated signs and control signs can be based on the fact that the preservative in the plywood samples was boiled out during the process of boiling and, thereafter, did not protect the sign from checking.

Cold water test on license plate signs:

A cold water test was next tried on No. 6, 9, and 14, a control sample. These signs were dipped in cold water for 24 hours. They were then taken and placed in natural room temperature to dry. After they were dried, they showed little affect caused by checking. The samples were then dipped in cold water for an additional 24 hours. They were then taken and dried again in natural room temperature. This brought out more checking, but still not enough to be readily noticeable. It was again noted the very small difference of the severence of checking.
Fig. 2.

Plywood license plate signs prior to being tested by the boiling method.
Fig. 3.
Plywood license plate signs after being dipped for one hour in boiling water.
between the two samples dipped with Woodtox and Woodfix and the sample with no preservative and just used as a control. If the tests continued to show this result, it would prove that it would not be profitable to dip the signs in the preservative for the small decrease in checking; however, too few tests have been made to prove such a point and the process of dipping the signs in preservative will be considered profitable until definitely proven otherwise.

**Testing under actual outdoor conditions:**

To further determine the benefit of the preservative, No. 2 of the license plate signs and No. 3, 6, and 7, control sample, of the "Keep Oregon Green" signs were placed outdoors in the weather free from protection. After three weeks outdoors, the signs showed slight checking. The checking was so slight, however, that it could be seen only if held in the light. This test at the end of the three weeks period showed very little difference between the dipped plywood and the control, in fact the control seemed to be standing the weather better than the plywood signs dipped in preservative. After seven weeks outside, the signs were again checked. Surface checking of the signs had not increased over that found after three weeks test. At this time, however, it was noticed that the control sample had begun to warp. None of the samples that had been dipped in preservative showed any indication
of warping. This was the first indicated advantage the samples dipped in preservative showed over the control samples. The black lettering on the No. 2 license plate sample was not harmed by seven weeks outside. The green lettering on No. 3 sample completely faded out. It was determined that the charcoal in the black india ink had much do with the ink's permanence. The signs remained outside until the end of 12 weeks. At this time there appeared to be little difference between the results now and at the end of seven weeks. The weather checks were faintly appearing on the surface of each sign. The control sample had an increase in warping while the samples dipped in preservative had not as yet shown any indications of warping. These results show a great deal of promise for the use of plywood for small exterior signs.

Cost of signs:

A cost study will be made only on a "Keep Oregon Green" sign. The cost of making a "Keep Oregon Green" sign out of plywood will be roughly estimated in order to give a comparison of cost between plywood and metal signs. The cost was divided into the processes necessary for making the sign.
Material cost, plywood ——— 4.6¢ per sign
Fabrication cost, sawing, sanding, and drilling ———- 4.0¢ per sign
Treating cost
Material ——— 0.1¢ per sign
Handling ——— 4.0¢ per sign
Printing ——— 4.0¢ per sign
Total cost of sign ——— 16.7¢ per sign

The above costs were based on a small operation and could undoubtedly be lowered if done by efficient mass production. As the cost now stands it compares favorably with metal signs. The metal "Keep Oregon Green" signs cost 17¢ per sign in comparison with the estimated cost of plywood signs at 16.7¢ per sign. It also must be kept in mind that metal for signs is becoming extinct at any price.

SUMMARY

Findings:

The boiling, cold water, and outside tests all indicated that there was little difference in surface checking of the plywood whether the signs were or were not dipped in a preservative. The only actual gain of dipping the signs in a preservative was determined from the outside tests in which the control sample was beginning to warp at the end of seven weeks and more so at the end of twelve weeks. No such action appeared on the signs that were dipped. The checking that did occur on
any of the signs was not enough to materially affect its appearance or strength. No distinction could be determined in the tests between the effect of Woodtox or Woodfix as preservatives.

The plywood being glued together with an adhesive called phenol-resin was not harmed by any of the tests. Since the glue withstood all the tests, it was concluded to be adaptable to outside use.

The black india ink having gone through the boiling and outside tests did not appear to have been injured in any way. The aluminum paint and Fuller's decorct enamel paint withstood the boiling test without injury.

The signs could be produced at a cost slightly lower or on equal terms with that of metal signs.

Conclusion:

All facts gathered tend to indicate that plywood can be used for small external signs. These points concerning the signs were determined. A good grade of plywood made of phenol-resin glue is suitable to outside use. The signs should be dipped with preservative to prevent warping and, even though not indicated in my tests but stated in trade literature, to prevent checking. The signs should be printed with a durable ink comparable with the black india ink used in the tests.

Considerable effort will be required before plywood
will actually be established as a material to be profitably used for small exterior signs. Favorable comment has been received from the personnel of the "Keep Oregon Green" program concerning the desirability and possibility of using plywood for "Keep Oregon Green" signs. Plywood has great possibilities along this line and if given a chance should prove itself as a suitable material for small signs and should hold its place in this field even after metal comes back into free circulation and competition.
Bibliography

