PRESERVATIVE REQUIREMENTS FOR EXTERIOR PARTICLEBOARD PREDICTED FROM ACCELERATED LABORATORY TESTS

M. E. HEDLEY
Forest Research Institute, New Zealand Forest Service, Rotorua

(Received for publication 29 March 1976)

ABSTRACT

Decay tests were used to determine levels of sodium pentachlorophenoxide required to provide desirable protection to exterior particleboard from decay fungi. The decay resistance of treated board was compared with that of timber (both naturally durable and preservative-treated) currently used in situations for which exterior particleboard is designed. Retention of 0.35% sodium pentachlorophenoxide should provide adequate protection.

INTRODUCTION

An unresolved problem regarding exterior particleboard and the need for preservative treatment is whether the board will retain structural integrity during its service life. Accelerated and natural weathering tests have shown that significant reduction in strength occurs during weathering, although the type of adhesive used has a marked effect on the rate of strength loss (Beech *et al.,* 1974; Geimer *et al.,* 1973; Lehman, 1973). Swelling of the wood particles due to moisture absorption and consequent glue failure is the main cause of strength reduction and a well-maintained paint coat has been found to be the most effective means of prevention (Geimer *et al.,* 1973). Factors affecting biological and physical degradation of particleboard are thus closely related: uptake of moisture will promote both reduction in strength and destruction by decay fungi. What has yet to be established is whether significant reduction in strength by physical effects occurs in advance of that due to fungal activity. If so, preservative treatment would be superfluous. Conversely, moisture contents may be attained in service which would not cause an unacceptable reduction in strength properties (e.g., with tannin-formaldehyde bonded particleboard, which resists swelling after moisture ingress) but which are suitable for fungal growth. There would then be a need for preservative treatment.

Because adequate paint covering cannot be assumed, unfavourable moisture contents may be encountered in service which may be suitable for fungal attack, and on this basis it is considered that preservative treatment is desirable.

ACCELERATED TESTING TO PREDICT IN-SERVICE PERFORMANCE

Expansion of exterior particleboard production in New Zealand has necessitated establishment of required loadings of the currently approved particleboard preservative (sodium pentachlorophenoxide) and, because of the absence of data from long-term service tests, basing these on the results of laboratory decay tests. This paper investigates the ability of such tests to predict the decay resistance of the board in an out-of-ground-contact situation.

Laboratory decay tests for wood preservatives, either agar/block (BS 838, 1961) or soil/block (ASTM D1413, 1967), produce an extremely high-decay environment of a type which will not be met in service. The major value of such tests is that the comparative performances of a number of preservatives can be assessed easily and quickly. However, it is arguable whether the comparative performance of chemicals as tested in the laboratory will be reproduced under field conditions, or whether laboratory results can be used as predictors of performance in ground-contact service situations. It is even more difficult to predict from standard laboratory tests the expected service performance of a wood preservative which will be used in a less demanding out-of-ground-contact situation.

There is at present no satisfactory accelerated test which simulates a low or moderate decay environment. "Fungus Cellar" tests, where the test sample size is an improvement on the small block concept of standard decay tests, have some predictive value (Deppe and Gersonde, 1975). Nevertheless, tests to establish necessary preservative loadings for out-of-ground-contact situations rely heavily on "natural" exposure trials (e.g., Scheffer *et al.,* 1971).

We believe that accelerated decay tests in the laboratory can be of value for predicting preservative requirements for exterior particleboard. The following is the rationale for such a belief.

A major potential use for exterior particleboard in New Zealand is house cladding. It is desirable that the decay resistance of the product be equal to that of timber or timber products currently employed. In New Zealand both preservative-treated *Pinus* species and the heartwood of durable species are approved or recommended for house cladding (NZSS 1900, 1964; NZSS 3602, 1975; TPA, 1969).

The major species used untreated is rimu (*Dacydium cupressinum* Lamb.). On the basis of laboratory soil/block tests (ASTM D1413, 1967) the heartwood is classed moderately-resistant to resistant.

The New Zealand Timber Preservation Authority (TPA) prescribes two levels of treatment for building timbers used out of ground contact: (1) Commodity Specification C7, in which the timber is exposed to the weather; (2) Commodity Specification C8 in which the timber is protected from the weather by roofs, external walls, or paint. The former specification requires a minimum copper-chrome-arsenate (CCA) retention of 5.0-5.4 kg/m^3 (depending upon the proprietary preservative formulation), and the latter 2.6-3.2 kg/m^3 with a minimum sapwood core loading of 0.04% arsenic. Decay-resistance properties of exterior particleboard should thus at least equal timber covered by Specification C8 but need be no greater than those implied by Specification C7.

Under high-decay test conditions, the threshold value for CCA preservative formulations (irrespective of specific formulation) is 4.0 kg/m^3 of preservative total oxides (Hedley, 1970). At this retention, decay is perceptible in test blocks but weight losses due to decay are less than 2%. For CCA preservatives currently used in New Zealand this retention is equivalent to commercial salt loadings of Celcure K33 at 5.3 kg/m^3, Celcure AN at 5.9/kg/m^3 and Tanalith NCA at 5.7 kg/m^3 — retentions only slightly greater than those required in TPA Specification C7.

Rimu heartwood and pine sapwood treated to intermediate retentions (C7 or, preferably, C8) can therefore be used as "markers" against which to compare the decay resistance of timber or board products which will have a similar end-use. If decay, in laboratory tests, of such products was less than that obtained in any of the "markers" then the decay resistance of the product should be suitable for its proposed end-use; if decay was greater than the least resistant "marker", the product would be unsuitable. Heavily treated or durable timbers can not be compared in the same way because they will not undergo attack.

EXPERIMENTAL

(a) *Particleboard in High-Decay Conditions*

Samples from six 12-mm thick production boards of "Structex" particleboard* bonded with tannin-formaldehyde were used. Sodium pentachlorophenoxide (NaPCP) (0.9% air-dry wood) was added to the adhesive before it was sprayed on the wood particles. Finished (oven-dry) boards had NaPCP concentrations of 0.35-0.69%. Such a discrepancy supports the view of Deppe and Petrowitz (1969) that up to 60% of NaPCP may be volatilised during hot pressing. Sample boards not containing preservative were prepared in the laboratory and tested simultaneously. In a preliminary investigation (Hedley, 1974) both leached and non-leached samples were tested using two methods of sample sterilisation, autoclaving at 120°C and fumigation with 1,2-epoxypropane. Little difference in extent of decay was obtained using combinations of these pre-exposure treatments. Because of this and in accordance with arguments of Deppe and Gersonde (1975) against leaching of particleboard test samples for decay tests, only non-leached blocks sterilised by autoclaving were used in this trial.

Samples were cut into 20 × 20 × 12 mm blocks and eight replicate blocks per sample, weighed at 12% equilibrium moisture content, were exposed to each decay fungus — *Gloeophyllum trabeum* (Pers. ex Fr.) Murr., *Coniophora puteana* (Schum) Karst., and *Fomes gilvus* (Schw.) Lloyd. Three treated blocks and one untreated block were exposed in each soil jar using a soil burial technique (Hedley and Foster, 1972). Weight losses were recorded after 10 weeks' incubation at 27°C.

(b) *Comparison with Solid Wood Samples*

The decay resistance of particleboard was compared with that of solid-wood timber samples using the standard ASTM D1413 exposure technique. Samples tested were commercial board containing 0.36% NaPCP (by analysis), radiata pine treated to three retentions of CCA preservative (6.0, 4.2 and 2.1 kg Boliden K33/m^3), untreated board, untreated rimu heartwood, and untreated radiata pine sapwood. Test samples were sterilised by fumigation with 1,2-epoxypropane and placed on the surface of previously inoculated 65 ×50 × 5 mm feeder strips in soil jars. Test fungi were *G. trabeum*, *C. puteana*, and an unidentified local isolate (U85) cultured from a decaying rimu window frame. Percentage weight losses were determined after 10 weeks' incubation at 27°C.

---

* Produced by Fletcher Timber Co. Ltd, New Zealand

RESULTS AND DISCUSSION

(a) Weight losses of samples in the soil burial tests are shown in Fig. 1. All NaPCP retentions successfully prevented decay by *G. trabeum* and *F. gilvus*. Decay by *C. puteana* was only slightly inhibited at NaPCP concentrations between 0.35 and 0.45%, but decay was prevented at 0.65%.

(b) Weight losses of untreated board exposed to *C. puteana* were similar to those obtained by soil burial, but weight losses caused by *G. trabeum* were much less than found previously (Fig. 2). Weight losses in treated board after exposure to *C. puteana* were only slightly less than those obtained in the first test. For all three test fungi, the decay resistance of particleboard containing 0.36% NaPCP was between that of rimu heartwood and radiata pine treated to a CCA retention of 2.1 kg/m^3 with Boliden K33.

Because samples treated to 0.65% NaPCP were highly resistant to decay by all test fungi and because of the severity of the test, caused mainly by the maintenance of high moisture contents within test blocks, this level was well above that necessary to protect the board in service. Board containing 0.36% NaPCP showed similar responses in both soil burial and ASTM D1413 tests; high resistance to *G. trabeum* (and to U85 in the second test) but only moderate resistance to *C. puteana.*

Coniophora puteana has been described as the most destructive fungus in housing timbers in Europe (Cartwright and Findlay, 1958). Although it has been isolated from decayed housing timbers in New Zealand, it is not considered to be widespread. Intolerant of low moisture contents, it ceases activity when the supply of moisture is removed. Intermittent wetting of a potential substrate is therefore unlikely to provide a suitable environment for establishment of this fungus. Exterior particleboard in service would seldom be subjected to more than intermittent wetting, for example, after temporary rupture of the paint coat, so *C. puteana* may not be a serious hazard. Like *Poria vaillantii* (D.C. ex Fr.) Cke* virulence in the laboratory may be an unusual phenomenon, of little practical importance in the decay of particleboard. If results with *C. puteana* are considered to be of doubtful relevance, the decay resistance of particleboard containing 0.36% NaPCP compares favourably with that of radiata pine treated to a retention of 4.2 kg/m^3 with Boliden K33, a retention in excess of that required by TPA Specification C8.

From the evidence in Fig. 2, the need for any treatment might be questioned. For all three test fungi, untreated particleboard showed only slightly less decay resistance than rimu heartwood, a timber that has given satisfactory performance as house cladding in New Zealand. However, there is an important difference between constructional uses of exterior particleboard and rimu heartwood. Whereas the latter is used as weatherboards, exterior particleboard is currently marketed, and designed for use, as 2400 × 1200 mm sheets. Because these sheets may be used as bracing or load-bearing members in a construction, decay in part of any sheet could require renewal of the entire sheet. Since the unit replacement cost is greater for exterior particleboard than

* Certain strains of which show exceptional tolerance to high retentions of CCA preservatives (Da Costa, 1959), but there is no documented evidence of **P. vaillantii** causing in-service failure of pine species adequately treated to prescribed CCA retentions, although such retentions would offer little resistance to attack by this fungus in laboratory tests.

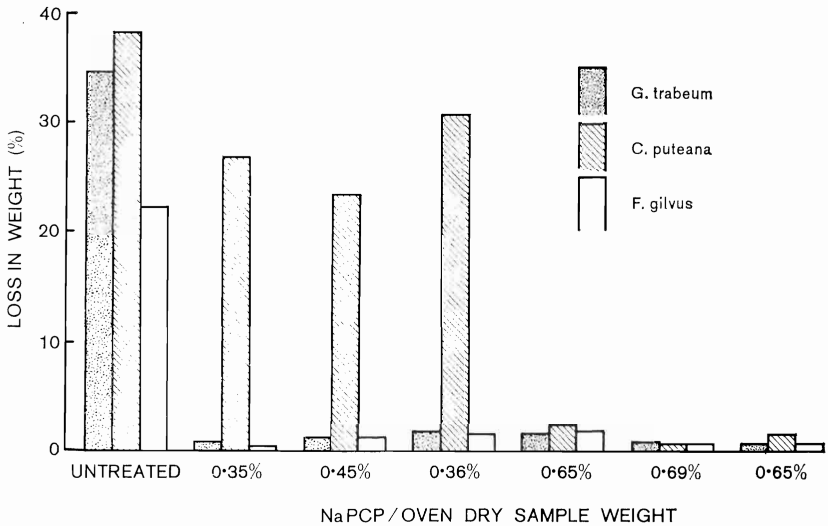

FIG. 1—Decay resistance of particleboard samples in soil burial exposure test (test 1).

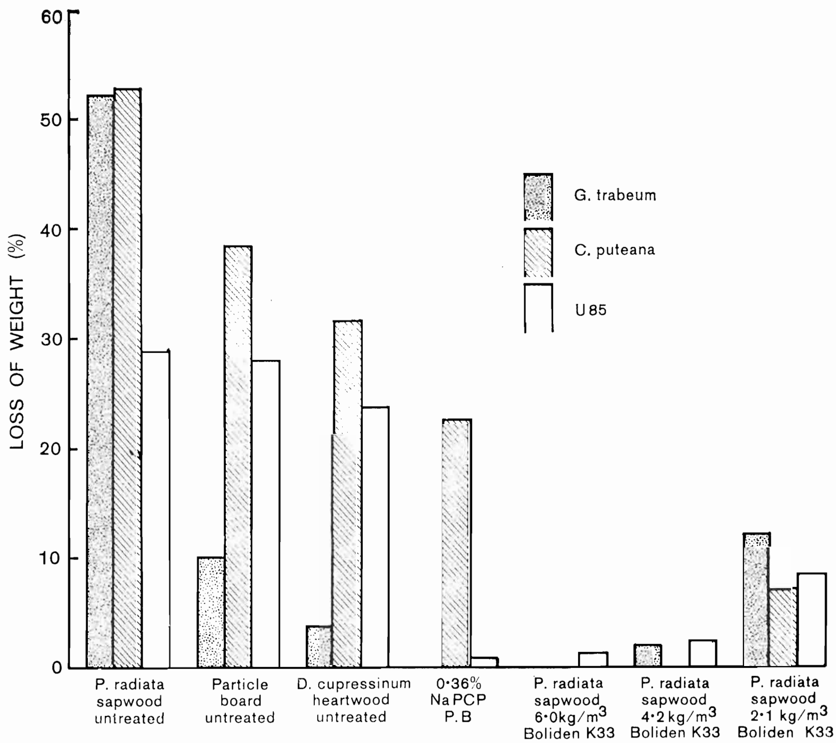

FIG. 2—Comparative performance of treated and untreated particleboard and solid wood samples (test 2).

for rimu weatherboard, it is desirable that there should be greater confidence in its ability to resist decay. It is considered that such confidence can be obtained with a NaPCP concentration in the finished board of 0.35% per oven-dry board weight.

ACKNOWLEDGMENTS

I wish to thank Mr J. B. Foster and Miss M. C. Hughes for assistance with the experimental work and Mr D. W. Smart, Fletcher Timber Company, Taupo for supplying particleboard samples.

REFERENCES

ASTM D1413 (1967): Testing wood preservatives by laboratory soil block cultures. Part 16 **in** "1967 Book of ASTM Standards", American Society for Testing and Materials, Philadelphia.

BS 838 (1961): Methods of test for toxicity of wood preservatives to fungi. British Standards Institution, London.

BEECH, J. C., HUDSON, R. W., LAIDLAW, R. A. and PINION, L. C. C. 1974: Studies of the performance of particleboard in exterior situations and the development of laboratory predictive tests. **Building Research Establishment, Current Paper 77/74.**

CARTWRIGHT, K. St. G. and FINDLAY, W. P. K. 1958: "Decay of Timber and its Prevention". H.M.S.O., London.

DA COSTA, E. W. B. 1959: Abnormal resistance of **Poria vaillantii** (DC ex Fr.) Cke strains to copper-chrome-arsenate wood preservatives. **Nature 183:** 910-1.

DEPPE, H-J and GERSONDE, M. 1975: Zur Situation des chemischen Schutzes von Holzwerkstoffen gegen Faulnis. **Holz Roh-u. Werkstoff 33:** 124-8.

DEPPE, H-J and PETROWITZ, H-J 1969: Untersuchungen zum Einsatz von Pentachlorophenol als Schutzmittel bei der Holzspanplatten-herstellung. **Holz-Zbl 95(71):** 1085.

GEIMER, R. L., HEEBINK, B. G. and HEFTY, F. V. 1973: Weathering characteristics of particleboard. **USDA For. Serv., Res. Pap.** FPL 212.

HEDLEY, M. E. 1970: Comparative toxicity of six proprietary copper-chrome-arsenate water-borne preservatives. **N.Z. For. Serv., For. Res. Inst., Forest Products Rep. 298** (unpubl.).

——— 1974: Decay resistance of tannin bonded particleboard. **N.Z. For. Serv., For. Res. Inst., Forest Products Rep. FP/WP 50** (unpubl.).

HEDLEY, M. E. and FOSTER, J. B. 1972: Modified soil/block technique for assessing wood decay. **N.Z. J. For. Sci. 2(2):** 237-48.

LEHMAN, W. F. 1973: Some experiences with durability of wood-based composite panels in the United States: moisture, overlay and finishing effects on panel performance. Paper at IUFRO Section V, Union of South Africa, September 23-October 6, 1973.

NZSS 1900 (1964): Construction requirements for buildings not requiring specific design. **Chapter 6 in "Model Building Bylaw"** N.Z. Standards Institute, Wellington.

NZSS 3602 (1975): Code of practice for specifying timber and wood-based products for use in buildings. Standards Association of N.Z., Wellington.

TPA (1969): "Timber Preservation in New Zealand: Specifications". Timber Preservation Authority, Wellington.

SCHEFFER, T. C., VERRALL, A. F. and HARVEY, G. 1971: Fifteen-year appraisal of dip treating for protecting exterior wood work: effectiveness on different wood species and in various climates. **Mater. u. Organ. 6:** 27-44.