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The Durability of Linseed Oil Putties and Rigid Acrylic Caulks as Fillers for Exterior Timber.

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THE DURABILITY OF LINSEED OIL PUTTIES AND RIGID ACRYLIC CAULKS AS FILLERS FOR EXTERIOR TIMBER

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SUMMARY

Samples of acrylic fillers and linseed oil putties were used to fill timber panels which were subjected to natural weathering. The fillers were placed in cavities which were: unprimed; primed with acrylic primer; and primed with alkyd primer. The panels were finished with both acrylic and alkyd topcoat systems and examined after six months and at one year's exposure. The fillers were subjected to movement and humidity cycling tests to determine the suitability of such accelerated test methods for these materials. The short term durability of the acrylic caulks was found to be similar to that of linseed oil putties. When used to fill exterior timber, both materials required overpainting, and priming holes before filling resulted in improved performance.

INTRODUCTION

Linseed oil putties have been used with some success since the eighteenth century. Basic formulations have changed little over this period, most still consist of linseed oil (10-16% by weight) and whiting (calcium carbonate). The use of putty in New Zealand is confined mainly to glazing in timber frames and for stopping nail holes, small knot-holes, and cracks in timber cladding, prior to painting. The surface of the putty oxidises to form a skin which slows the rate of oxidation of the bulk putty, allowing it to remain plastic. When weathering or movement of the substrate causes a break in the surface layer, oxidation continues further into the putty. This process will eventually result in the putty failing completely. A maximum movement capability of the order of five per cent is usually recommended for linseed oil based putties [1,2]. Regular painting is also suggested to enhance the service life. Acrylic caulks were developed from latex acrylic sealants. These sealants have a movement capability of the order of 10% and accept paint. They have not found extensive use as timber filling materials because of their relatively high price compared to linseed oil putties, and the fact that they shrink by 20% on curing. By raising the filler content and decreasing the resin content in latex acrylic sealants both the price and the shrinkage are decreased.

EXPERIMENTAL PROCEDURE

Two commercially available linseed oil putties, plus one made up to the the formulation shown in Appendix 1, and three commercially available acrylic caulks, plus two made to the formulations shown in Appendix 2 were used in the experiments.

The putties and acrylic caulks were used to fill finger-jointed Pinus radiata panels as shown in Fig. 1. The panels were conditioned at 20±2°C and 65±5 % relative humidity for 3 weeks before filling. Priming and overcoating of the panels was carried out using a water-based acrylic system and a solvent-based alkyd system in the combinations shown in Table 1. The fillers were placed in the primed panels then coated with the undercoats and topcoats. The panels were painted on the ends, sides and both faces. The panels were placed facing north at 45° on an exposure site at Judgeford (longitude 41° 07' S) near Wellington. The panels were examined after six months and at one years exposure for filler and putty failure. The rating scale was from 1 to 10, with 10 representing no failure, and 1 severe failure. Photographs of fillers showing various degrees of failure were used to help maintain consistent ranking. The paint coating over the fillers was evaluated to ASTM standards [3,4,5] for paint cracking, flaking and checking.

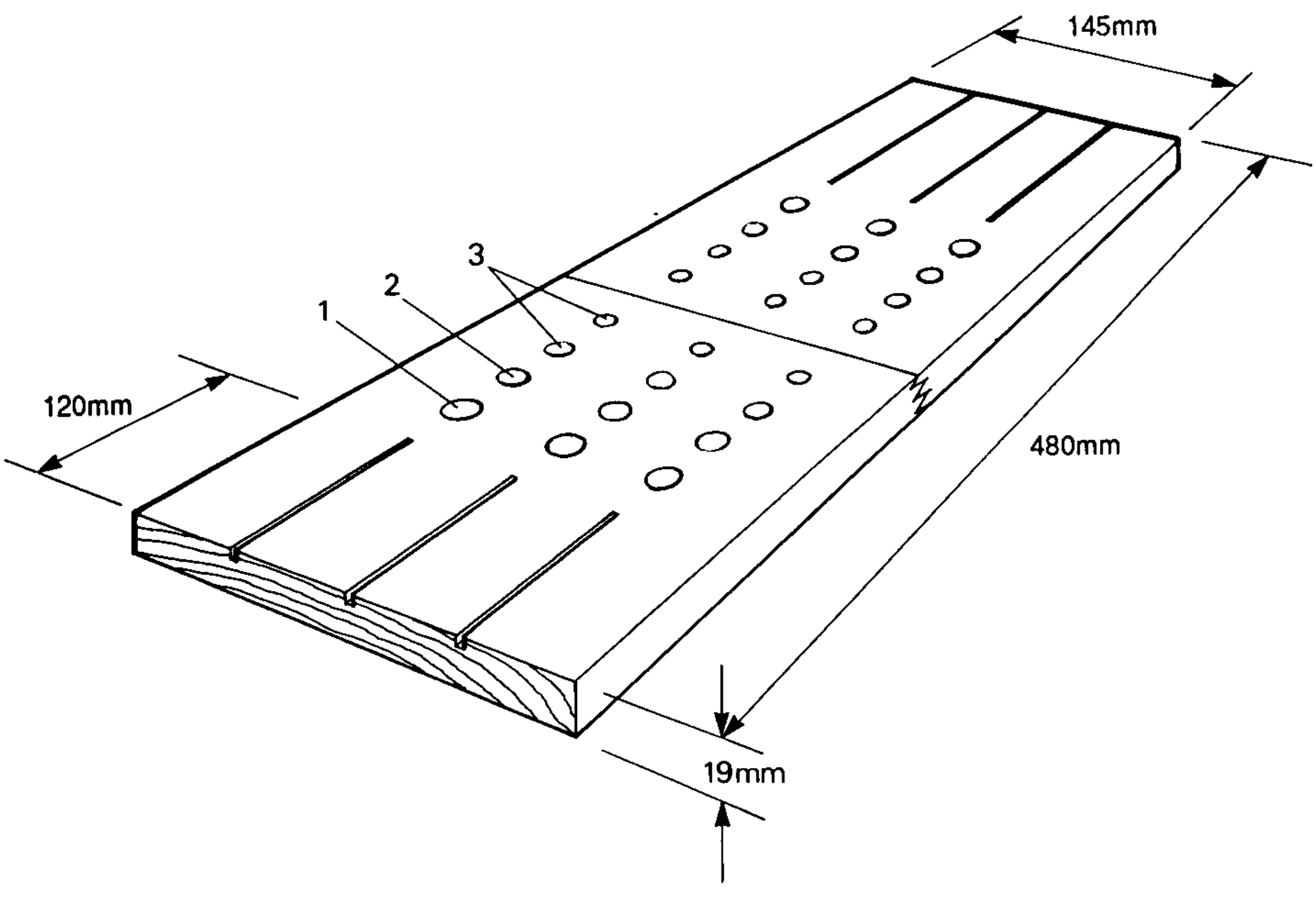

Figure 1: Finger jointed timber panels used for outdoor exposure of fillers (slot depth 10 mm, width 3mm; hole 1 diameter 12mm, depth 8mm; hole 2 diameter 9mm, depth 4mm; hole 3 diameter 3.8mm, depth 2-3mm.

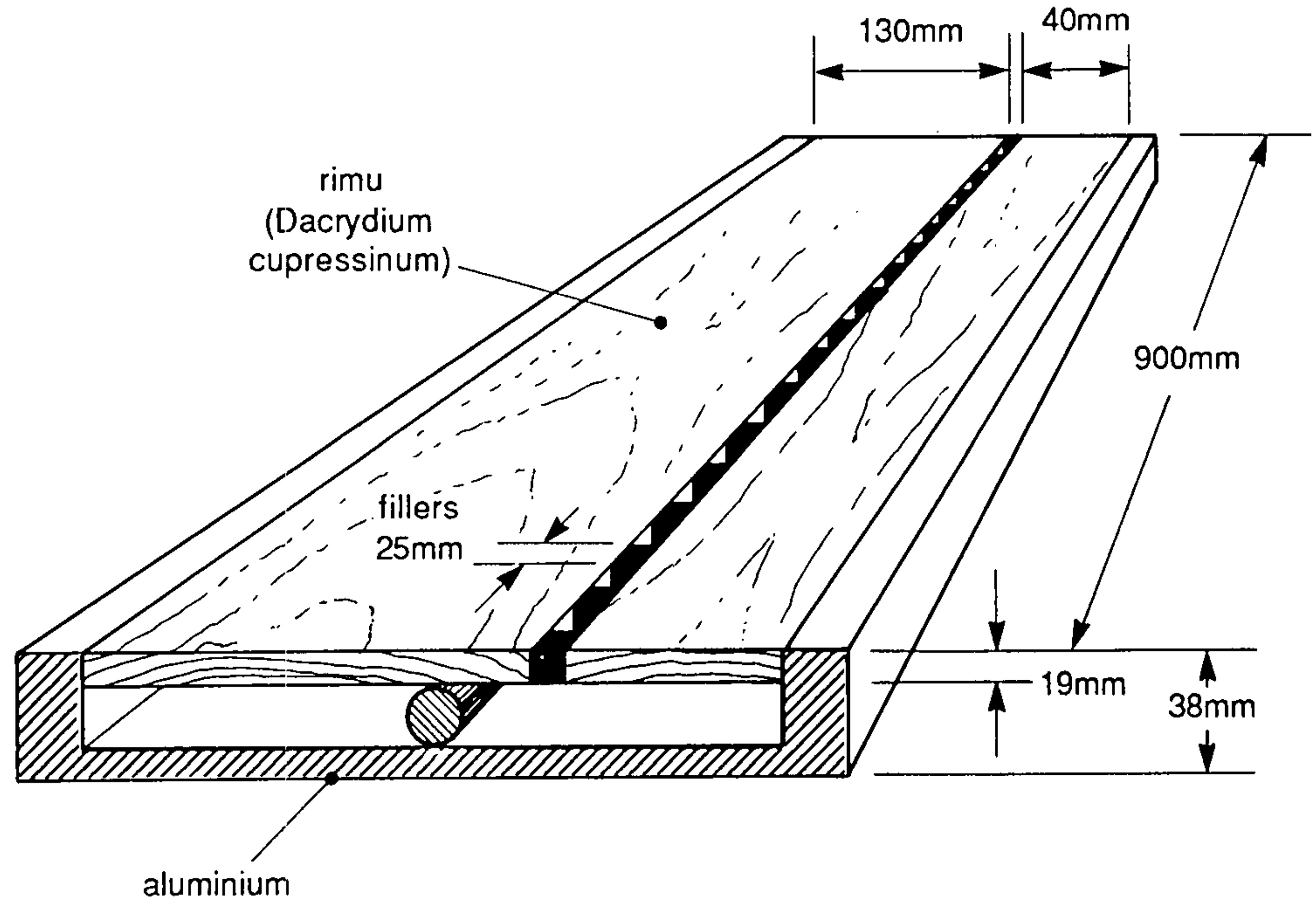

Figure 2: Cyclic Movement Rig

TABLE 1 Primer and undercoat systems used on timber panels for natural weathering

PRIMER	UNDERCOAT		TOPCOAT	
	W	S	W	S
no primer	-	-	-	-
WP/UH	x		x	
WP/UH		x		x
SP/UH	x		x	
SP/UH		x		x
WP/PH	x		x	
WP/PH		x		x
SP/PH	x		x	
SP/PH		x		x

SP = solvent borne primer, S = solvent borne undercoat/topcoat
WP = waterborne primer, W = waterborne undercoat/topcoat
UH = unprimed holes
PH = primed holes

The materials were also subjected to laboratory tests. Shrinkage was determined using the method from British Standard BS 3712: part 2 [6]. Extensibility and tensile strength for the acrylic caulks were measured using an Instron 6022 tensile testing machine with 3.5mm layers of caulk between two 38 x 38 x 19mm dollies of Pinus radiata. Unprimed dollies and dollies primed with water-based primer were used. The samples were pulled apart at a speed of 0.1mm/s. Cyclic testing was carried out using the rig shown in Fig. 2. Movement was induced by shifting the rig from a humidity of 65% to 93% and vice versa at 24 hourly (72 hours over weekends) intervals. For a width of 3.5±0.3mm the movement in the rig was in the range of 15-25%. The fillers were applied with the rig equilibrated at 65% relative humidity, which resulted in most movement being in the compressive direction. This is consistent with New Zealand painting practice where most filling and painting is done over the drier summer months. The fillers were rated for failure after 12 and 26 weeks using the same procedure as for the naturally weathered panels.

RESULTS

After six months, and at one years outdoor exposure, little failure had occurred apart from the case where the panels were exposed without painting. Here all putties and fillers performed poorly. Most failure was through adhesion loss, apart from acrylic caulk B which underwent cohesive failure. Painting the timber panels reduced the degree of cracking in the fillers considerably. Because the degree of failure in the painted panels was small, statistical methods were used to test for significant differences between different fillers, paint combinations and hole locations. The analysis showed no significant difference between the putties and acrylic caulks. However, when the results for different primer/overcoat combinations were analysed, priming holes before filling produced less filler failure. In particular, using a waterborne acrylic primer with solvent borne undercoat and topcoat without priming the holes was least effective at preventing filler failure. Four per cent of the punched nail holes were showing rust staining on panels where the holes were unprimed. No rust staining was observed for the panels where the holes were primed. There was no significant difference between the performances of the individual fillers except for acrylic caulk D which had a mean failure rating which was less than the others.

Fillers placed in the slot on the panel suffered more failure than when placed in the holes. Little interaction between the fillers and either the waterborne or solvent borne paints was seen, except where linseed oil putty was used in panels where the holes had been primed. In these cases the putty required more time to skin than where the holes were unprimed.

Latex acrylic primers and topcoats applied to the putty before a satisfactory skin had been obtained, were unable to coalesce to form a coherent paint film. In these cases extensive cracking appeared within 24 hours. Solvent borne alkyd paints formed a film but developed severe wrinkling. Linseed oil bleeding through the paint coats was observed after twelve months exposure on 2.4% of the primed putty filled holes, with all but one case occurring where the solvent borne primer was used.

A test for tack-free time for building sealants was adapted from British Standard BS 3712 [6] to determine when sufficient skinning of the putty had taken place to allow painting. A 150 x 65 x 3mm layer of putty was spread on a glass plate. At daily or two-daily intervals an 85mm x 30mm strip of polyethylene was placed across the putty and a 30g weight measuring 50mm x 25mm placed on it. The weight was left on the polyethylene for between 10 and 20 seconds. The absence of oil marks on the plastic when it was removed indicated the putty had skinned sufficiently to paint. The results of this test were consistent with painting trials on putties.

Cyclic movement testing of the fillers produced failure in a relatively short time. The results shown in Table 2 appear to indicate superior performance by the linseed oil putties. The observations after 12 weeks were complicated by the skin on the surface of the putties which obscured cracking and adhesion loss and cohesive cracking within the bulk of the putty. The cyclic testing results did not correlate well with the outdoor weathering results.

The results of the shrinkage tests are shown in Table 3. The acrylic caulks and linseed oil putties have low values of shrinkage with the exception of caulk B. This filler resembled a high-build acrylic paint in consistency. Table 3 also shows the results of extensibility tests on acrylic caulks. These ranged from 3-11% with the best results being obtained with primed timber substrate.

TABLE 2 Failure rating of fillers after cyclic testing

filler	12 weeks *	26 weeks *
putty A	10	2
putty B	10	2
putty C	10	2
caulk A	7	1
caulk B	4	1
caulk C	3	1
caulk D	3	1
caulk E	7	2

* Average of 8 replicates

TABLE 3 Results of tests for shrinkage, tensile strength and extension

filler	% shrinkage * 20°C	70°C	% extension at break ** P	U	tensile stress MPa **
caulk A	0.5	3.4	11		0.81
				8	0.45
caulk B	32	30	8.5		0.27
				7.4	0.18
caulk C	6.2	16	10		0.54
				9.5	0.56
caulk D	8.3	-	8		0.38
				3.5	0.13
putty B	1.8	2.4	-		-
				-	-
putty C	2.7	2.9	-	-	-

* = average of two values
** = average of four values
P = dollies primed with acrylic primer
U = unprimed

DISCUSSION

The brief exposure period of the natural weathering tests to date, limits the conclusions that can be drawn from the results. However, even at this early stage, several points can be made. Firstly, both linseed oil putty and acrylic caulks require protection from the environment to perform satisfactorily. In the case of putty, the oxidised surface skin must be protected from radiation and moisture to ensure that the bulk of the putty does not oxidise and harden. For both putty and acrylic caulks in timber substrates, a coating system is necessary to reduce the rate and magnitude of moisture-induced movement in the timber. The limited movement capability of these materials suggest they should not be used where more than about 5% movement will occur. Filling holes and cracks in timber is generally accepted as a suitable use. The results, however, indicate that narrow cracks are likely to produce more failure than larger holes. Widening such cracks before filling or using a more flexible filler (e.g., sealant) should give better results.

The results of the primed and painted panels are not unexpected as most putty manufacturers recommend priming exposed timber before filling holes. Priming prevents loss of linseed oil to the timber which can result in premature hardening of the putty. Priming also results in better adhesion of fillers to the timber and prevents rust staining over punched nails. The lack of correlation between the cyclic movement results and the outdoor exposure results may be due to the relatively large movement the fillers are subjected to by the rig, or the short duration of the outdoor exposure.

CONCLUSIONS

The short term durability of rigid-setting acrylic caulks is similar to that of linseed oil putties in painted exterior timber. With the present trend of using water-based exterior timber paints there is some advantage in that the rapid drying properties of the acrylic caulks allow almost immediate over-painting. Both linseed oil putty and rigid acrylic caulks are not suited for use where more than a few per cent movement is likely to occur. Priming of the timber panel and the hole to be filled, followed by topcoating after filling will result in optimum durability.

ACKNOWLEDGEMENTS

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APPENDIX 1

Formulation of linseed oil putty A

	parts by weight
Microfine 10	17.5
Kocarb 200	70.0
Raw linseed oil	12.5

APPENDIX 2

Formulation of acrylic caulks A and B

Acrylic caulk A

	parts by weight
Texicryl 13-036	20.110
Bevaloid 681F	0.181
3% Natrasol 250 Hr solution	1.812
Super Adit	0.362
D.B.P	0.725
20% Calgon T	0.362
Dispex.G40	0.362
Harvical 75	76.086
	100.000

From Revertex formulation ref AQU/84/970

Acrylic caulk B

	parts by weight
KTPP	0.151
Texanol	1.108
Primal AC-64	30.818
Orotan 731, 25 PCT	1.208
Triton X-405	0.121
Proxel GXL-20	0.121
Bevaloid 643	0.403
Propylene Glycol	6.143
Tioxide RHD-2	4.532
Omyacarb 20	36.257
Omyacarb 2	12.287
Ammonia 28 PCT	0.201
Primal ASE-60	2.014
Water	4.635
	100.000

From Rohm and Haas formulation GTL-4-137

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