

Preservation Techniques of Coconut (*Cocos nucifera* L.)
Palm Timber for Electric Power/Telecommunication
Poles and Fence Posts

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ABSTRACT

The utilization of coconut trunks for electric power/telecommunication poles and fence posts were investigated. Three (3) techniques of preservative treatment were employed namely: Vacuum/pressure (Bethell process) treatment for seasoned materials; pressure sap displacement for freshly-cut materials; and hot-and-cold bath treatment for both seasoned and unseasoned materials. The first two techniques used copper-chrome-arsenate (CCA) solution while the latter used copper sulphate solution for hot bath and chrome-arsenate solution for cold bath.

The schedule of treatment for each technique was established to meet the recommended average dry salt retention (ADSR) for exposed timber in ground contact.

Satisfactory results were obtained from this study. An ADSR of 17.1 kg./cu. m. was obtained for 35 minutes vacuum and 120 minutes pressure from round poles/posts air-dried after five (5) months. For quarter-sawn posts, an ADSR of 18.3 kg./cu. m. was obtained for the same schedule of treatment. For pressure sap displacement technique, it appeared that penetration of preservative was satisfactory for five (5) hours and thirty (30) minutes pressure of 800 kpa using 10% CCA solution. Spot test revealed patchy to complete penetration of preservative both in the outer and inner zone of the logs. For hot-and-cold bath technique, an ADSR of 16.8 kg./cu. m. was attained for six (6) hours hot bath of 12% copper sulphate solution and overnight cooling, before soaking for another 24 hours in a cold bath of 12% chrome-arsenate solution.

The pressure sap displacement and hot-and-cold bath techniques are adaptable to the rural areas due to their simplicity in operation and very low cost of initial investment. On the other hand, the vacuum/pressure treatment which requires high cost of investment is intended for commercial operation.

Graveyard and service tests were properly installed and they are still in very sound condition after three (3) years of exposure.

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INTRODUCTION

The government, thru the Philippine Coconut Authority, is embarking on a massive coconut replanting program which involves the felling of approximately six (6) million palms per year by 1985. On the basis of one cubic meter of timber per tree, about six million cubic meters per year shall be readily available as raw material for economic utilization at the peak of the program.

The development of economic uses of the coconut trunks would not only create unexpected income to the coconut farmers but would also provide a system of proper disposal at replanting time, which if not done with the necessary safeguards, can cause tremendous pests problems to the new plantings.

There are a wide range of potential end-uses and products of coconut wood which have been made at the PCA-Zamboanga Research Center. Among others include furnitures, wall panels/shingles, assorted decorative items, tool handles, charcoal and building construction materials.

The utilization of coconut trunks for electric power poles play an important role in the government program to intensify electrification in the country, particularly in the rural areas. As the supply of conventional wood poles remains a problem, as evidently illustrated with the utilization of concrete poles in some parts of the country, coconut wood pole is certainly a possible substitute for this purpose if properly protected from decay or attack of insects.

Likewise, coconut trunks used as fencing material would be welcomed by many landowners provided their service life could be optimized. On the other hand, the utilization of concrete posts are not only expensive material for fencing but also difficult to handle during installation. Indeed, coconut trunks if

readily available and properly treated could be cheap and attractive material for fencing, either in round form or quarter-sawn form.

Untreated coconut timber will undoubtedly rot in a short time if used in ground contact or exposed to weather. Service tests conducted at the PCA-Zamboanga Research Center on untreated round power poles/fence posts showed severe decay after two and one-half (2 1/2) years. Graveyard test (Jensen, 1979) revealed that untreated soft portion were completely destroyed by termites and fungi after six (6) months while the hard outer part were destroyed by the same organism after twelve (12) months.

With this benchmark information, preservative treatment of coconut timber intended for ground contact and exposed condition is indispensable in order to guarantee its optimum and effective utilization. Coconut timber should receive specialized treatment to ensure a long, trouble-free service life.

Preservative treatment can be applied while the coconut timber is in green (freshly cut) and in seasoned condition. However, different treatment techniques and wood preservatives are involved in either of the two conditions.

On preservative treatment of coconut trunks without bark, Mosteiro, et. al (1976), obtained a retention of 115.2 to 172.8 kg./cu. m. of creosote for eight to ten hours of heating and overnight cooling. Creosote temperature maintained during hot bath was 92.4°C to 97.9°C, with an average moisture content of 120% in the inner and 35% in the outer portions of the trunk at the time of treatment.

On the other hand, preliminary tests (PCA Annual Report, 1977) on round and debarked coconut power poles showed an average

dry salt retention (ADSR) of 14.50 kg./cu. m. was obtained for six (6) hours and fifteen (15) minutes pressure using 5.61% CCA solution. The coconut trunks having an average moisture content of 81.72% were subjected to a maximum pressure of 1400 kpa up to refusal.

Martin (1978) reported that high penetration and a high rate of retention of water-borne preservative was achieved on newly-felled coconut palms employing the Tutu insertion process of treatment. A pressure sap displacement method, the process uses pipes inserted radially into the trunks to inject preservative at a pressure of 827 kpa.

Likewise, suitable pole treatment process was developed in Papua, New Guinea (1977). Extensive field testing of the improved equipment and technique for high pressure sap displacement system was carried out for small diameter poles which proved to be ideal. However, problems were experienced in obtaining manufactured bands large enough for bigger poles. The development of equipment adaptable to any size of pole was being done as well.

The preservative treatment of round fence posts by sap replacement method also proved to be satisfactory (CSIRO, 1961). This method is cheap, effective and requires little attention which will give equal protection to the timber when used as posts. Only the ends of posts need to be immersed in a water-borne preservative solution.

The development of suitable and effective methods/techniques of preserving coconut trunks for power/telecommunication poles and fence posts will certainly maximize the utilization of coconut timber and will eventually promote forest conservation as well as creating job opportunities to the rural people.

This paper deals primarily on the different techniques of coconut timber preservation which are currently employed at the PCA-Zamboanga Research Center. These techniques are vacuum/pressure treatment (Bethell process), pressure sap displacement and hot-and-cold bath treatment.

MATERIALS

A. Vacuum/pressure treatment

- 12 pcs. round fence posts, debarked and 8 feet long
- 36 pcs. round power poles, debarked and 35 feet long
- 12 pcs. quarter-sawn posts, debarked and 8 feet long

B. Pressure sap displacement

- 9 pcs. round poles, with bark, freshly cut and 26 feet long

C. Hot-and-cold bath treatment

- 9 pcs. round poles, debarked and 8 feet long

Preservatives used were copper-chrome-arsenate (CCA) for vacuum/pressure and pressure sap displacement techniques, and copper sulphate for hot bath and chrome-arsenate for cold bath technique. All preservatives used were water-borne.

METHODS

Vacuum/pressure treatment technique

Prior to treatment the round posts/poles without bark were air-dried under cover for 5 months while the quarter-sawn posts for 3 months. After the required drying was attained, the mate-

rials were loaded in a pressure cylinder for treatment. Sample discs 2 cms. thick were cross-cut 25 cms. from the butt of six logs for moisture content determination. A six (6) per cent CCA solution was used in all the treatment charges. The schedule of treatment were as follows: First vacuum of -85 kpa, 35 minutes; pressure of 1400 kpa, 120 minutes and second vacuum, 5 minutes. Preservative absorption and retention were calculated based from the levels of the solution before and after treatment, and the strength of solution used.

Pressure sap displacement technique

The process adapted involves the use of threaded pipes, instead of pressure cap, screwed to a depth of 7 - 8 cm. across the freshly-cut, unbarked coconut trunk. The threaded pipes were connected parallel to the pressure pump to inject the CCA solution, thus displacing the sap and causing the preservative to penetrate inside the log (Figs. 1 and 2). A 10% CCA solution was used with a pressure of 800 kpa which was maintained for five hours and thirty minutes. Five pipes were screwed to the log and were located 90 cm., 210 cm., 370 cm., 525 cm., and 690 cm., respectively, from the basal end of the trunk. After treatment, sample discs were cross-cut from the different sections of the log. The samples were sprayed with chrome-azurol S to test the extent of preservative penetration.

Hot-and-cold bath technique

The process consisted of immersing seasoned or unseasoned coconut posts without bark successively in baths of hot and relatively cool preservative solution. The hot bath vaporises the moisture and expands the air in the outer portion of the timber, whereby air and water vapor are expelled. The cold bath induces the remaining air to contract causing partial vacuum within the timber. The atmospheric pressure forces the solution to enter into the timber until the vacuum is filled.

The posts were loaded in an open tank half-full of 12% copper sulphate solution. The posts were totally submerged in the solution while it was heated to a maximum temperature of 96°C for six hours. After the required heating periods, the solution was allowed to cool overnight before the posts were transferred to another tank half-full of cool, 12% chrome-arsenate solution for 24 hours soaking. After treatment, the posts were allowed to drip off excess preservative.

Preservative absorption was determined by weighing the timber before and after treatment and dividing the difference in weights by the total volume of the timber. Retention was calculated by multiplying the absorption by the strength of preservative solution divided by 100.

RESULTS AND DISCUSSION

Vacuum/pressure treatment

Debarking of coconut trunks prior to air-drying was made in order to hasten seasoning. Experience showed that the bark greatly retards moisture removal from the core causing attack of insects and decay during the seasoning period. The average moisture content of the logs after five (5) months air-drying under shed was 20.80% in the outer and 149.26% in the inner portion of the log. Likewise, the average moisture content of the quarter-sawn posts after three (3) months seasoning was 45.25%.

Previous investigation showed that moisture content was found to be the chief factor influencing preservative absorption and retention of coconut timber by vacuum/pressure treatment (Palomar, 1979). Generally, the best range of moisture content of timber for satisfactory treatment is 25 - 30%. However, result of experiment showed that coconut timber can be pressure treated satis-

factorily at moisture content above 30%.

Table 1 presents the preservative absorption and retentions of round poles/posts employing the vacuum/pressure treatment. Results showed that round coconut poles/posts air-dried after five months without bark can be pressure treated satisfactorily. Employing the treatment schedule of -85 kpa vacuum for 35 minutes and 1400 kpa pressure for 120 minutes, an ADSR of 17.10 kg./cu. m. was easily obtained from round poles/posts. This retention is about 6.4% higher than the recommended South-East Asia ADSR for exposed timber in ground contact.

For quarter-sawn posts, an ADSR of 18.3 kg./cu. m. was obtained following the same schedule of treatment (Table 1). Higher retention was achieved from the quarter-sawn posts than the round poles/posts due to a relatively lower moisture content of the former.

Penetration test showed that complete and even distribution of preservative was obtained to a depth of 3 to 6 cm. from the surface, for round poles/posts as well as for quarter-sawn posts.

Table 1. Preservative absorption and retention of pressure treated electric poles and fence posts.

Particular	Preservative Absorption l./cu. m.	ADSR kg./cu. m.
Posts/Poles		
Round fence posts / ¹	285.2	17.1
Quarter-sawn posts / ¹	305.0	18.3
Round electric poles / ²	285.6	17.1

/¹ - Mean of 12 posts.

/² - Mean of 36 poles.

Pressure sap displacement

Modern technique of pressure sap displacement involved the use of pressure cap fitted to the basal end of the log employing a pressure of up to 1400 kpa. Initial experiment using this method was made on freshly-cut coconut logs. In this process, the cap was used to inject CCA preservative under pressure of 800 kpa into the log, thus displacing the sap and causing the preservative to retain inside it. However, unsatisfactory result was obtained due to leak of preservative between the cap and the log. An effective seal between the cap and log should still have to be developed in order to insure considerable movement of preservative solution into the log while being treated.

However, an alternative technique was developed by using threaded pipes, rather than pressure cap, inserted across the freshly-cut coconut logs (Fig. 2). Result showed that CCA solution flowed easily in both ends of the log. After five (5) hours and thirty (30) minutes continuous treatment, sample discs were cut and sprayed with reagent solution to test the extent of preservative penetration. Spot test indicated that patchy to complete penetration of preservative was observed in the outer as well as in the inner zone of the log. Complete preservative penetration was apparent near the point of insertion.

Table 2 presents the rate of flow and solution strength that came out from the basal and distal ends of the logs collected every half-hour interval for 5 hours and 30 minutes. The original CCA solution strength which was injected into the log through the insertion pipes was 10%.

Table 2. Rate of flow and solution strength from basal and distal end of the log collected every half-hour interval. ^{/1}

Basal End		Distal End	
Rate of Flow l./hr.	Sol. Strength ^{/2} %	Rate of Flow l./hr.	Sol Strength ^{/2} %
14.46	5.2	17.10	4.9
11.68	6.6	14.04	6.8
8.98	7.2	10.86	7.0
8.24	7.4	9.92	7.1
7.06	7.5	8.60	7.1
7.00	7.5	8.40	7.2
6.52	7.5	7.88	7.3
6.40	7.5	7.80	7.3
5.88	7.5	7.20	7.3
5.80	7.5	7.00	7.3
5.48	7.5	6.60	7.3

^{/1} - Mean of 9 logs.

^{/2} - Original CCA solution strength was 10%.

It was observed that the rate of preservative flow from the distal end was slightly faster than from the basal end despite more pipes were inserted near the base of the log. Furthermore, a fine white precipitate present in the solution inhibited the flow of preservative through the log causing a relatively decreased flow rate.

Insertion of threaded pipes 7 - 8 cms. deep across the log enabled a pressure of up to 900 kpa to be applied leak-free at the insertion point. In general, the method has great potential in achieving the recommended levels of preservative retention. In this regard, further investigations into this technique should explore to establish the optimum size and number of pipes to be used, location of pipes into the log for greatest and most uniform penetration, optimum treatment time, level of pressure applied as well as CCA concentration. Likewise, determination

of retention in relation to the different distances away from the insertion point should be done by bio-assay, which is not covered by this study, to ensure all elements in the log are adequately penetrated and preserved.

Hot-and-cold bath treatment

Table 3 shows the preservative absorption and retention of round posts using the hot-and-cold bath treatment. An ADSR of 16.8 kg./cu. m. was achieved for six hours hot bath in a 12% copper sulphate solution and overnight cooling before soaking for another twenty four hours in a cold bath of 12% chrome-arsenate solution. The average moisture content at the time of treatment was 75.9% in the outer and 232.4% in the inner zone of the posts.

Measurements of preservative penetration were taken from freshly-cut cross sections of the posts, using the Chrome-Azurol S indicator for copper. Spot test showed complete penetrations of approximately 4 - 7 cm. from the surface of the posts.

Table 3. Preservative absorption and retention of fence posts employing the hot-and-cold bath treatment.

Fence Posts	Preservative Absorption	Retention
No.	l./cu. m.	kg./cu. m.
1	125.0	15.0
2	134.6	16.2
3	127.4	15.3
4	147.6	17.7
5	152.3	18.3
6	215.5	25.9
7	111.1	13.3
8	118.8	14.3
9	127.6	15.3
Average dry salt retention		= 16.8

Service tests

Treated poles were under service tests in electric power/telecommunication lines along the diversion road in Davao City (Fig. 7). Likewise, similar treated poles were installed at the PCA-Davao Research Center and Davao Woods Preserving Company compounds. The treated pole stubs, installed in a graveyard as shown in Fig. 8, were under test during the last three years and are still in very sound condition.

Service tests were also installed at PCA-Zamboanga Research Center compound (Fig. 7). Annual inspection is being done on these poles/posts to keep an up-to-date record on their service performance.

Economic implication

The life expectancy of properly treated coconut round poles/posts is more than 25 years. Even if the price is slightly higher than that of untreated ones, treatment is still desirable because it guarantees long service life. Untreated coconut round poles/posts under service last only two to three years (Fig. 8). In the long run properly treated coconut poles/posts are more economical to use where conditions favor the rapid deterioration of untreated posts/poles by decay or insect attack.

The three techniques of timber preservation discussed here could be economically and effectively applied for coconut posts/poles preservation. However, the vacuum/pressure treatment requires high cost of investment as well as trained technicians to operate the plant. In a developing countries, like the Philippines, the economic pressures would not justify the adoption of the traditional vacuum/pressure process. It is estimated that the cost of a medium-size vacuum/pressure treatment plant, including log yard area, is from ₱1.5 to ₱2.0 million. The large capital investment and the technical problems involved

compel an alternative treatment technique appropriate to the level of technology available in the country. This technique of preservation must not only be effective, simple, and economic, but also practical in regions lacking sophisticated technological resources. Thus, the low cost of investment of the pressure sap displacement, and hot-and-cold bath treatments are more adaptable to the rural areas. In addition, the simplicity of operation and maintenance allows local operators to be trained, a major advantage in developing countries.

CONCLUSION

Properly seasoned coconut trunk in round or quarter-sawn forms could be treated satisfactorily to the recommended retention as electric/telecommunication poles and fence posts by employing the vacuum/pressure method as well as the hot-and-cold bath method of preservative treatment.

Newly-felled coconut trunks with bark could be treated by pressure sap displacement technique. This technique of preservative treatment eliminates pre-drying operations since the poles/posts could be installed immediately after treatment.

The pressure sap displacement and hot-and-cold bath techniques are very much adaptable to the developing countries as substitute for the sophisticated and expensive vacuum/pressure method of coconut timber preservation.

RECOMMENDATION

For posts/poles which are to be treated dry, leaving the bark delays drying and encourages decay and attack of insects.

It is therefore necessary to debark coconut trunks prior to seasoning and treatment.

For posts/poles which are to be treated green, by pressure displacement method, treatment should be done immediately after felling. Debarking should be made after treatment.

Since the performance of treated coconut palm timber used as poles and posts has not been fully known yet, the establishment of desired and effective retention levels by durability trials should be undertaken throughout the country to determine their optimum service life under varied soil types and agro-climatic set-ups.

In areas where vacuum/pressure equipment is not accessible, the adoption of either the hot-and-cold bath or pressure sap displacement technique of coconut timber preservation is recommended.

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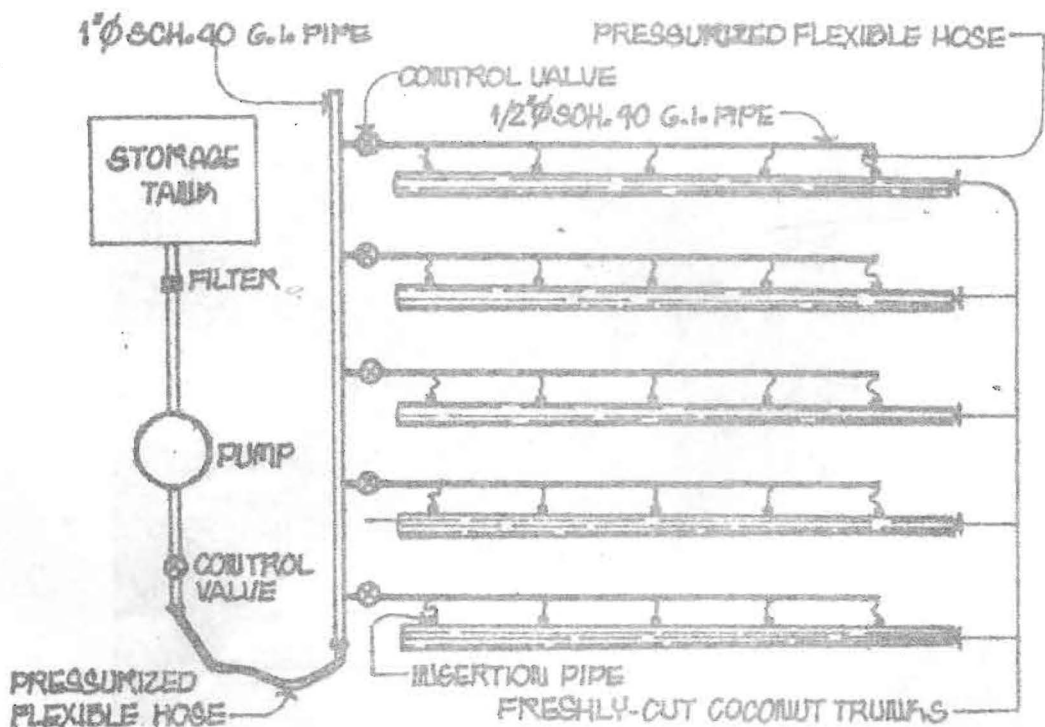


Fig. 1. Schematic diagram of pressure sap displacement technique capable of treating five (5) coconut poles at the same time. Additional connections maybe made to accommodate the desired number of logs to be treated.



Fig. 2. Treatment of freshly-cut coconut log by pressure sap displacement technique. Background photo (left) shows the experimental vacuum/pressure treatment plant.

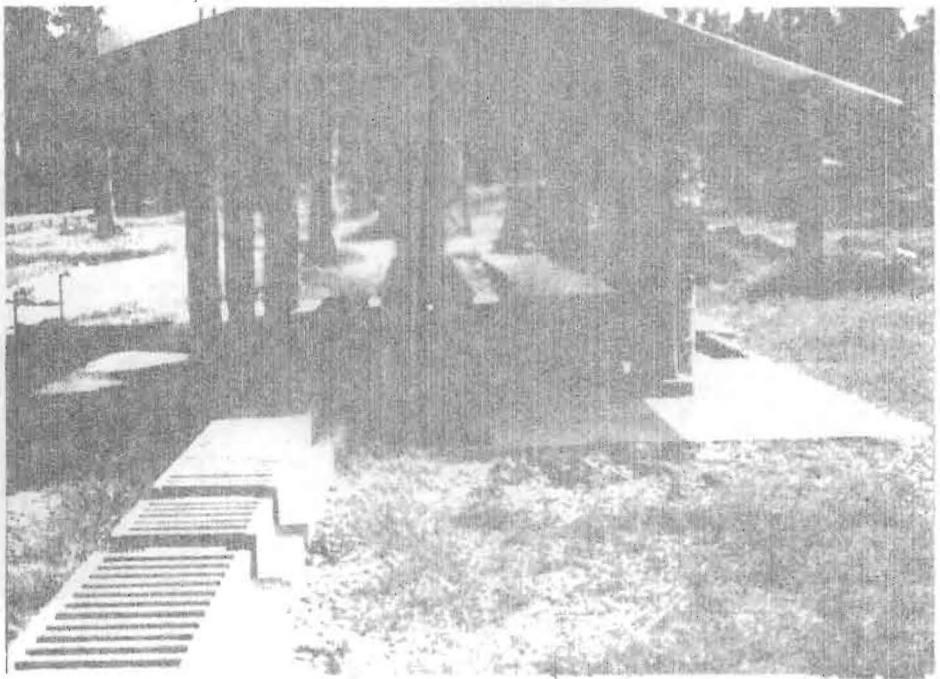


Fig. 3. The hot-and-cold bath treatment plant.



Fig. 4. The expensive and sophisticated vacuum/pressure treatment plant.
(Courtesy of Davao Woods Preserving Company, Inc.)

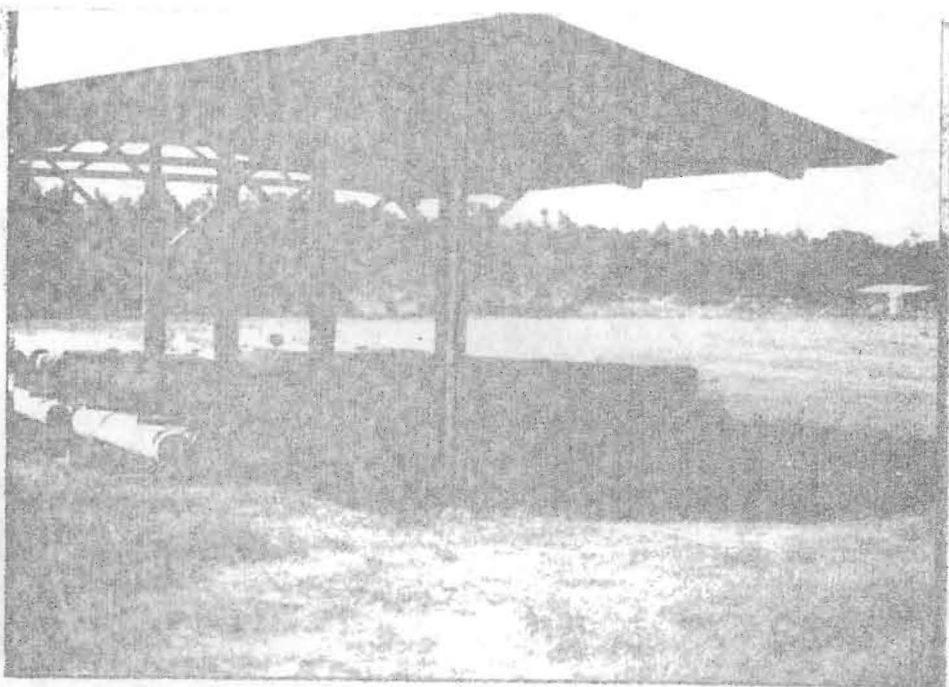


Fig. 5. Treated coconut posts by hot-and-cold bath technique (left). Coconut poles awaiting preservative treatment (right).



Fig. 6. Treated quarter-sawn posts by vacuum/pressure technique being re-dried prior to installation.



Poles treated by vacuum/pressure technique under service test in Davao City.

Poles treated by pressure sap displacement technique under service test at PCA-Zamboanga Research Center.



Fig. 7. Treated coconut poles under service test.

Treated poles after three (3)
years of service

Untreated post after
three (3) years of
exposure.

Treated post after
three (3) years
of exposure.

Fig. 8. Graveyard tests of coconut poles
and posts.