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ROMCONSULT

ROMANIAN CONSULTING INSTITUTE

UNIDO PROJECT
DP – VIE – 80/027

17175

TESTING THE SUITABILITY OF SELECTED VIETNAMESE TIMBER SPECIES FOR THE MANUFACTURE OF WOODEN ACCESORIES FOR THE TEXTILE INDUSTY IN THE SOCIALIST REPUBLIC OF VIETNAM

FINAL REPORT

CODE 86/37/RK

BUCHAREST ROMANIA

— 1988 —

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SYNTHESIS (SYNOPSIS)

U.N.D.P. financed a project, executed by UNIDO to support the setting up of a section for the production of wood accessories for the textile industry in Vietnam (Project VIE/80/027), a portion was subcontracted to ROMCONSULT-ICPIL to select and test 5 Vietnamese wood species in order to determine their workability and suitability for the production of wood accessories as well as for drawing up the manufacturing processes for these products.

The contract provisions first included a bibliographical study of the main Vietnamese wood species; this research work was submitted to UNIDO - Vienna in 1986, annex 12)

Based on the bibliographical research from the list of the Vietnamese commercial wood species which were specified in the appendix of UNIDO's terms of reference, the preselection of 8 species (or groups of species) was suggested, of which 5 species were to be selected for researching and testing during the stay of the consultant's team in the project area.

ROMCONSULT-ICPIL team was in the project area in Vietnam, between the 19-th of July and 15-th of August 1986.

On this occasion, the consultant's team together with the representatives of the Ministry of Light Industry in the presence of the deputy representative UNDP in Hanoi, drew up the list of the 7 species to be researched and tested for the above mentioned scope.

The samples, consisting only of solid wood species, for the test pieces necessary for testing and researching were sent to ICPIL's laboratory in Bucharest by the Ministry of Light Industry, Vietnam in July 1987.

Tests and research on the 7 species were requested to be performed in the presence of the two Vietnamese specialists for whom UNIDO-Vienna arranged a 2 month "study tour" to Romania; consequently, testings started in February 1988, respectively after 7 months from the reception of samples.

The conclusions after testing of the seven wood species showed the proper species which are suitable for the production of wood accessories (shuttles, pirns, picking sticks) for the textile industry and the main minimum conditions necessary for the manufacturing of these products consequently, from the 7 wood species which were tested.

The most suitable species for the production of shuttles, pirns and picking sticks are considered to be Dypterocarpus, Vatica, Dialium, Aglaia, Lagerstroemia and Castanopsis spp.

This report specifies both the requirements implied in the selection and processing of raw material and the processing and sequence of operations for the manufacturing of high quality products necessary for the manufacturing of these products.

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2. Testing performed
3. Main results
4. Final opinion

Code 86/37/RK

I. INTRODUCTION

1. TITLE OF WORK :

Testing the suitability of selected Vietnamese wood species for the manufacture of wooden accessories for the textile industry in the Socialist Republic of Viet Nam.

2. STAGE

Study - Final report

3. ORGANIZATION :

ROMCONSULT- Research and Design Institute for Wood Industry (ICPIL) Bucharest.

4. BASIS OF WORK

- Contract signed by UNIDO Vienna and ROMCONSULT;
- Bibliographical research, drawn up by ICPIL;
- Briefing received in Vienna, 2-6.07.1986, by project manager of ROMCONSULT;
- Activity developed in the project area by the ROMCONSULT-ICPIL delegation;
- Protocol concluded in Hanoi 15.08.1986, between the ROMCONSULT-ICPIL delegation and the representatives of the Ministry of Light Industry of Viet Nam.
- Debriefing received in Vienna, 7-12.09.1986 by the project manager of ROMCONSULT.

5. SCOPE :

Within the supporting program put forth by UNIDO Vienna, for the implementation of pilot plant for manufacturing wood accessories for textile industry in Viet Nam the elaboration of some research work on the wood species available in this country was requested.

The work aims at :

- establishing the priority and conditions under which Vietnamese wood species are suitable for manufacturing wood accessories for the textile infustry.

- analyse and propose an improved technology for manufacturing wood accessories of the selected species so that the following shall be obtained :

. reduction of specific consumption of local made shuttles up to the level of imported shuttles;

. diminish negative influence brought about by poor quality of shuttles upon the textile quality and upon labour productivity.

6. PROGRAM DATA :

Within the Union of Textile Enterprises from Viet Nam (U.T.E) there are 4 sections for shuttle production located near the following textile factories: 8 March, NAM DINH, VINH PHU and VIET TANG.

Production of the 4 factories is 230000shuttles/ year changer type, and other accessories such as shuttle blocks and picking sticks.

The raw material for the production of shuttles and picking sticks is shuttle blocks, while for the pirns it is solid wood of Vietnamese wood species.

The tests of Vietnamese wood species shown in the appendix to the Contract includes 37 species (Annex I).

Based on a bibliographical research of these 37 species and in a comparative analysis of physical and mechanical properties of these species with other species used for same purpose in Europe, the following eight species have been pre-selected :

- Dipterocarpus alatus Diery (Tra, Dau)
- Hopea odorata (Dao, Kien, Kien)
- Vatica tonchinensis (Lau Tau)
- Dalbergia cochinchinensis (Trac lai)
- Lagerstroemia calyaclata (Bang lang)
- Sindora cochinchinensis (Sepotir)
- Dialium cochinchinensis (Xaoy)
- Sageraea elliptica (sang may)

Following the visit in Viet Nam during 19 July to 15 August 1986, at three shuttle sections (8 March, Nam Dinh and Viet Thang) and at two sections for laminated wood (Cau Duong and Hoa Binh), and based on the discussions with regard to the availability of wood species for the production of wood accessories the following seven species have been selected for further testing :

- Dipterocarpus alatus (Dau),
- Vatica fleuriana (Lau Tau),
- Lagerstroemia calyaclata (Bang Le),
- Dialium cochinchinensis (Xoay),
- Aglaia species (Goi Tia),
- Castanopsis chinensis (Gie Gai),
- Podocarpus imbricatus (Thong Nang).

Scantlings of solid wood of various sizes, were received for the carrying out of these mentioned tests in July 1987.

Veneer samples have not been supplied.

Consequently, based on the samples received by us, the following tests have been executed :

- micro and macroscopic analysis of wood,
- determination of physical, mechanical and elastic properties of wood,
- determination of artificial drying conditions of wood,
- determination of wood behaviour under climatization conditions,
- solutions for the improvement of wood quality,
- determination of the optimal conditions for machining the wood.

II. PRELIMINARY DATA

1. PROGRESS OF THE WORK

In accordance with the provisions of the contract the ROMCONSULT team arrived in Vietnam where, together with the local authorities, they had to select the most suitable wood species for the production of wood accessories intended to textile industries following that and based on the tests,

to establish process data necessary for a pilot plant which shall produce these accessories.

For this reason during the visit in Viet Nam, the ROMCONSULT team held discussions with the representatives of Light Industry (MOLI) - Union of Textile Enterprises of Viet Nam - and visited three sections for shuttle production and two sections for processing laminated shuttle blocks.

The list of factories visited by the ROMCONSULT team and the persons which have participated in discussions are given in Annex 2.

Just from the first meeting with the representatives of MOLI on 24.07.1986, in the presence of UNDP representative, the project manager proposed a plan of activities including:

a. Meetings with the experts of Forest Inventory and Wood Industry with the aim of :

- final selection of wood species for testings,
- stating precisely the yearly volume of wood necessary for the production of the accessories;
- final determination of the technical conditions for the raw material for the production of wood accessories and the yearly demand;
- elements of cost structure for the accessories produced under the existing conditions;

b. Visiting sections for the production of shuttles and wood accessories and sections for the production of laminated shuttle blocks with the aim of :

- analysing the actual production of shuttles and other wooden accessories with regard of the raw material supply, selection, preparation and processing of the wood,
- equipment and tools used for process,
- fittings for shuttles, pirns, picking sticks,etc.,
- analysing of main problems encountered with the shuttles produced under the existing situation and at the same time with the poor quality of the shuttles.

The conditions for carrying out of activities by ROMCONSULT team in the project area result from the documents drawn up during the period from 24.07. to 16.08.1986 (annexes 3 - 3.1 to 3.8) which mention in brief the following :

- from those 37 wood species shown in the annex to contract concluded between UNIDO and ROMCONSULT, VOLI representatives have stated that only 6-7 species are available for the production of shuttles and accessories namely:

- Castanopsis tonchinensis (Cia coi)
- Dacridium pierrei (Hoang Dau Gia)
- Lagerstroemia calyaclata (Sang Le)
- Betula alnoides-Buch (Cang Lo)
- Anisoptera cochinchinensis (Ven Ven)
- Peltophorum dasirachis (Lim xet)
- Podocarous imbricatus (Thanc Nang)

- The wood species preselected by bibliographical research are not available for the production of shuttles and accessories (except for those mentioned above).

- Meetings with the representatives of Forest Research Institute have permitted the consultation of wood samples only for the above mentioned species; a visit to the Forest Research Institute was not organized.

- In the above period, short visits to the three sections for shuttles and accessories belonging to textile factories 8 March, Nam Dinh and Viet Thang have been organized as well as to the two sections for laminated shuttle blocks belonging to the plywood factories Cau Duong and Hoa Binh.

Some of the statements made on the occasion of these visits have been noted down in the annexes 4 (4.1. to 4.7.).

- From the opinions expressed by Vietnamese partner we have understood that shuttle production cannot be solved by selection of most suitable species but only by a structural change of quality of some species they consider available.

It is worth mentioning that for the said production of wood accessories a quantity of only about 500 - 700 m^3 of scantlings should be required. This corresponds to 2000 m^3 round wood, compared with about 2000000 m^3 wood cut annually.

In spite of insistence of the ROMCONSULT representatives it has been decided that tests be carried out for a number of 7 wood species (see chapter I - point 6).

By the protocol concluded on 15th August 1986 was specified that for the carrying out of tests stipulated in the contract UNIDO-ROMCONSULT the Vietnamese partner has to freight

to Bucharest the samples (wood scantlings and veneer sheets in the conditions of the handed specifications) within the next two months i.e. at the beginning of November 1986.

These samples comprising 108 parcels reached Bucharest in July 1987.

They had the following composition:

284 wood scantlings of Dipterocarpus alatus Roxb.

281 wood scantlings of Vatica sp.

282 wood scantlings of Lagerstroemia calyculata Kurz

274 wood scantlings of Dialium cochinchinensis Pierre

287 wood scantlings of Aglaia sp.

277 wood scantlings of Castanopsis tribuloides

253 wood scantlings of Podocarpus imbricatus

The samples of veneer sheets were not shipped and we have been informed in February 1988 (by the two Vietnamese who arrived on the Study Tour), that these will not be supplied.

It has to be mentioned that in the telex dated 04.09.1987 UNIDO requested the tests be started after the arrival of the two Vietnamese specialists for the study tour.

As to above said, the tests have been started in February 1988 after a storage time of more than seven months.

During this time the wood reached moisture contents below 30% and even 20% being necessary at the same time to ensure measures for preservation of material.

We have to mention here that in the account of number of pieces and dimensions of samples received by us these complied with the provisions of the contract but they have not complied at the same extent with technical conditions shown in the specifications with regard to production of scantlings (blocks) by radial and semiradial cuttings.

2. Testing performed

In the conditions shown above we have carried out the following research and tests :

a. Macro and microscopic research.

b. Tests for determination on physical properties:

- determination of volume weight for a moisture content of 12%, for the anhydrous state and for conventional;

- determination of shrinkage and swelling ratios between grain saturation point and the anhydrous conditions in longitudinal, radial and tangential directions.

c.Tests for the determination of elastic and mechanical properties :

- static bending strength,
- modulus of elasticity,
- impact bending strength,
- compresion strength parallel to grain,
- tensile strength parallel and perpendicular to grain,
- longit dinal parallel shear,
- splitting test in radial and tangential direction
- hardness test,

d. Tests for artificial drying of wood of various species and determination of drying conditions for each wood species.

e. Tests for climatization of wood and determination of effects on physical characteristics of wood in the conditions of hot-humid environment and hot-dry environment.

f. Tests for improvement of wood quality by :

- densification,
- surface impregnation after complete processing.

g. Tests for workability by :

- ripping on a circular saw,
- thicknessing on a thickness planer (four knife cutter spindle),
- moulding (longitudinal and transversal) on a moulder,
- turning,
- boring on horizontal slot borer,
- mortising on a router.

The workability tests have been carried out both with natural timber and with densified wood.

3. Main results

Herewith are presented briefly the main results of research, as follows :

3.1. Physical, mechanical and elastic properties.

The results are presented taking also into account the scope of work and consequently we have a grading of data obtained by comparison with the characteristics of the wood species Carpinus betulus used in Romania as raw material for shuttle production.

The presentation of the above data enable the grouping of the results by stresses considered as most important for shuttles and picking sticks.

In this way it is considered that shuttles are subjected to compression, static bending, splitting and dynamic stresses while the picking sticks are subjected to tensile, dynamic bending and hardness stresses.

These results have been summarized below:

Volume weight kg/m^3	R	D	C	V	D.A	L	A	P
	844	959	952	901	921	653	611	426
Compression (MPa)	R	D	V	C	L	A	DA	P
	60.5	87.3	78.6	69.2	61.0	54.2	45.1	40.7
Modulus of elasticity MPa	R	C	DA	V	D	L	A	P
	16600	16870	16450	14670	13790	12660	10730	8360
Static bending (MPa)	R	V	C	D	L	A	DA	P
	142.9	154.2	146.3	124.9	118.6	116.3	112.7	67.7
Impact bending strength (J/cm^2)	R	C	V	DA	A	D	L	P
	0.07	0.13	0.11	0.10	0.09	0.07	0.05	0.04
Splitting (MPa)	R	V	C	D	L	DA	A	P
	0.80	0.89	0.69	0.69	0.57	0.46	0.36	0.26
Tensile parallel to grain (MPa)	R	V	C	L	A	DA	D	P
	160.4	168.9	147.5	139.0	155.8	111.2	89.8	67.5
Hardness (MPa)	R	D	C	V	L	DA	A	/P
	80.1	150.0	116.8	99.6	52.0	50.7	49.2	18.9
Parallel-longitudinal shear, tangential direction (MPa)	R	D	C	V	A	DA	L	P
	21.5	20.1	13.6	14.8	14.2	12.8	9.9	7.9

Where :

D.A. = Dipterocarpus alatus
A = Aglaia sp.
V = Vatica sp.
D = Dialium
L = Lagerstroemia
C = Castanopsis
P = Podocarpus
R = Carpinus betulus

3.2. Results of artificial drying :

For the drying tests the following were considered :

- physical, mechanical and elastic properties of wood species,
- moisture content of samples in the moment of tests (below 30% and even 15% in case of Podocarpus),
- determination of drying proper-conditions to prevent the internal stresses in the wood.

Based on the drying conditions determined by the tests, the drying time of wood scantlings (blocks) is :

- Podocarpus - 72 hours (from 12% to 8% MC),
- Aglaia and Lagerstroemia - 244 hours (from 26% to 12%),
- Dipterocarpus alatus - 288 hours (from 20% to 12% MC),
- Dialium, Vatica and Castanopsis - 484 hours (from 25% to 12% MC).

It is worth mentioning that :

- to ensure proper kiln artificial drying it is necessary to air dry to a moisture content below 30%,
- accurate drying conditions will be determined in accordance with the characteristics of the kiln driers to be purchased,
- quality of drying depends on the direction of the drying process and on the drying equipment to be provided.

3.3. Results concerning wood quality improvement.

By carrying out of these tests we have considered the following:

- contribution to the production of shuttles from Vietnamese wood species with increased efficiency;

- achievement of improvements with the means and materials that can be found in Viet Nam,

- production of shuttles at lower costs than at present,

- the solutions proposed must be checked practically in production conditions.

Consequently, these solutions were:

- densification of wood by hot pressing the wood scantlings that have previously been dried to 12% MC,

- surface impregnation in a bath at a temperature of 50°C.

By densification, the properties of wood are improved such as :

- volume weight increases by 30 - 74%;

- static bending strength increases by 21.5-30%;

- splitting strength increases by 5-245%.

Surface impregnation with linseed oil will result in hygroscopic stability, increase of wear resistance and reduction at a high extent of woolines and respectively the risk of yearns hitching.

3.4. Results concerning wood workability.

These tests are aimed to determine :

- the behaviour of the seven wood species in the working conditions using machines with speeds and tools differing from the existing situation;

- the behaviour of tools working on natural wood and densified wood.

The results show that in case of natural wood the usual tools (monoxital-different kind of steel) can be used. The densified wood can only be processed by carbide tipped tools.

4. Final opinions

Analysing the test results the following conclusions can be drawn out :

4.1. Production of shuttles in Viet Nam can be improved efficiently by densification of the Vietnamese species researched by us, excepting the Podocarpus species which cannot be used for shuttle production.

Preference order is :

a. for shuttles:

- Vatica sp.
- Castanopsis tribuloides.
- Dipterocarpus alatus,
- Lagerstroemia calyculata Kurz

b. for bobbins:

- Lagerstroemia calyculata Kurz
- Aglaia sp.

c. for picking sticks:

- Dialium cochinchinensis Pierre
- Castanopsis tribuloides

4.2. To improve the shuttle production in the conditions resulted from our research it is necessary to set up a pilot plant equipped with machinery and tools corresponding to proposals made in this study.

4.3. For the above purposes it is necessary to draw up standard or technical norms for products to be manufactured and for raw materials to be used which are basic conditions for high quality products.

4.4. The operating staff must be trained with regard to production management as well as to machinery operation and maintenance.

Note: The laboratory tests have been carried out in the presence of the two Vietnamese specialists, Mr. Do Van Gian and Mr. Vu Trong Kuan who took part in a study tour organized by UNIDO.

The protocol concerning the activities carried out by the study tour is shown in annex 5.

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CHAPTER III

THE TECHNICAL REPORT

1. Design date
2. Date concerning test pieces
3. Working method
4. Study of work properties
4.1. Macroscopic and microscopic aspects of the wood tested.
4.2. Physical, mechanical and elastic of the wood tested

III. THE TECHNICAL REPORT

1. Design data

1.1. The following program data come out from the documentation received from UNIDO on Vienna :

- At present, the Viet Nam shuttle production is limited in four production units belonging to the Union of Textile Enterprises (U.T.E) which reach annually an output of 230,000 shuttles (changer type), out of which:

- Section 8 March	85000 pcs/year
- Section Nam Dinh	90000 pcs/year
- Section Vinh Phu	12000 pcs/year
- Section Viet Thang	43000 pcs/year

The "8 - March" and Viet Thang sections manufacture additional 330,000 pcs pirns/year, out of which:

- "8 - March"	300000 pcs/year
- Viet Thang	80000 pcs/year

The main raw material necessary for shuttle manufacturing is laminated shuttle block; produced in the sections of plywood factories Cau Duong (Hanoi) and Go Dich (Ho Chi Minh City) and natural wood scantlings; for pirns strips of different wood species are used.

1.2. Shuttles as well as the other wood accessories produced at present in Viet Nam have a low viability respectively a higher consumption for 1000 m cloth than imported shuttles and bear serious negative influences upon productivity and quality of the textile production.

1.3. The yearly wood consumption estimated as necessary for the prodduction of wood accessories intended for the textile industry is :

- for shuttles :
  250000 pcs. x 400 mm x 50 mm x 40 mm = 200 m^3
- for pirns :
  450000 pcs. x 250 mm x 40 mm x 40 mm = 120 m^3
- picking sticks : informative = 320 m^3

TOTAL 700 m^3

Demand of round wood calculated considering the raw material selection conditions is of: 700 m^3 x 2.5 m^3 log/m^3 scantlings = 1750 m^3.

It is worth mentioning that, although the wood volume necessary for the production is reduced, the supply of this material as well as wood conversion into scantlings is of utmost importance to ensure the improvement of the shuttle production.

2. Data concerning test pieces

2.1. Technical conditions required for test pieces.

In order to fulfill the obligations of the contract, Mr.Teodorescu Alexandru, D.Sac. specialist of charge of this, sent a letter on 29.07.1986 (annex 3.2) to the Ministry of Light Industry of Viet Nam to inform them on the technical conditions to be taken into consideration in the preparation of the wood test pieces.

The test pieces had to be prepared during the visit of ROMCONSULT team to the project area so that the team could ascertain their conformity to the required standard sizes.

This request could not be assured because of different aspects linked to the indentification of wood species for testing so that the test pieces were sent to ROMCONSULT one year after the team left the project area.

Under these conditions the test pieces were prepared and sent by Ministry of Light Industry of Viet Nam, the results recorded from tests are directly determined by the characteristics of the scantlings received.

The test pieces received were stored and conditioned in store of the Research Institute, between July 1987 and February when the research work began.

2.2. Wood species for tests

According to the Protocol signed on 15.08.1986 in Hanoi (annex 3.7) it was established that the following wood species was to be tested :

Dipterocarpus alatus (Dau), Vatica fleuriana (Lau Tau), Lagerstroemia calyculata (Sang Le), Dialium cochinchinensis (Xoay), Aglaia species (Coi Tia) and supplementary

Castanopsis chinensis (Gie Gai) and Podocarpus imbricatus (Thong Nang).

The 108 parcels received from Viet Nam contained the test pieces in the dimensions specified in table 1 :

Table 1 - List of species tested

Crate no.	Specie	Dimensional specification in mm	No. of pieces delivered	No. of pieces in contract
1	2	3	4	5
1.	Dipterocarpus alatus Roxb (DAU)	400 x 60 x 60	101	90
		400 x 70 x 70	99	100
		600 x 80 x 80	20	20
		680 x 70 x 70	37	45
		800 x 80 x 80	27	20
		TOTAL	284	275
2.	Vatica sp. (Tau)	400 x 60 x 60	95	90
		400 x 70 x 70	107	100
		600 x 80 x 80	19	20
		680 x 70 x 70	50	45
		800 x 80 x 80	20	20
		TOTAL	291	275
3.	Lagerstroemia calyculata Kurz (Bang Lang)	400 x 60 x 60	106	90
		400 x 70 x 70	104	100
		600 x 80 x 80	24	20
		680 x 70 x 70	41	45
		800 x 80 x 80	17	20
		TOTAL	292	275

1	2	3	4	5
1.	Dialium cochinchinensis Pierre (Xoay)	400 x 60 x 60	101	90
		400 x 70 x 70	93	100
		600 x 80 x 80	20	20
		680 x 70 x 70	45	45
		800 x 80 x 80	15	20
		TOTAL	274	275
5.	Aglaia species (Coi Tia)	400 x 60 x 60	90	90
		400 x 70 x 70	102	100
		600 x 80 x 80	19	20
		680 x 70 x 70	55	45
		800 x 80 x 80	21	20
		TOTAL	287	275
6.	Castanopsis tribuloides ADC (Choi)	400 x 60 x 60	90	90
		400 x 70 x 70	99	100
		600 x 80 x 80	20	20
		680 x 70 x 70	45	45
		800 x 80 x 80	23	20
		TOTAL	277	275
7.	Podocarpus imbricatus BL (Thong)	400 x 60 x 60	53	90
		400 x 70 x 70	97	100
		600 x 80 x 80	20	20
		680 x 70 x 70	45	45
		800 x 80 x 80	20	20
		TOTAL	255	275

It results some small differences vs. the provisions of the contract concerning dimensional specification; during the preparation of test pieces these minor problems have been overcome according the request to the research works.

Samples have been cut from the test pieces received according to the standards set for each kind of research work.

3. Working method

According to the data mentioned in chapter II, item 2, the research work has been carried out according to the provisions of the contract and under the condition set by the wood test pieces received.

The research work was carried out according to the Romanian standards affiliated to the International Standard Organization - ISO (Standard 84-67; 85-69; 86/1-67; 337-67; 338/1-68; 6891-72; 1651-83; 1039-82; 338-82; 2417/1-87) or according to technical norms.

The tests were carried on test pieces for establishing physical, elastic and mechanical properties, as well as properties for kiln drying and impregnation in oil bath.

For the tests concerning artificial drying, densification and workability of the wood, the wood pieces used were in the form they were received.

The results of the research work are specified in tables, diagrams, photograms hereunder.

4. STUDY OF WOOD PROPERTIES

4.1. Macroscopic and microscopic aspects of the wood tested

The macroscopic research was performed directly on the scantling and the microscopic analysis on transverse and longitudinal sections obtained from these scantlings are presented hereunder :

4.1.1. Dipterocarpus alatus

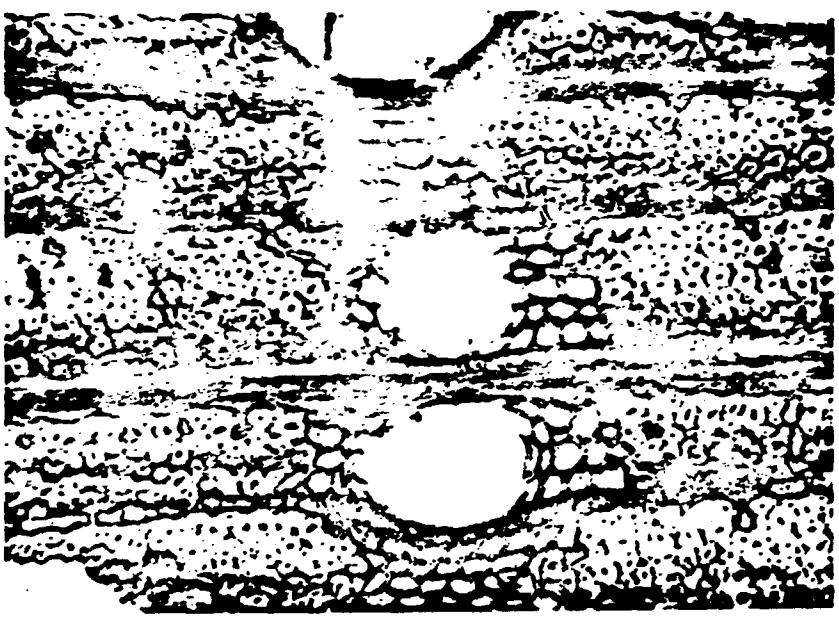


Fig.1.-Cross section of Dipterocarpus alatus

Macroscopic: hardwood species, light reddish-grey sapwood and pink-brown to reddish, brown heart wood. Annual rings are generally undistinguishable.

Pores are visible with the naked eye, large and uniformly spread. They appear on the longitudinal sections as scratches of various lengths.

There are substances release which appear on the crosscut and dry wood, as fine and numerous drops.

Visible radii on the radial section appearing as darker silver grain, often bright.

Microscopic: vessels of various dimensions; separate most often or in pairs as well, there are very few tiles.

Deposits of coloured substances inside most of the vessels, vessel elements with simple perforations, grain wall thicker than 6-10 microns, single series and multi-series radii (2-7 series), heterogenous, with cells having frequent deposits of brown substances, longitudinal parenchyma, mostly as short strips between pores, the circumvascular and the diffuse parenchyma are lesser representative.

The wood grain is generally straight, slightly waved occasionally; the wood texture is rough enough and uniform.

4.1.2. Melaia sp.

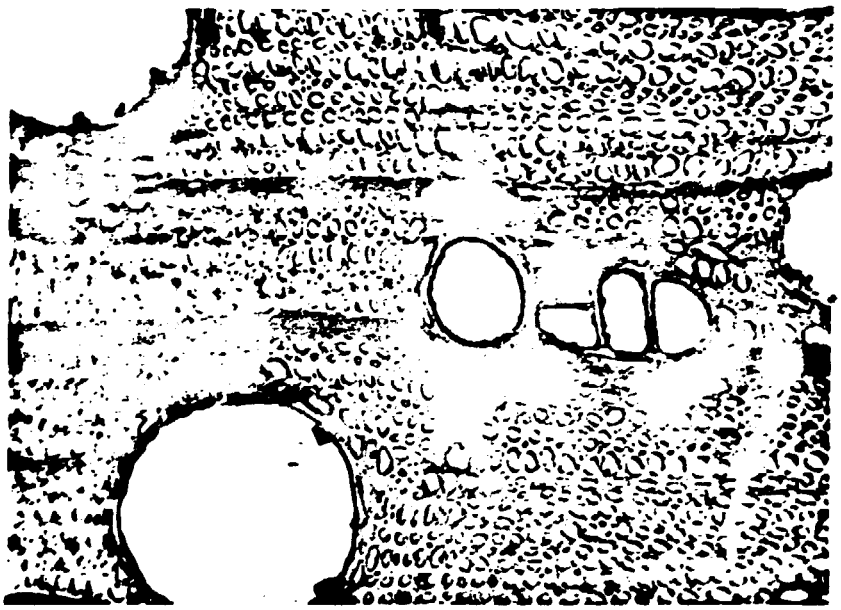


Fig.2. - Cross section of Melaia sp.

Macroscopic: hardwood species, light pink-brown. Non-visible annual ring limit. Visible pores with the naked eye, small, uniformly spread. The pores appear as fine scratches on the longitudinal section. Distinctive and very numerous radii.

Microscopic : Separate vessels, rarely in groups of 2 or 3 vessels, many of them with reddish coloured substance deposits.

Vessel elements have perforated walls with numerous simple punctuation marks. The wall grain has a thickness of max. 6 microns.

Rayries and rarely uni-series radii, homogenous, distinctively marked due to the red-brown colour.

Variously displayed parenchyma: narked, circumvascular, in strips.

The most parenchyma cells have red coloured substances. The wood grain is generally straight, slightly waved occasionally, with average texture, slight decorative aspect on the radial section due to the radius denseness and display.

REMARK: The wood texture showed filament tissue due to fungus in vessels.

4.1.3. Vatica sp.

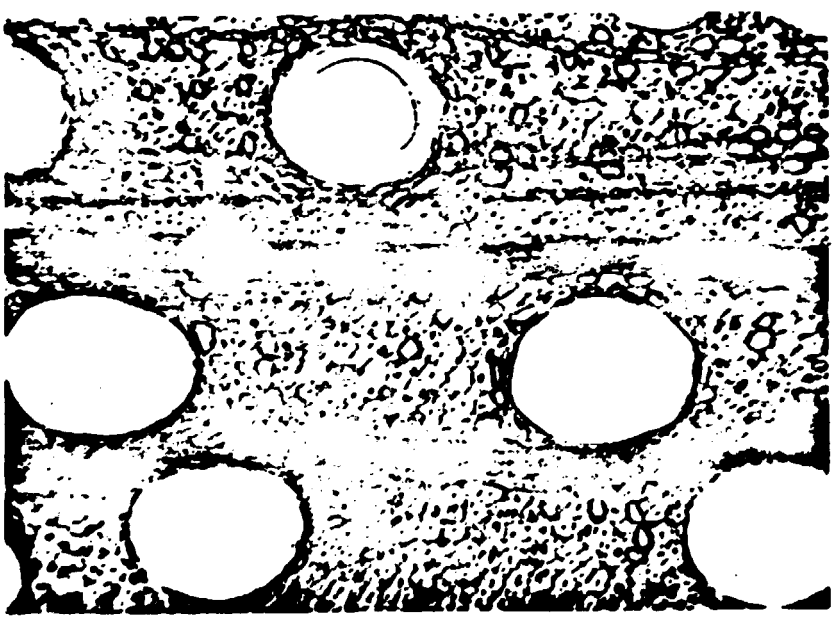


Fig.3. - Cross section of Vatica sp.

Macroscopic : Hardwood species with yellowish sapwood, grey-greenish shadow and yellow-brown or brown-olive-coloured heart-wood, with strips or darker spots occasionally.

Pores are very fine, hardly visible, uniformly spread, numerous. They appear as fine strips on the longitudinal section. There are radii, hardly visible with the naked eye; the radii appear only on the radial section, with brighter silver grain.

Microscopic: uniformly enough spread vessels full with coloured tiles (occasionally brown). Vessel elements have simple punctuations. Grains with a wall thickness up to max. 8 microns, displayed between radii. Heterogenous radii, 3-5 series, some of them are very fine, single series.

The longitudinal wood parenchyma appears both diffuse or discontinuously circumvascular.

The wood grain is straight, the texture is fine, without decorative aspect.

The smell is slightly aromatic.

4.1.4. Dialium cochinchinensis Pierre.

Fig.4.- Cross section of Dialium cochinchinensis

Macroscopic: hardwood species, brown-reddish. Slightly marked annual rings, pores visible with the naked eye, small and numerous, uniformly spread.

There are white coloured substances inside most of pores. Radius hardly visible with the naked eye.

Microscopic: Separate vessels, seldom in groups of 2-3 vessels, empty or partially full, with brown-reddish substance deposits. Vessel elements have simple perforations. Thickness of grain wall to max. 9 microns. Bi-serial radii, single series rarely, homogenous.

Some cells have brown-reddish substances. The parenchyma displayed in confluent, horizontal, dense strips, of 2-3 rows of cells.

The wood grain is straight, the texture is fine, reduced decorative aspect due to the alternation of grained surfaces with parenchyma strips.

Odourless wood.

4.1.5. Lagerstroemia calyaclata Kurz

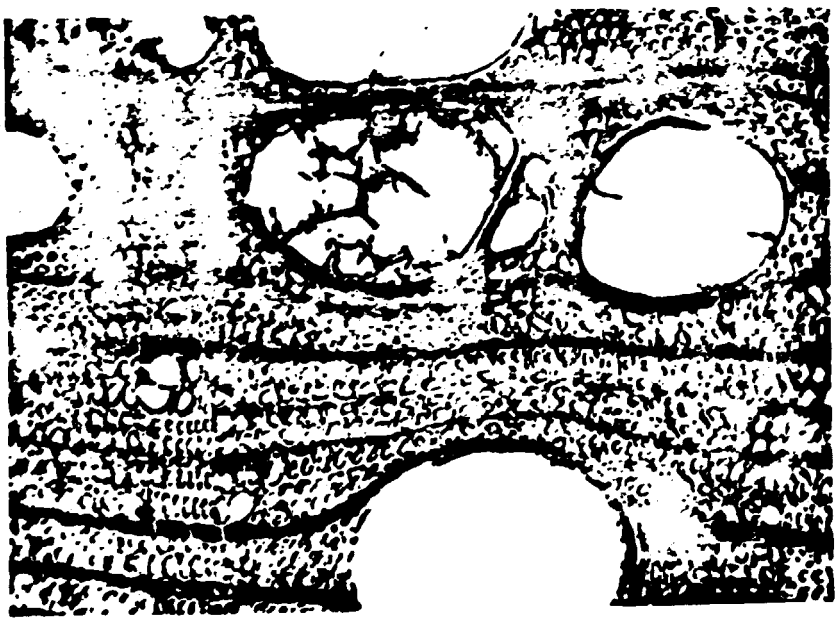


Fig.5.-Cross section of Lagerstroemia calyaclata Kurz

Macroscopic : hardwood species, light-grey or light yellow-grey sapwood, dark grey or grey-brown heart wood. Slightly visible annual rings.

Pores hardly visible. Slightly visible and numerous radii.

Microscopic: Separate vessels or in groups of 2-3 radial rows, empty or with tile. Vessels are variable in diameter, grater diameter for earlywood and smaller diameter for late wood (diameter dimensions are not gradual). Vessel elements are short, with perforated walls.

The grains in number of seven are displayed on irregular surfaces between the strips of wood parenchyma. Fine radii, heterogenous, 1-2 series, short.

Cells of radial parenchyma contain reddish coloured substance deposits.

The wood parenchyma is displayed mostly in narrow strips, irregularly waved, connecting several vessels.

The wood grain is straight but also wavy or matted; the texture is generally fine, bright, silky aspect, average decorative as well, due to grains especially.

4.1.6. Castanopsis tribuloides ADC.

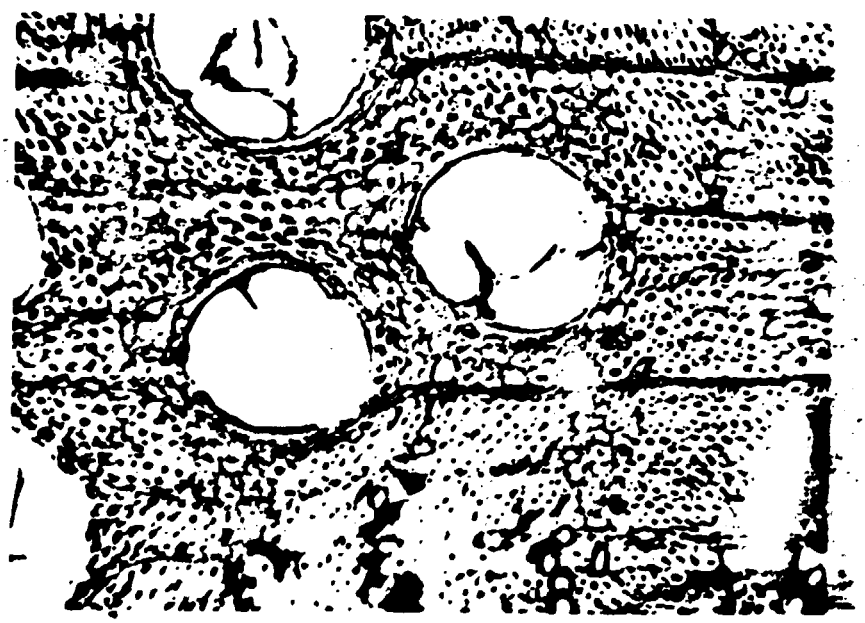


Fig.6.-Cross section of Castanopsis tribuloides ADC

Macroscopic: hardwood species, yellow-grey coloured or yellow-pink wood. Pores of the annual ring are large, visible with the naked eye, displayed in radial rows. Annual rings are clearly distinctive. Some pores contain bright substances. Numerous short radii, slightly visible on the radial section.

Microscopic: microscopic structure, dense aspect. Separate numerous vessels, having the tendency of displaying in radial rows. Vessels with growing tiles or obturated by tiles. Numerous, single series fine radii placed between wide multiseriial radii.

Grains arranged in packs with thick walls of max. 7 microns.

Wood parenchyma in continuous transverse strips between wide radii.

Some cells of this parenchyma contain brown coloured substances.

Light wood, the wood grain is generally straight, the texture is fine, bright, odourless.

REMARK: The wood has spores and filament tissue.

4.1.7. Podocarpus imbricatus BI

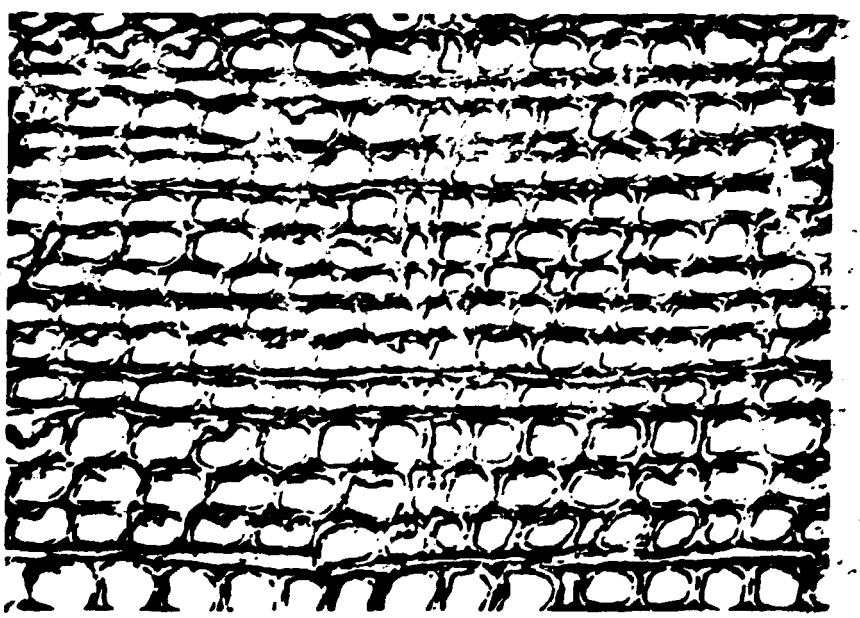


Fig.7. - Cross section of Podocarpus imbricatus BI

Macroscopic: Softwood species, white-yellowish wood. Slightly visible annual rings; hardly distinctive limit between the earlywood and the late wood.

The wood grain is straight, no decorative wood figure; there are grain patterns on the tangential section, marked by very fine lines.

Microscopic: Species of regular structured wood, traheids with this walls, areolar punctuations with oval opening, single and multi-series homogenous radii, light fine textured wood.

4.2. Physical, mechanical and elastic properties of the wood tested

The wood samples selected for establishing the physical and mechanical properties have been stored, prior to cutting of test pieces, in conditioning rooms at 20±3°C temperature and 65 ± 2% relative air humidity.

The following properties have been determined:

- volume weight,
- shrinkage and swelling ratios,
- parallel compression strength,
- static bending strength,
- parallel and perpendicular tensile strength,
- longitudinal-parallel shear strength,
- resistance to splitting,
- impact bending resilience,
- Janka hardness,
- modulus of elasticity at flexure.

The shape and size of test pieces as well as design procedure and test method are in conformity with provisions of Romanian standards (annex 1.3) affiliated to international standards ISO and CAER.

The shape and dimensions of test pieces are shown in figures 8 to 16.

During the tests the moisture content of test pieces has been 12 ± 3%.

The test values have been recalculated for wood at a moisture content of 12%.

The test results are presented in the tables 2 to 23 which include mean and end scale values for the wood species existing in Viet Nam and for 12% MC.

For the comparison of data there have been indicated also the values for Romanian hornbeam (Carpinus betulus) and beech wood (Fagus silvatica) which are used as raw material for the production of shuttles.

At the same time a statistical analysis of the established factors has been carried out for the characterization of data variation and accuracy.

The statistical analysis includes:

- arithmetic mean,
- mean square deviation,
- mean error of arithmetic mean,
- variation factor,
- accuracy.

4.2.1. Physical properties.

From this group of properties we have determined: volume weight, total shrinkage and swelling ratio. The determinations have been carried out on the test pieces shown in the fig.8.

4.2.1.1. Volume weight.

The following have been determined:

- volume weight for 12% moisture content,

$$\rho_{12} = \frac{m_{12}}{V_{12}}$$

- volume weight for over dry wood

$$\rho_o = \frac{m_o}{V_o}$$

- conventional volume weight

$$\rho_o = \frac{m_o}{V_{max.}}$$

The established values are shown in table 2.

Analysing by comparison the above data with volume weight of Romanian hornbeam and beech wood species it can be found that:

- Dipterocarpus species are, from this point of view much the same as the hornbeam wood, higher values being ascertained for the species Vatica, Castanopsis and Dialium, the other three species Lagerstroemia, Aglaia and Podocarpus having more reduced volume weight. The comparison with beechwood is nearly the same.

4.2.1.2. Overall shrinkage and swelling ratios

We have determined by measurements the overall shrinkage and swelling ratios established between wood grain saturation moisture and over dry wood.

The ratios have been established for radial, tangential and longitudinal directions being also determined the volumetric coefficient as shown in tables 3 and 4.

4.2.2. Mechanical and elastic properties.

4.2.2.1. Modulus of elasticity in static bending

The modulus of elasticity in static bending has been determined by the test pieces used subsequently for determination of static bending strength (fig.9). The test results are shown in the table 5.

Analysing the mean values in this table it can be found that Podocarpus and Aglaia species have elastic properties higher than other species.

The species having the values closer to the modulus of elasticity of hornbeam are Dipterocarpus and Castanopsis. The value of wood of Vatica species is lower than the value of beechwood.

4.2.2.2. Static bending strength.

The static bending strength is presented in the table 6. Analysing the said values it can be found that Vatica and Castanopsis species have strengths higher than those for beechwood, the other species having properties similar to beechwood with the excention of Podocarpus which has a lower value.

4.2.2.3. Impact bending resilience

The value impact bending resilience has been determined by test pieces similar with those for static bending strength (fig.15).

The table 7 shows the values obtained.

Analysing the data in the table it can be found that impact bending strength of hornbeam and beechwood have values close to Dialium and Aglaia species.

Lagerstroemia and Podocarpus are situated to a little low level while the Dypterocarpus, Vatica and Castanopsis have higher values compared with hornbeam and beechwood.

4.2.2.4. Compression strength

We have determined compression strength parallel to grain. The shape of test piece is shown in the fig.10. The table 8 presents the values of compression strength.

Analysing the data in comparison with hornbeam and beechwood it can be found that Vatica and Dialium have higher strengths.

The value nearest to hornbeam is registered by Lagerstroemia, the Aglaia is as much as close to beechwood Podocarpus and Dypterocarpus species present more reduced values.

4.2.2.5. Tensile strength

We have determined the tensile strength parallel to grain and perpendicular to grain, the latter being established in radial and tangential direction to growing rings.

The shape and the dimensions of test pieces are presented in fig.12 and 13.

The table 9 shows the strengths determined.

Analysing data in this table with regard to strength parallel to grain it can be found that mean value for Vatica is in the limits of Romanian hornbeam, even higher, but the other species have more reduced values.

Compared with the beechwood, Lagerstroemia shows mean values while Castanopsis and Vatica have values which exceed these limits, the other species being under the values of beechwood.

For perpendicular tensile strength it can be found that beechwood has the highest values of mean strengths. Vatica has similar values of strength in radial direction and lower values of strength in tangential direction.

All the other species studied in this work have lower values.

4.2.2.6. Shearing strength

We have determined the longitudinal-parallel shearing strength. The test has been carried out in radial and tangential direction to growing rings.

The test pieces used in this test have the shape and dimensions shown in the fig,11, The values of shearing strength are presented in the table 10.

The properties of Dialium species exceed the values of hornbeam, the other species being under these limits. Compared with beechwood the Lagerstroemia, Dypterocarpus and Podocarpus have strength ratios with more reduced values.

4.2.2.7. Splitting strength

Splitting strength has been determined in radial and tangential direction to the growing rings. The test pieces are as shown in the fig.14.

The strength determined is presented in table 11.

Analysing the data in this table it can be found that strength ratio for hornbeam and beech have values close to Dialium and Aglaia species. Lagerstroemia and Podocarpus have lower values but Dypterocarpus, Vatica and Castanopsis show higher values compared with hornbeam and beechwood.

4.2.2.8. Hardness

The hardness has been determined by Janka method. The test piece is presented in fig.16.

The hardness has been established by three directions (radial, tangential and transversal).

The test results are presented in table 12.

Analysing the data in the table it can be found that Dialium has the highest hardness, followed by Castanopsis and Vatica.

All these three species have the hardness higher or a little smaller than 100 MPa. The hornbeam has a hardness below this value. The other Vietnamese wood species studied in this report have the hardness close to beechwood and consequently lower than hornbeam, with the exception of Podocarpus specie, which has a hardness extremely low. The statistical factors have been estimated for all the determined properties and the values are presented in the tables 13 to 23.

TEST PIECES DETAILS dimensions in mm

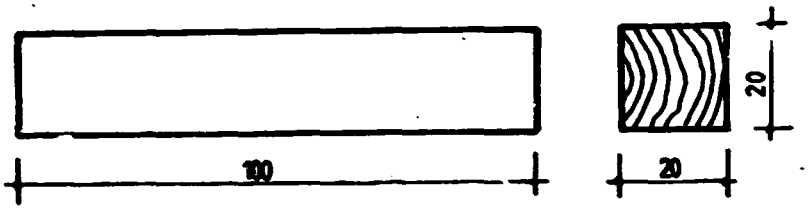


Fig. 8. Test pieces for volume weight and shrinkage + swelling.

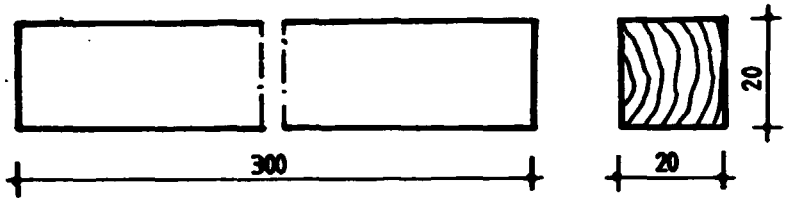


Fig. 9. Test pieces for static bending.

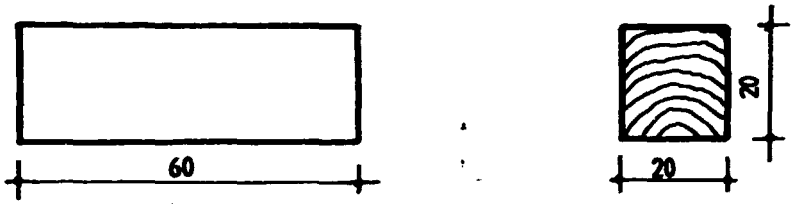


Fig. 10. Test pieces for parallel compression.

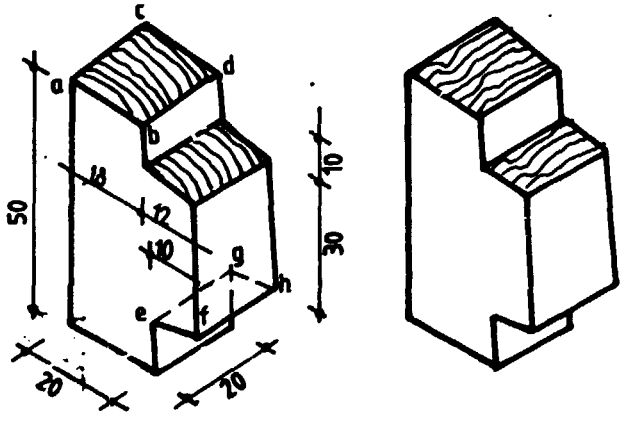


Fig. 11. Test pieces for parallel, longitudinal shear.

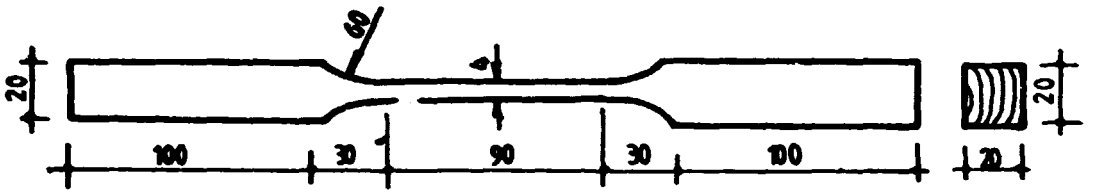


Fig.12. Test pieces for parallel tensile.

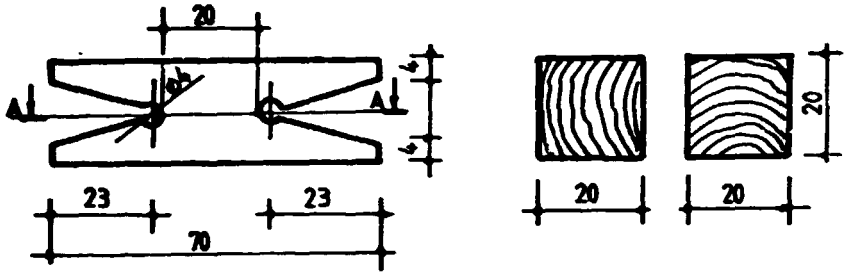


Fig.13. Test pieces for perpendicular tensile.

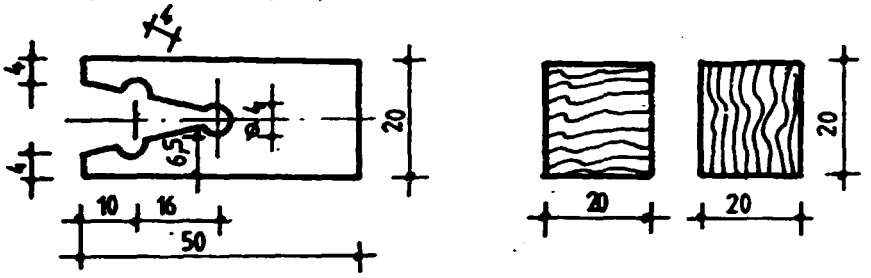


Fig.14. Test pieces for splitting.

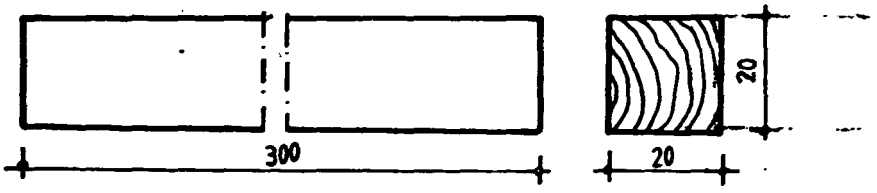


Fig.15. Test pieces for impact bending.

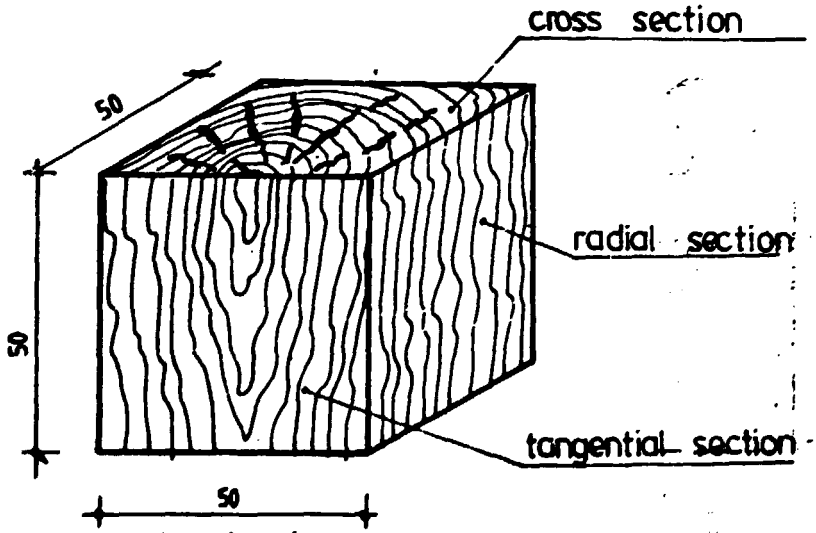


Fig.16. Specimen for hardness.

TABLE 2 - VOLUME WEIGHT OF WOOD SPECIES TESTED

Wood species	Volume weight (kg/m^3)								
	at U=0%			at U=12%			Conventional		
	min.	med.	max.	min.	med.	max.	min.	med.	max.
Podocarpus imbricatus Bl	300	390	450	345	426	476	280	370	460
Dipterocarpus alatus Roxb.	670	740	850	752	821	869	600	640	720
Aglaia sp.	490	570	650	531	611	691	430	500	570
Vatica sp.	675	818	882	748	901	1010	631	736	793
Dialium cochinchinensis Pierre	813	861	940	919	959	1032	753	815	881
Lagerstroemia calyaclata Kurz	511	565	607	599	653	720	502	547	586
Castanopsis tribuloides ADC	809	911	999	870	952	1002	689	783	837
Carpinus betulus L.	710	812	920	770	844	938	630	656	730
Fagus sylvatica L.	485	677	820	535	719	874	423	581	700

TABLE 3 - TOTAL SHRINKAGE COEFFICIENT OF WOOD SPECIES TESTED

Wood species	Total shrinkage coefficient of wood (%)											
	longitudinal			radial			tangential			volumetric		
	min.	med.	max.	min.	med.	max.	min.	med.	max.	min.	med.	max.
Podocarpus imbricatus Bl	0.0	0.2	0.4	1.8	3.4	6.1	4.9	6.8	10.0	7.7	10.4	13.6
Dipterocarpus alatus Roxb.	0.0	0.2	0.7	2.5	4.3	5.6	4.6	8.3	10.9	8.7	12.6	15.2
Aglaia sp.	0.0	0.2	0.4	3.7	5.0	6.9	5.5	7.5	9.6	10.1	12.3	14.5
Vatica sp.	0.1	0.3	0.5	2.0	3.5	4.5	3.7	5.6	6.9	6.5	9.3	13.9
Dialium cochinchinensis Pierre	0.2	0.3	0.4	1.7	2.5	3.0	2.1	4.7	5.8	6.2	8.4	8.6
Lagerstroemia calyculata Kurz	0.1	0.3	0.6 x)	1.6	2.3	3.4 x)	2.1	2.7	4.6 x)		-	
Castanopsis tribuloides DC	0.1	0.3	0.4	2.7	4.5	9.3	7.0	10.1	11.4	9.3	14.1	19.1
Carpinus betulus L	0.1	0.3	0.7	4.3	6.9	10.1	7.4	12.5	16.1	13.8	18.8	23.1
Fagus sylvatica L	0.1	0.3	0.7	3.9	5.2	7.4	6.4	9.9	14.8	9.6	14.1	21.0

x) Non-edifying values due to the marked tendency of wood to distorsion; about 93% of the test pieces have been strongly distorted.

TABLE 4 – TOTAL SWELLING COEFFICIENT OF WOOD SPECIES TESTED

Wood species	Total swelling coefficient wood (%)											
	longitudinal			radial			tangential			volumetric		
	min.	med.	max.	min.	med.	max.	min.	max.	med.	min.	med.	max.
Podocarpus imbricatus Bl	0.0	0.2	0.4	1.8	3.9	6.5	5.2	7.3	11.1	8.3	12.0	15.7
Dipterocarpus alatus Roxb.	0.0	0.2	0.7	2.6	4.2	5.9	4.8	8.3	12.1	9.5	14.4	17.9
Aglaia sp.	0.0	0.2	0.4	3.1	5.3	7.4	5.8	8.1	10.6	11.2	14.0	17.0
Vatica sp.	0.1	0.3	0.5	1.0	3.6	4.7	3.8	5.9	7.4	7.0	10.3	16.1
Dialium cochinchinensis Pierre	0.2	0.3	0.4	1.7	3.0	4.0	2.1	4.9	6.2	6.6	9.2	9.4
Lagerstroemia calyaclata Kurz	0.1	0.3	0.6[x)]	1.6	2.4	3.5[x)]	2.1	3.0	4.8[x)]		-	
Castanopsis tribuloides ADC	0.1	0.3	0.4	2.8	5.6	10.3	7.5	10.9	12.9	9.5	16.4	23.6
Carpinus betulus L	0.1	0.3	0.7	4.5	7.4	11.2	7.9	14.3	19.2	16.0	23.1	30.0
Fagus sylvatica L	0.1	0.3	0.7	3.1	5.5	7.9	6.8	9.9	17.4	10.6	16.4	26.6

x) See table 3.

TABLE 5 - MODULUS OF ELASTICITY OF WOOD SPECIES TESTED

Wood species	Modulus of elasticity to static bending MPa		
	min.	med.	max.
Podocarpus imbricatus Bl	6570	8360	9950
Dipterocarpus alatus Roxb.	14980	16450	18240
Aglaia sp.	9220	10730	12910
Vatica sp.	11700	14670	16630
Dialium cochinchinensis Pierre	10460	13790	16640
Lagerstroemia calyculata Kurz	10350	12660	14390
Castanopsis tribuloides ADC	13970	16870	19280
Carpinus betulus L	10900	15600	21000
Fagus sylvatica L	10100	15000	19600

TABLE 6 - STATIC BENDING RESISTANCE OF WOOD SPECIES TESTED

Wood species	Static bending resistance-MPa		
	min.	med.	max.
Podocarpus imbricatus Bl	58.5	67.7	73.8
Dipterocarpus alatus Roxb.	100.0	112.7	122.1
Aglaia sp.	96.8	116.3	134.1
Vatica sp.	138.0	154.2	163.7
Dialium cochinchinensis Pierre	90.3	124.9	148.6
Lagerstroemia calyculata Kurz	95.2	118.6	135.1
Castanopsis tribuloides ADC	114.2	146.3	163.0
Carpinus betulus L	89.3	142.9	188.2
Fagus sylvatica L	78.6	119.3	164.0

TABLE 7 - IMPACT BENDING RESILIENCE OF WOOD SPECIES TESTED

Wood species	Impact bending resilience j/m^2		
	Min.	med.	max.
Podocarpus imbricatus Bl	0.02	0.04	0.06
Dipterocarpus alatus Roxb.	0.06	0.10	0.16
Aglaia sp.	0.05	0.08	0.10
Vatica sp.	0.07	0.11	0.18
Dialium cochinchinensis Pierre	0.04	0.07	0.12
Lagerstroemia calyaclata Kurz	0.03	0.05	0.08
Castanopsis tribuloides ADC	0.08	0.13	0.18
Carpinus betulus L	0.02	0.07	0.20
Fagus sylvatica L	0.03	0.08	0.15

TABLE 8 - COMPRESSION STRENGTH (PARALLEL DIRECTION TO WOOD GRAIN) OF WOOD SPECIES TESTED

Wood species	Compression strength parallel direction to wood grain MPa		
	min.	med.	max.
Podocarpus imbricatus Bl	34.9	40.7	48.5
Dipterocarpus alatus Roxb.	33.5	45.1	51.0
Aglaia sp.	50.1	54.2	59.5
Vatica sp.	73.9	78.6	83.3
Dialium cochinchinensis Pierre	68.5	87.3	99.5
Lagerstroemia calyaclata Kurz	50.3	61.0	68.5
Castanopsis tribuloides ADC	63.7	69.2	76.0
Carpinus betulus L	30.9	60.3	80.7
Fagus sylvatica L	34.4	53.2	73.3

TABLE 9 -- TENSILE STRENGTH OF WOOD SPECIES TESTED

Wood species	Tensile strength (MPa)								
	parallel direction to wood grain			perpendicular direction on wood grain					
				radial direction			tangential direction		
	min.	mod.	max.	min.	mod.	max.	min.	mod.	max.
Podocarpus fribricatus Bl	53.0	67.9	93.6	0.5	1.0	1.5	0.9	1.4	2.0
Dipterocarpus alatus Roxb.	93.1	111.2	136.3	2.1	2.6	3.5	1.9	3.2	4.0
Aglaia sp.	80.3	115.9	136.0	1.6	2.3	2.9	1.6	2.4	3.2
Vatica sp.	128.1	168.9	214.0	2.1	3.5	4.6	2.6	3.5	4.3
Dialium cochinchinensis Pierre	66.2	89.8	131.9	1.5	2.2	3.1	1.4	2.3	3.1
Lagerstroemia calyculata Kurz	113.3	139.9	161.2	1.7	2.4	3.1	1.7	2.2	2.9
Castanopsis tribuloides ADC	107.1	147.5	194.9	1.9	2.7	3.6	3.3	4.9	5.0
Carpinus betulus L	59.1	139.4	230.9	1.7	3.5	5.6	2.2	4.5	6.8
Fagus sylvatica L	55.5	130.1	227.6	2.9	3.4	5.1	2.5	4.2	6.4

TABLE 10 - SHEAR STRENGTH (PARALLEL-LONGITUDINAL DIRECTION) OF WOOD SPECIES TESTED

Wood species	Shear strength, parallel-longitudinal direction MPa					
	Radial direction			Tangential direction		
	Min.	Med.	Max.	Min.	Med.	Max.
Podocarpus imbricatus Bl	6.0	7.7	9.1	5.4	7.3	8.2
Dipterocarpus alatus Roxb.	6.6	9.0	12.0	11.1	12.8	14.1
Aglaia sp.	12.5	14.4	18.7	11.4	14.2	17.1
Vatica sp.	8.6	13.1	15.6	11.2	14.9	18.2
Dialium cochinchinensis Pierre	16.4	19.3	23.4	15.9	20.1	25.5
Lagerstroemia calyaclata Kurz	9.1	11.5	12.9	6.1	9.9	13.3
Castanopsis tribuloides ADC	13.7	15.1	16.6	15.0	18.6	21.8
Carpinus betulus L	9.1	15.6	28.6	13.5	21.5	28.6
Fagus sylvatica L	6.6	12.0	17.5	7.3	15.6	20.0

TABLE 11 - SPLITTING RESISTANCE OF WOOD SPECIES TESTED

Wood species	Splitting resistance - MPa					
	radial direction			tangential direction		
	min.	med.	max.	min.	med.	max.
Podocarpus imbricatus L	0.22	0.23	0.37	0.17	0.29	0.30
Dipterocarpus alatus Roxb.	0.34	0.46	0.57	0.39	0.50	0.63
Aglaia sp.	0.22	0.36	0.43	0.20	0.40	0.52
Vatica sp.	0.69	0.89	1.07	0.80	1.07	1.21
Pahudia cochinchinensis Pierre	0.52	0.69	1.00	0.61	0.86	1.00
Lagerstroemia calyculata Kurz	0.42	0.57	0.78	0.46	0.58	0.74
Castanopsis tribuloides ADC	0.53	0.69	0.87	0.93	1.13	1.32
Carpinus betulus L	0.58	0.80	1.11	1.01	1.26	1.51
Fagus sylvatica L	0.42	0.76	1.35	0.60	1.13	2.01

TABLE 12 - JANKA HARDNESS OF WOOD SPECIES TESTED

Wood species	Janka hardness								
	radial section			tangential section			cross section		
	min.	med.	max.	min.	med.	max.	min.	med.	max.
Podocarpus imbricatus BT	13.1	18.9	25.1	14.8	20.2	25.5	23.6	32.0	37.7
Dipterocarpus alatus Roxb.	41.4	50.7	53.2	38.8	43.7	55.0	50.7	57.2	64.7
Aglaia sp.	45.0	49.2	54.9	45.4	51.2	57.4	57.4	60.1	72.0
Vatica sp.	76.5	99.6	127.1	76.5	99.6	116.5	93.3	108.5	120.0
Dialium cochinchinensis Pierre	134.0	150.0	176.0	121.0	148.0	172.0	151.0	169.0	194.0
Lagerstroemia calvaclata Kurz	39.0	52.0	62.0	41.0	51.0	61.0	43.0	56.0	73.0
Castanopsis tribuloides ADC	102.5	110.8	127.5	90.0	89.1	112.0	104.0	113.3	126.0
Carpinus betulus L	51.4	90.1	109.0	47.4	81.7	104.1	67.6	96.6	122.6
Fagus sylvatica L	31.4	52.6	80.7	38.5	54.4	77.6	45.3	68.8	90.9

TABLE 13 - STATISTICAL INDICES FOR VOLUME WEIGHT

(for U=12%/U=0%/conventional)

Wood species	Statistical indices				
	Medium value	Quadratic medium deviation	Medium error of arithmetic mean	Variation coefficient %	Accuracy %
Podocarpus imbricatus Bl	426 399 370	33.2 30.3 33.4	5.9 5.4 5.9	7.7 7.7 9.0	1.4 1.4 1.6
Dipterocarpus alatus Roxb.	821 740 640	40.0 40.0 30.0	7.0 7.0 5.2	4.9 5.4 4.7	0.8 0.9 0.8
Aglaia sp.	611 570 500	35.9 30.6 31.9	6.4 6.9 5.7	5.9 6.0 6.4	1.1 1.2 1.1
Vatica sp.	882 813 736	68.1 59.4 25.4	10.9 10.5 4.5	7.5 7.3 3.5	1.2 1.3 0.6
Dialium cochinchinensis Pierre	959 869 815	35.8 45.0 22.9	6.0 9.2 4.2	3.7 5.2 2.9	0.7 0.9 0.5
Lagerstroemia calyculata Kurz	566 547 663	26.7 22.3	4.9 4.2	4.7 4.2	0.9 0.8
Castanopsis tribuloides DC	952 911 703	37.2 45.3 35.3	6.8 8.3 6.4	3.9 4.9 4.5	0.7 0.9 0.8

TABLE 14 - STATISTICAL INDICES FOR TOTAL SHRINKAGE

(RADIAL / TANGENTIAL / VOLUME)

Wood species	Statistical indices				
	Medium value	Quadratic medium deviation	Medium error of arithmetic mean	Variation coefficient	Accuracy
Polocarpus imbricatus Bl	3.4	1.015	0.13	30.2	3.2
	6.8	1.177	0.21	17.3	3.1
	10.4	1.615	0.29	15.7	2.8
Dipterocarpus alatus Roxb.	4.3	0.790	0.16	18.4	3.7
	9.6	0.900	0.19	9.4	2.0
	13.8	0.820	0.17	5.9	1.2
Aglaia sp.	5.0	0.720	0.12	14.0	2.4
	7.5	0.760	0.14	10.1	1.9
	12.3	1.060	0.19	8.6	1.5
Vatica sp.	3.5	0.650	0.14	20.3	4.0
	5.6	0.800	0.17	14.3	3.0
	9.3	1.160	0.25	12.5	2.7
Dialium cochinchinensis Pierre	3.0	0.450	0.15	16 0	5.0
	4.9	0.550	0.15	15.3	3.1
	7.7	0.750	0.22	9.7	2.9
Lagerstroemia calyculata Kurz	2.3	0.440	0.11	20.0	5.0
	2.7	0.480	0.12	17.8	4.4
	-	-	-	-	-
Castanopsis tribuloides ADC	4.5	0.970	0.19	21.6	4.2
	10.1	0.940	0.18	9.5	1.8
	14.1	2.910	0.54	20.6	3.8

TABLE 15 - STATISTICAL INDICES FOR MODULUS OF ELASTICITY TO STATIC BENDING

Wood species	Statistical indices				
	Medium value	Quadratic medium deviation	Medium error of arithmetic mean	Variation coefficient	Accuracy
Podocarpus imbricatus Bl	8360	1177.8	392.6	14.1	4.7
Dipterocarpus alatus Roxb.	16450	908.5	302.8	5.5	2.1
Aglaia sp.	10730	1278.3	426.1	12.5	4.2
Vatica sp.	14670	1423.7	450.5	9.7	3.1
Dialium cochinchinensis Pierre	13790	2220.7	489.3	15.9	4.1
Lagerstroemia calyaclata Kurz	12660	1325.0	410.3	10.1	3.2
Castanopsis tribuloides ADC	16870	2127.6	673.3	12.7	4.0

TABLE 16 - STATISTICAL INDICES FOR STATIC BENDING RESISTANCE

Wood species	Statistical indices				
	Medium value	Quadratic medium deviation	Medium error of arithmetic mean	Variation coefficient %	Accuracy %
Podocarpus imbricatus Bl	67.7	5.045	1.630	7.4	2.5
Dipterocarpus alatus Roxb.	112.7	7.009	2.340	7.9	2.4
Aglaia sp.	116.3	11.670	4.420	11.1	4.2
Vatica sp.	154.2	9.451	2.991	6.1	1.9
Dialium cochinchinensis Pierre	124.9	20.740	5.550	15.5	4.1
Lagerstroemia calyaclata Kurz	118.6	13.729	4.345	10.9	3.4
Castanopsis tribuloides ADC	146.3	15.31	4.840	10.6	3.3

TABLE 17 - STATISTICAL INDICES FOR IMPACT BENDING RESILIENCE

Wood species	Statistical indices				
	Medium value	Quadratic medium deviation	Medium error of arithmetic mean	Variation coefficient %	Accuracy %
Podocarpus imbricatus Bl	0.04	0.0005	0.0015	29.3	4.5
Dipterocarpus alatus Roxb.	0.10	0.0100	0.0033	30.3	3.3
Aglaia sp.	0.08	0.0150	0.0050	30.3	2.7
Vatica sp.	0.11	0.0350	0.0060	29.4	5.0
Dialium cochinchinensis Pierre	0.07	0.0070	0.0023	9.7	2.3
Lagerstroemia calyculata Kurz	0.05	0.0116	0.0022	20.7	3.9
Castanopsis tribuloides ADC	0.13	0.0314	0.0052	22.9	3.8

TABLE 18 - STATISTICAL INDICES FOR COMPRESSION STRENGTH PARALLEL DIRECTION TO WOOD GRAIN

Wood species	Statistical indices				
	Medium value	Quadratic medium deviation	Medium error of arithmetic mean	Variation coefficient %	Accuracy %
Podocarpus imbricatus Bl	49.7	7.20	1.75	17.7	4.3
Dipterocarpus alatus Roxb.	45.1	3.72	1.41	8.7	3.3
Aglaia sp.	54.2	2.67	0.95	5.2	1.8
Vatica sp.	78.6	3.42	0.90	4.3	1.1
Dialium cochinchinensis Pierre	87.3	8.24	1.76	9.6	1.9
Lagerstroemia calyculata Kurz	61.9	4.79	1.05	7.5	1.7
Castanopsis tribuloides ADC	69.2	3.24	0.73	4.8	1.1

TABLE 19 - STATISTICAL INDICES FOR PARALLEL, TANGENTIAL SHEAR STRENGTH (RADIAL DIRECTION, TANGENTIAL DIRECTION)

Wood species	Statistical indices				
	Medium value	Quadratic medium	Medium error of arithmetic mean	Variation coefficient %	Accuracy %
Podocarpus imbricatus Bl	7.7	0.357	0.247	12.1	3.2
	7.3	0.327	0.257	12.7	3.5
Dipterocarpus alatus Roxb.	9.0	1.211	0.329	14.4	3.8
	12.8	0.790	0.211	7.0	1.8
Aglaia sp.	14.4	1.555	0.347	10.9	2.4
	14.2	1.526	0.412	11.9	2.9
Vatica sp.	13.1	2.025	0.499	14.7	3.8
	14.9	1.842	0.493	11.3	3.9
Dialium cochinchinensis Pierre	19.3	2.332	0.661	11.7	3.2
	20.1	2.393	0.855	14.9	4.1
Lagerstroemia calyculata Kurz	11.5	1.330	0.369	12.3	3.4
	9.9	1.592	0.442	16.4	4.6
Castanopsis tribuloides DC	15.1	1.039	0.279	6.9	1.8
	13.6	1.042	0.539	13.4	3.9

TABLE 20 - STATISTICAL INDICES FOR TENSILE STRENGTH PARALLEL DIRECTION TO WOOD GRAIN

Wood species	Statistical indices				
	Medium value	Quadratic medium	Medium error of arithmetic mean	Variation coefficient %	Accuracy %
Podocarpus imbricatus Bl	67.9	11.03	2.68	16.6	4.0
Dipterocarpus alatus Roxb.	111.2	16.15	4.49	12.3	4.3
Aglaia sp.	115.8	20.06	5.90	17.2	5.0
Vatica sp.	168.9	22.46	5.61	13.7	3.4
Dialium cochinchinensis Pierre	89.8	17.31	4.63	19.6	5.0
Lagerstroemia calyaclata Kurz	139.0	14.27	3.46	9.6	2.3
Castanopsis tribuloides ADC	147.5	28.94	7.00	19.5	4.7

TABLE 21 - STATISTICAL INDICES FOR TENSILE STRENGTH PERPENDICULAR DIRECTION OF WOOD GRAIN (RADIAL TANGENTIAL DIRECTION)

Wood species	Statistical indices				
	Medium value	Quadratic medium	Medium error of arithmetic mean	Variation coefficient %	Accuracy %
Podocarpus imbricatus Bl	1.9 1.4	0.229 0.111	0.050 0.025	22.2 8.3	4.9 1.8
Dipterocarpus alatus Roxb.	2.6 3.2	0.439 0.490	0.107 0.116	17.1 15.3	4.3 3.9
Aglaia sp.	2.3 2.4	0.436 0.455	0.102 0.117	19.2 19.1	4.5 4.9
Vatica sp.	3.5 3.5	0.565 0.617	0.141 0.132	14.9 16.9	3.7 3.6
Dialium cochinchinensis Pierre	2.2 2.3	0.373 0.521	0.075 0.117	16.3 20.9	3.3 4.7
Lagerstroemia calyculata Kurz 1	2.4 2.2	0.345 0.375	0.075 0.096	14.6 17.3	3.2 4.0
Castanopsis tribuloides ADC	2.7 4.0	0.547 0.516	0.117 0.112	19.6 12.9	4.2 2.8

TABLE 22 - STATISTICAL INDICES FOR SPLITTING RESISTANCE
(RADIAL DIRECTION/TANGENTIAL DIRECTION)

Wood species	STATISTICAL INDICES				
	Medium value	Quadratic medium	Medium error of arithmetic mean	Variation coefficient %	Accuracy %
Podocarpus imbricatus Bl	0.23 0.28	0.052 0.040	0.013 0.011	18.6 17.6	4.5 4.3
Dipterocarpus alatus Roxb.	0.46 0.59	0.075 0.069	0.019 0.017	17.0 14.4	4.3 3.5
Aglaia sp.	0.36 0.40	0.059 0.060	0.014 0.014	15.4 15.0	3.9 3.5
Vatica sp.	0.89 1.07	0.090 0.124	0.021 0.025	9.3 10.9	2.3 2.2
Dialium cochinchinensis Pierre	0.52 0.86	0.149 0.170	0.033 0.040	19.2 12.7	4.9 4.4
Pentaspadon velutinus Hook.	0.57 0.58	0.083 0.083	0.019 0.021	15.6 14.3	3.2 3.6
Castanopsis tribuloides ADC	0.69 1.19	0.082 0.124	0.019 0.027	11.4 10.9	2.5 2.2

TABLE 23 - STATISTICAL INDICES FOR JANKA HARDNESS
(RADIAL/TANGENTIAL/TRANSVERSAL DIRECTION)

Wood species	statistical indices				
	Medium value	Quadratic medium	Medium error of arithmetic mean	Variation coefficient %	Accuracy %
Podocarpus imbricatus Bl	18.9	2.97	0.54	15.7	2.9
	20.2	3.91	0.55	14.9	2.7
	32.0	4.33	0.79	13.5	2.5
Dipterocarpus alatus Roxb.	50.7	3.76	0.74	8.0	1.6
	48.7	3.62	0.71	8.0	1.6
	57.2	3.33	0.73	6.2	1.4
Aglaia sp.	49.2	6.02	1.14	12.2	2.3
	51.2	5.36	1.20	12.4	2.3
	60.1	4.30	0.81	7.1	1.3
Vatica sp.	99.6	16.59	4.29	14.8	4.3
	99.6	16.03	4.63	14.3	4.1
	109.5	9.73	2.81	8.9	2.3
Dialium cochinchinensis Pierre	150.0	12.72	2.40	8.1	1.5
	148.0	14.44	2.73	9.4	1.8
	169.0	7.75	1.47	4.4	0.8
Lagerstroemia calyaclata Kurz	52.0	5.51	0.90	10.0	1.6
	51.0	5.15	0.84	10.3	1.7
	56.0	7.50	1.22	13.7	2.2
Castanopsis tribuloides ADC	110.8	6.84	1.34	6.2	1.2
	99.15	8.88	1.74	8.9	1.7
	113.3	5.90	1.15	5.2	1.0

UNIDO PROJECT DP/VIE/80/027

CHAPTER III

THE TECHNICAL REPORT

5. Drying and conditioning.

5.1. Artificial drying of the wood tested

5.2. Conditioning of the dry wood pieces

5. DRYING AND CONDITIONING

In conformity with the provisions of this offer we have carried out a series of experiments for artificial drying of wood test pieces of the species mentioned in table 1.

After drying, the wood pieces have been tested for determination of behaviour of these species at [illegible] climatic conditions using a climatic chamber.

5.1. Artificial drying of the wood test

The experimental tests for the drying of wood test pieces of the species studied in this report have been carried out within two pilot plants existing in the wood drying laboratory of ICTIL, each of them having a capacity of 0.200 m^3.

The respective pilot plants are each provided with an axial type fan, a heating system (filament resistance), devices for air moistening by evaporation and thermometers with two platinum resistances connected to electrical controllers mounted on the control panels of the driers.

The experiments have been carried out in accordance with provisions of Romanian standards.

The dimensions of the wood test pieces were:

- 30 x 80 x 510 mm
- 55 x 70 x 500 mm
- 55 x 55 x 300 mm
- 60 x 80 x 410 mm
- 80 x 80 x 320 mm
- 65 x 70 x 510 mm

The wood specimens which have been dried with longer than 6 months allowed the carrying out of experiments only with a range between 12° and 30° MC.

The scantlings have been grouped by wood species and by dimensions for the following drying conditions:

- condition No.4 for the wood species Melina, Canarium and Vatica having the volume weight in the range of 950 kg/m^3 at 12% MC and a high degree of difficulty for drying (similar to oak species).

- condition No.3 for the wood species Dipterocarpus having the volume weight in average of 820 kg/m^3 at 12% MC but with reduced degree of difficulty for drying (similar to beech species).

- condition No.2 for wood species Aglaia and Lagerstroemia having the volume weight in average of 650 kg/m^3 and an average degree of difficulty for drying (similar to walnut sycomore and hornbeam species).

- condition No.1 for wood species Podocarpus (resinous wood) having the volume weight in average of 425 kg/m^3 at 12% MC and a reduced degree of difficulty for drying (similar to fir species).

For the above drying conditions we have prepared control specimens (duplicate) which have been weighed at the beginning and during the drying process for assessing the variation in wood moisture content.

At the time of sampling of controls we have prepared test pieces for the determination of initial moisture contents by the gravimetric method in accordance with the Romanian standard STAS. In case of drying wood specimens with an initial moisture contents lower than 30% the moistening of the air is no more necessary.

During the process, the dry bulb temperature was constantly maintained in the range of values established for the said drying condition by the temperature controllers existing on the control panels.

Table 24 shows the drying conditions applied during the experiments and figures 17 to 23 present the diagrams of variation in time of moisture contents. From above diagram it results that the Podocarpus wood specimens were dried in shorter time that is a drying rate of 0.17% per hour.

The species Vatica and Dialium dried heavier with a drying ratio of 0.026% per hour.

In all the above situations the quality of dry material was suitable, without specific drying defects (splits, deformations, stainings), the moisture gradient was between 1.0 and 2.1%, the higher values being measured at the wood scantlings with higher moisture contents.

Tables 25 to 31 present the decrease of moisture content in time for each wood species depending on its drying condition.

The proper drying condition is also demonstrated by stress test pieces prepared after drying from dry scantlings as shown in fig.24.1 - 24.8.

TABLE 24- DRYING CONDITIONS

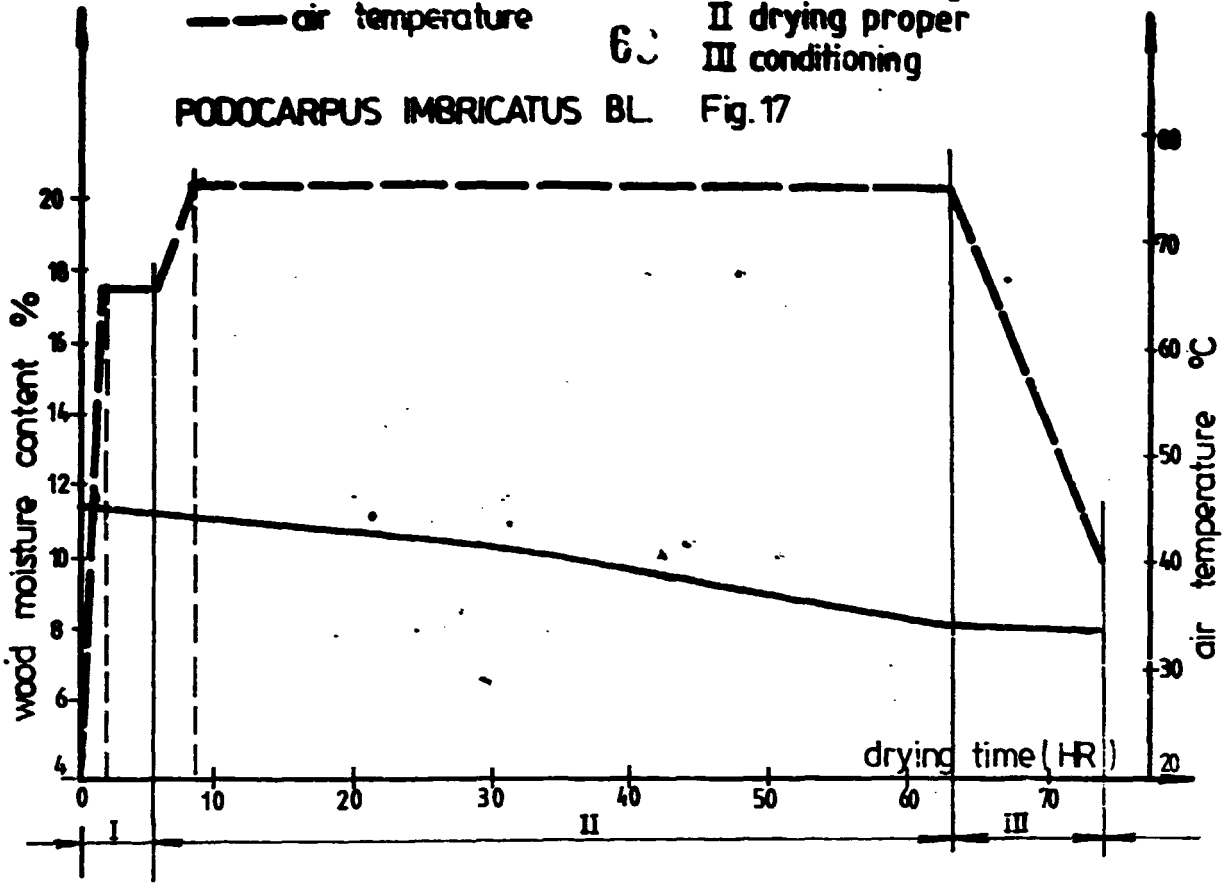
I. MATERIAL

Assortment	Species	Size - mm	Initial MC / Final MC %	Stage/MC level %	Dry bulb °C	Time h
Condition 1						
Lath 7	Podocarpus	70 x 70 x 680	12/8	1.Initial drying	65	6
				2.Drying proper		
				25 - 20	65	
				20 - 15	70	
				15 - 8	75	63
				3.Equilibrium	40	5
				TOTAL		74
Condition 2						
Lath 2	Aglaia	70 x 70 x 530	26/12	1.Initial drying	60	6
5	Lagerstroemia			2.Drying proper		
				25 - 20	60	
				20 - 15	65	
				15 - 9	70	218
				3.Equilibrium	40	23
				TOTAL		244
Condition 3						
Lath 1	Dipterocarpus	65 x 70 x 680	20/12	1.Initial drying	55	6
				2.Drying proper		
				25 - 20	55	
				20 - 15	60	
				15 - 9	65	256
				3.Equilibrium		26
				TOTAL		288
Condition 4						
Lath 4	Dialium			1.Initial drying	45	6
3	Vatica	65 x 70 x 680	25/12	2.Drying proper		
6	Castanopsis			25 - 20	45	
				20 - 15	50	436
				15 - 10	55	42
				3.Equilibrium		
				TOTAL		484

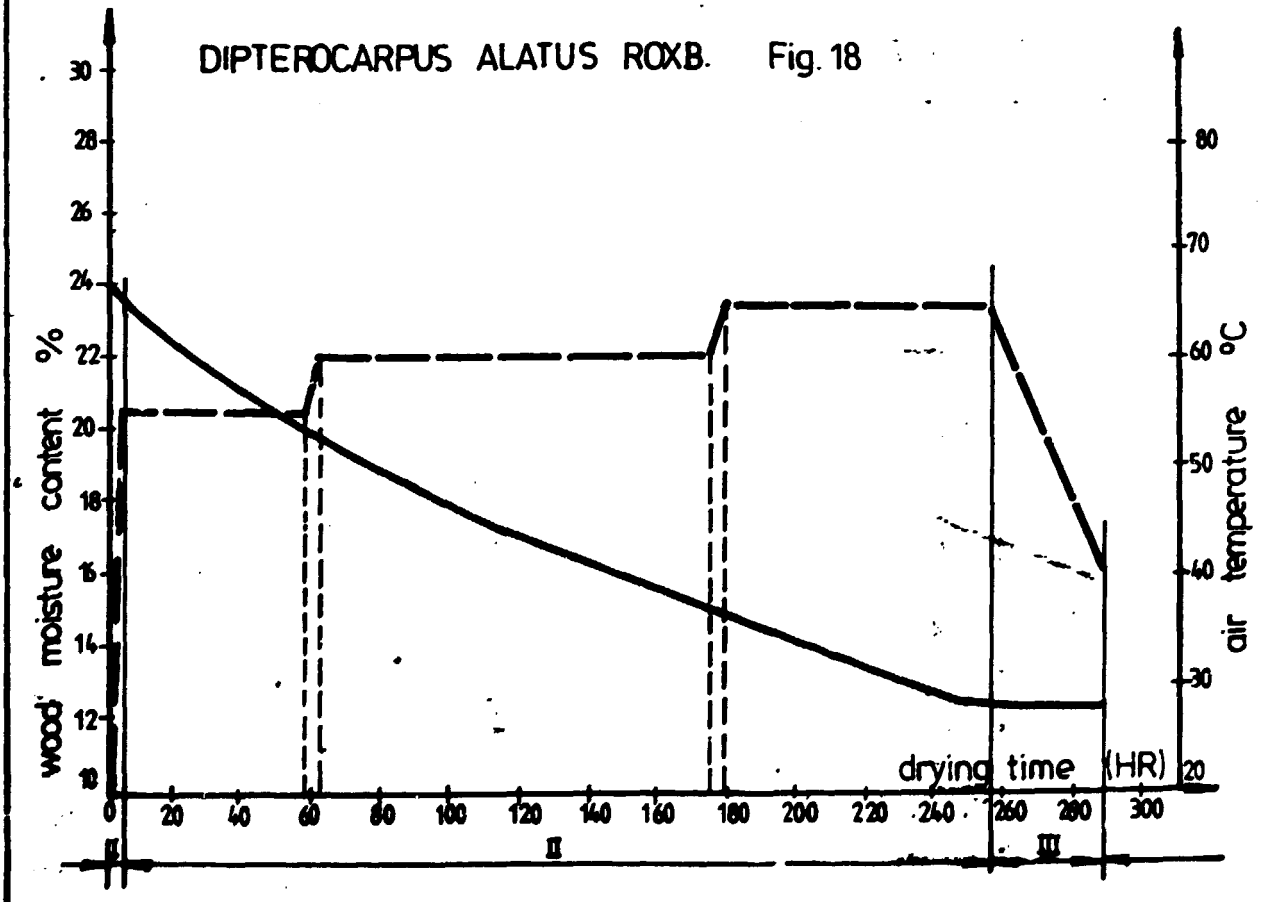
wood moisture content
air temperature

I initial heating
II drying proper
III conditioning

PODOCARPUS IMBRICATUS BL. Fig. 17



DIPTEROCARPUS ALATUS ROXB. Fig. 18



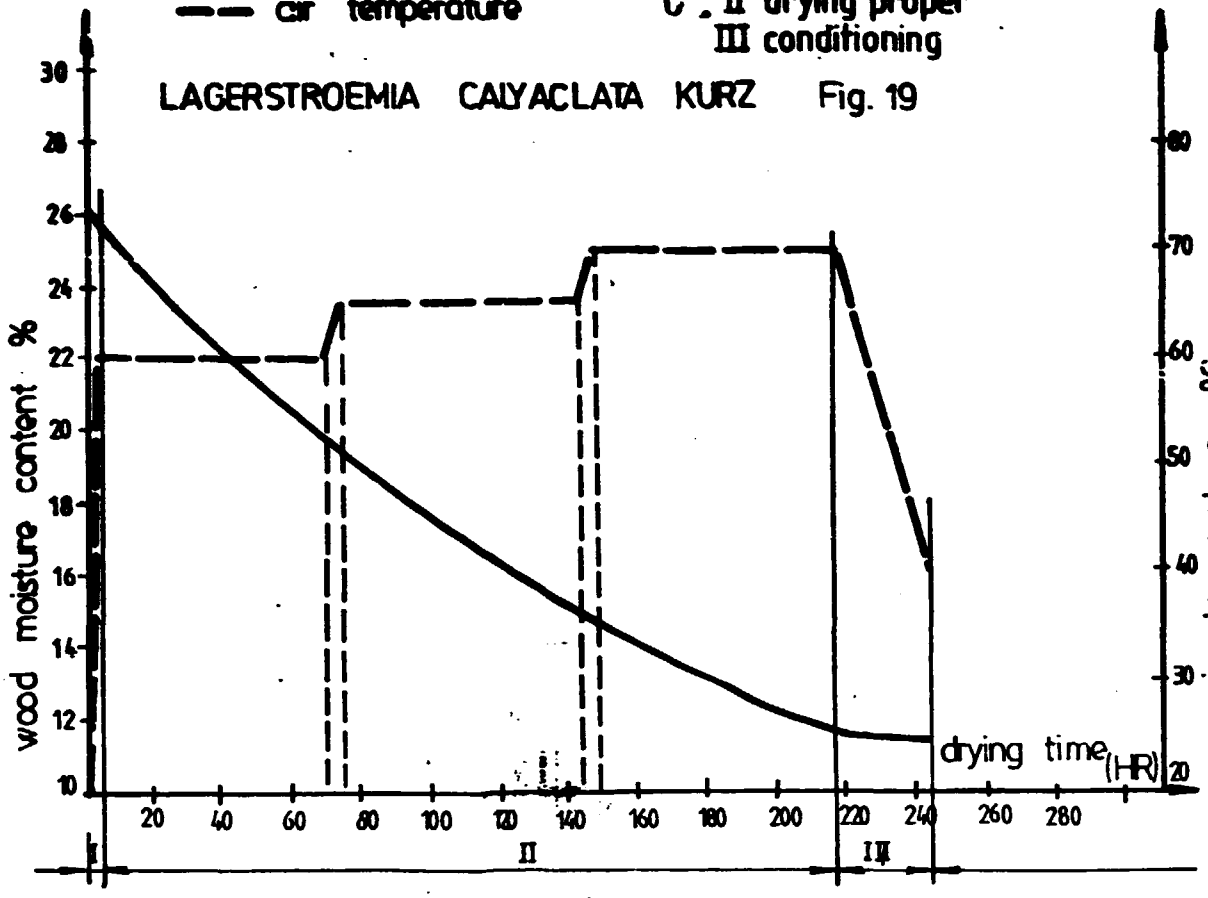
wood moisture content

air temperature

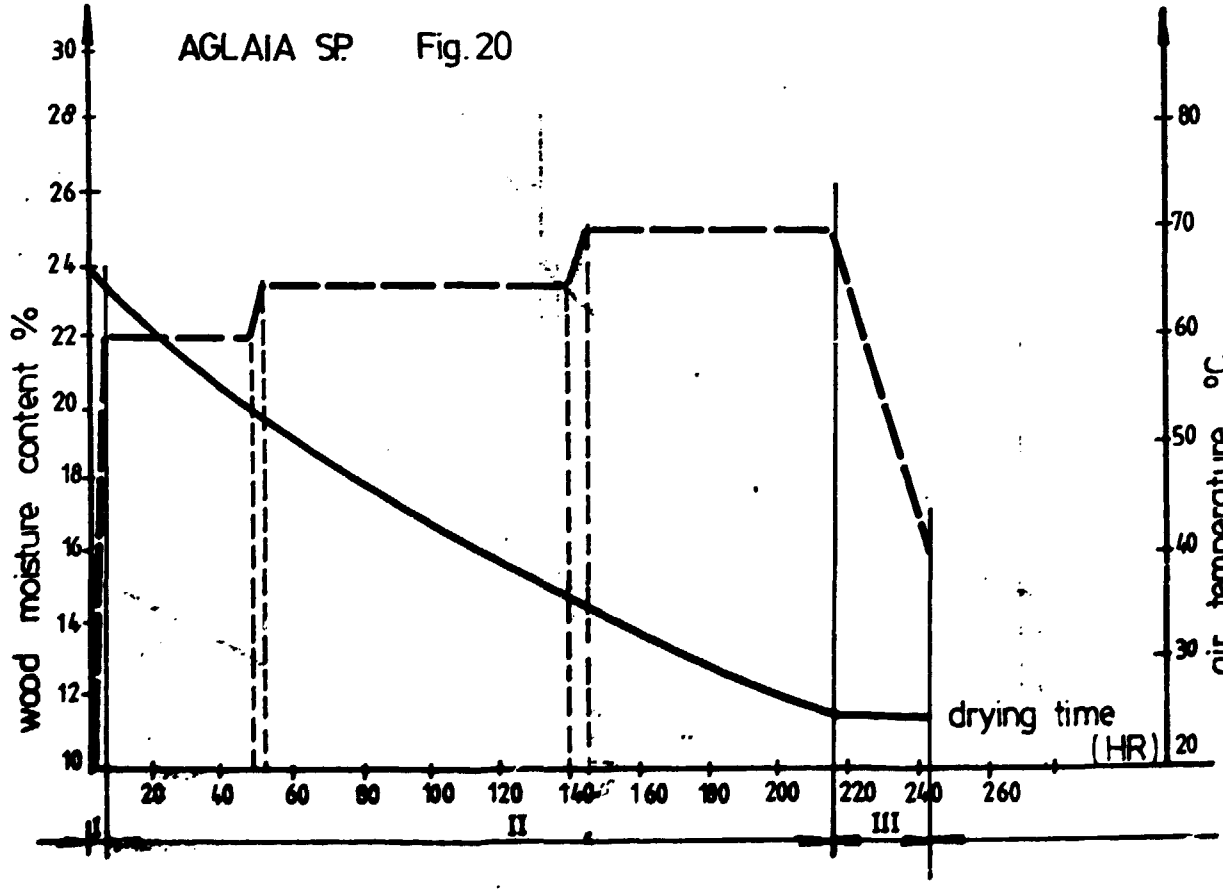
II drying proper

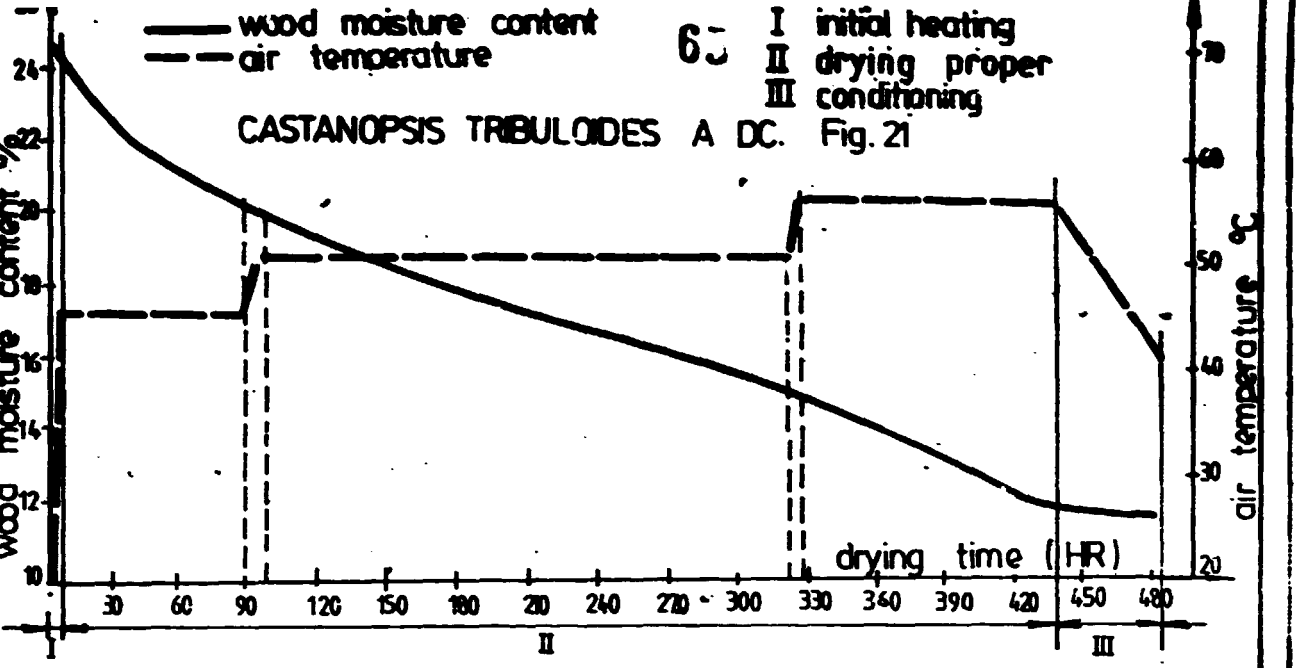
III conditioning

LAGERSTROEMIA CALYACLATA KURZ Fig. 19

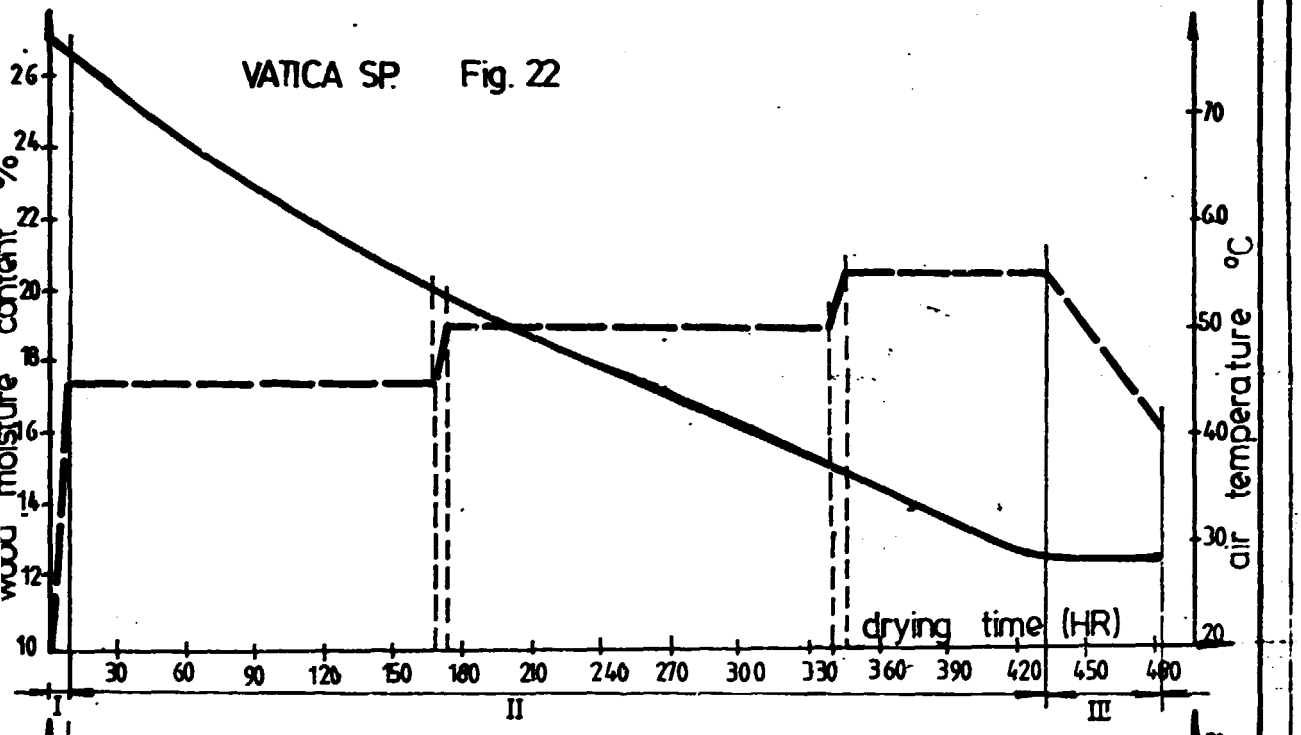


AGLAIA SP. Fig. 20

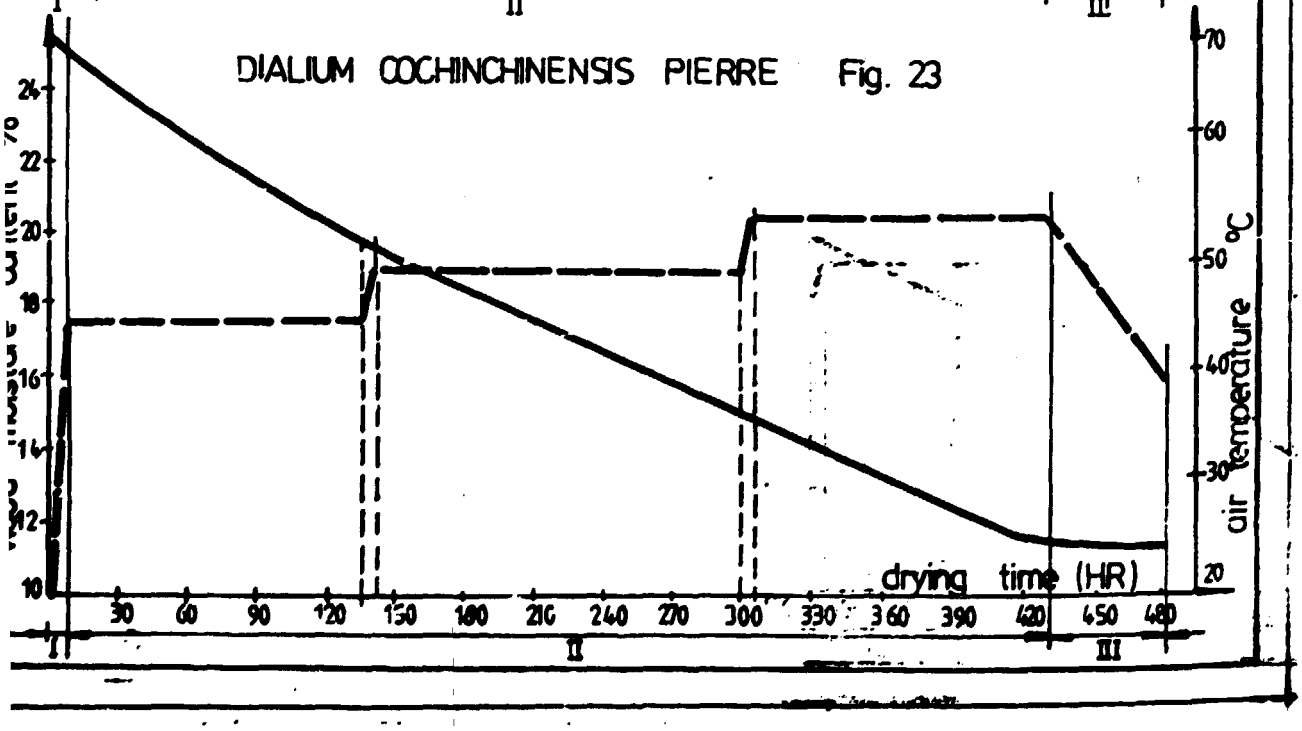




CASTANOPSIS TRIBULOIDES A DC. Fig. 21



VATICA SP. Fig. 22



DIALIUM COCHINCHINENSIS PIERRE Fig. 23

STRESS TEST PIECES FOR THE

DRYING CONTROL

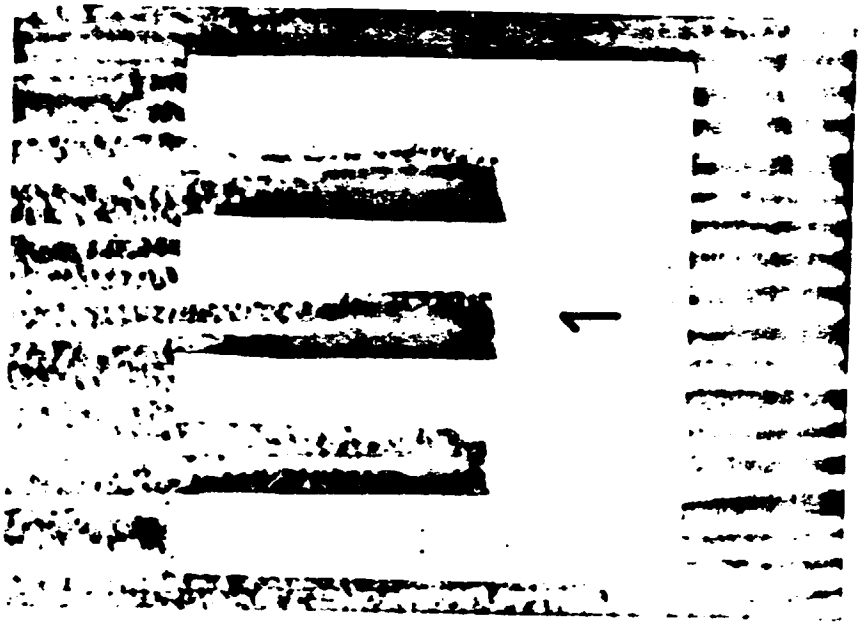
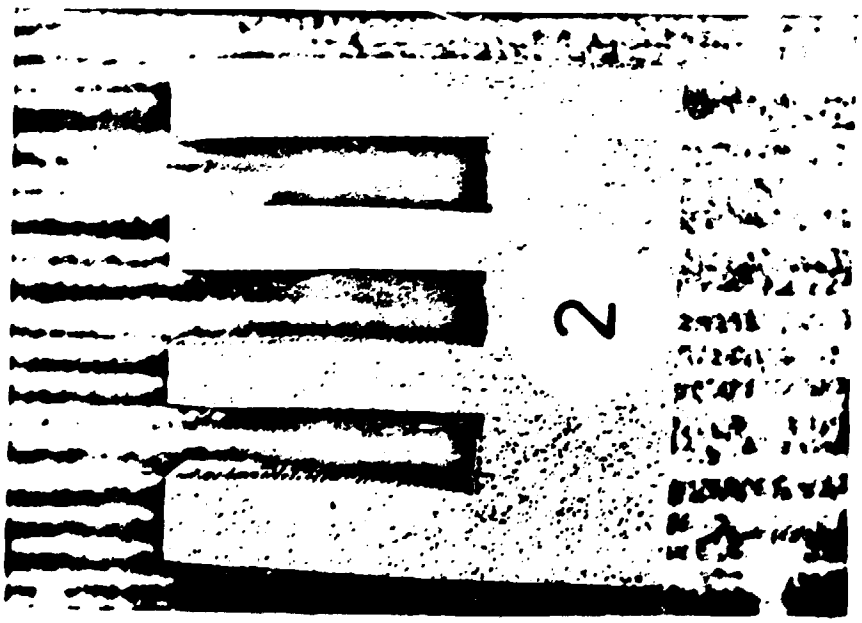


Fig.24.1.-Podocarpus imbricatus



ig.24.2.-Dipterocarpus alatus

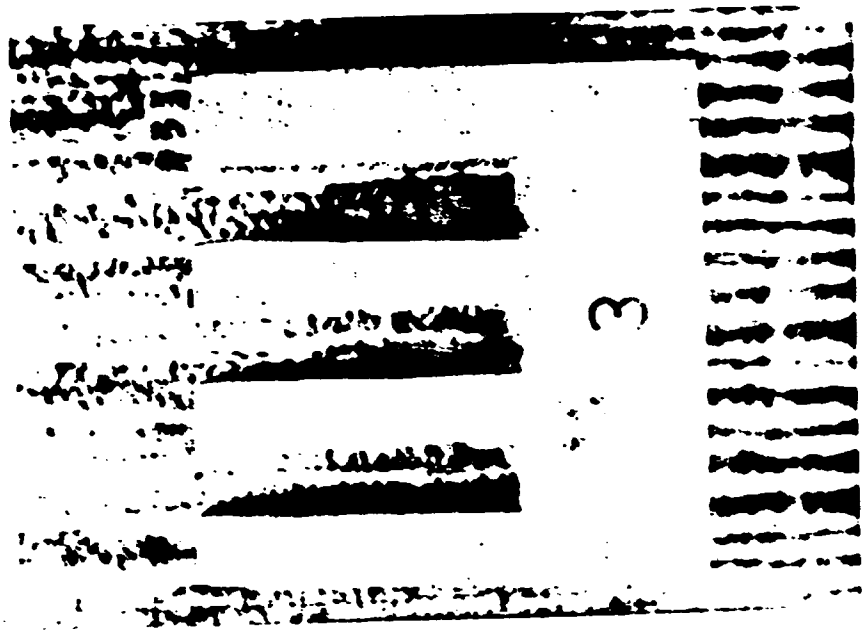


Fig.24.3.- Vatica sp.

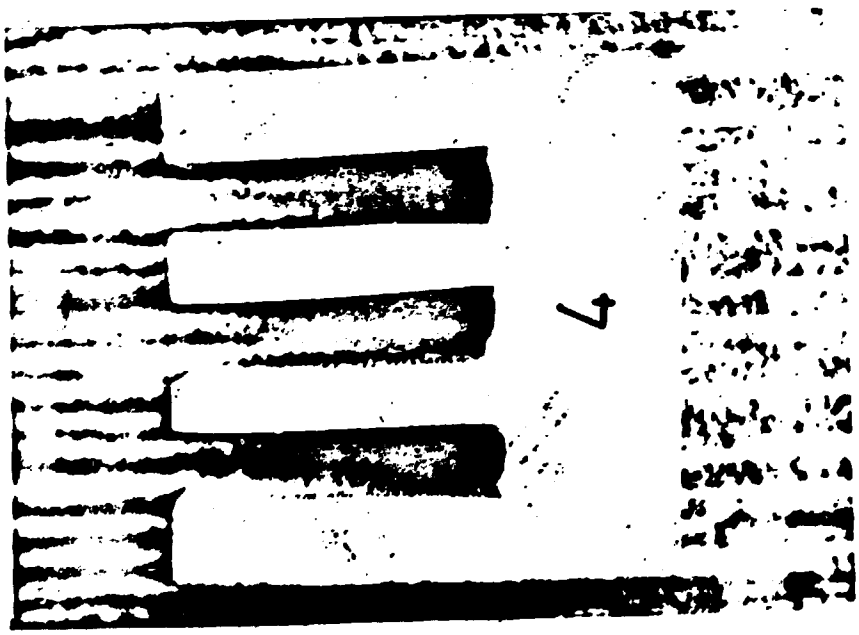


Fig.24.4. Lagerstroemia calyaclata

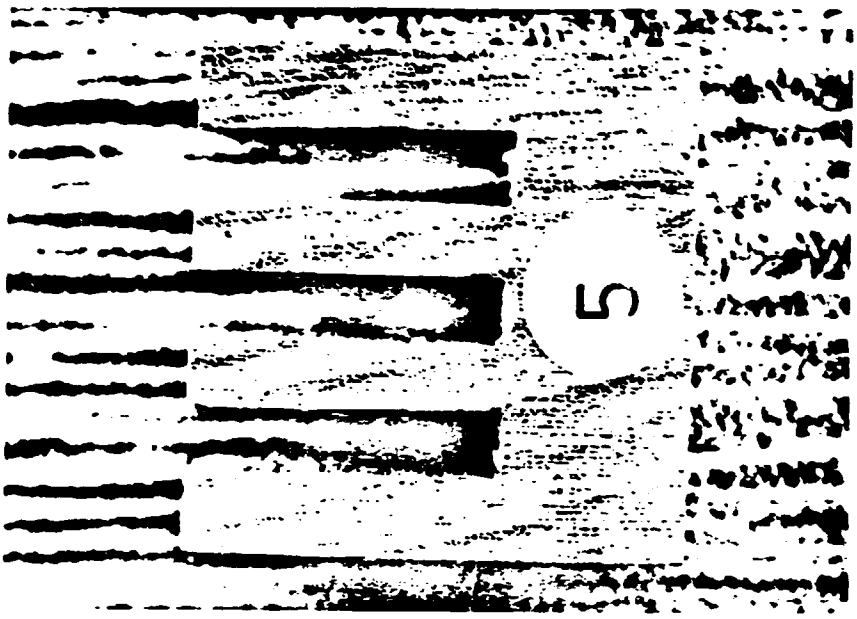


Fig.24.5.-Dialium cochinchinensis

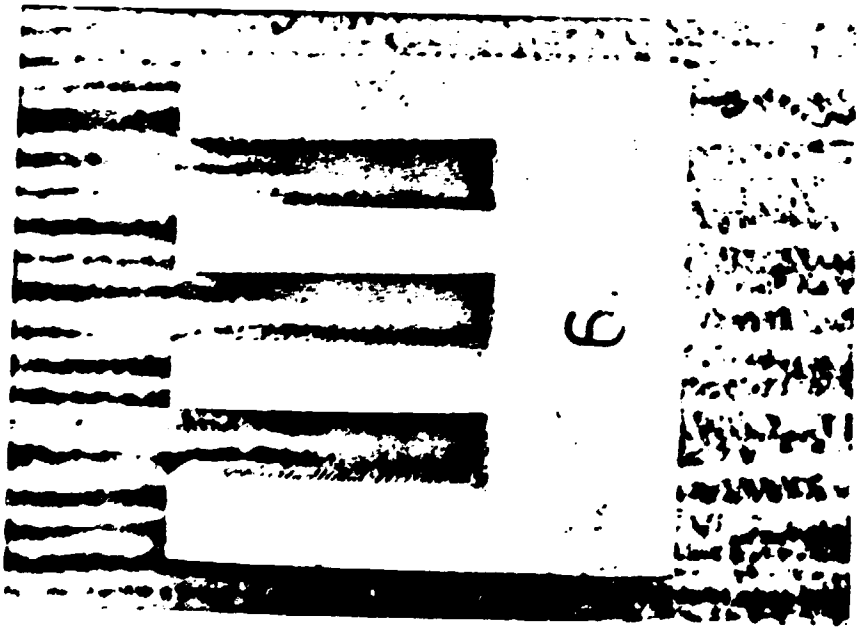


Fig.24.6.-Aglaia sp.

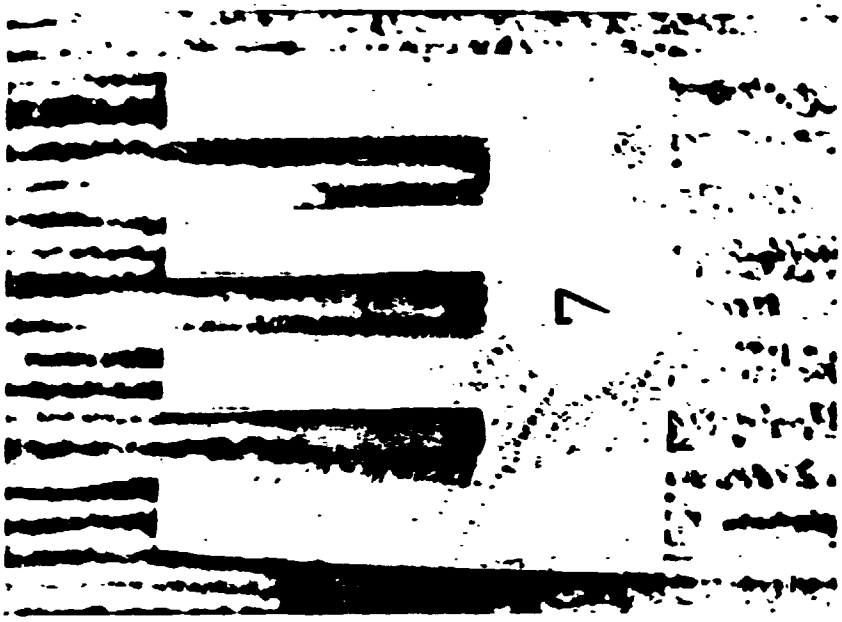


Fig.24.7.-Castanopsis tribuloides

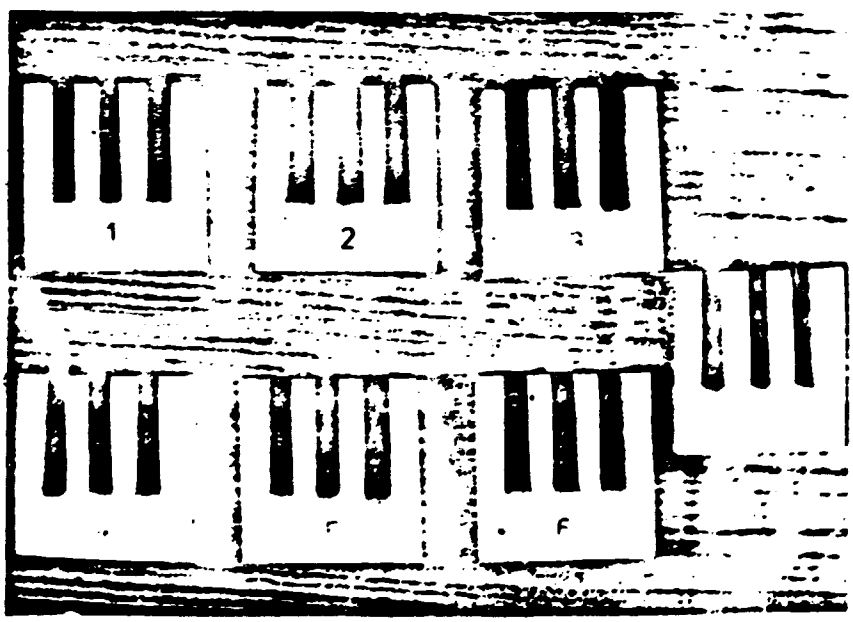


Fig.24.8.- Test pieces

TABLE 25 - DRYING CONDITION NO.1

Species	7.Podocarpus imbricatus DL				
Control	Specimen 1		Specimen 2		
Aver.initial MC	11.7%		12%		
Reproduction rate(e)	0.0643057		0.0629213		
Time (h)	Weight(g)	MC(%)	Weight(g)	MC(%)	
1	1725	11.79	1780	12.1	Drying proper easy and quick
24	1710	10.82	1763	10.96	
48	1688	9.38	1741	9.54	
64	1668	8.10	1721	8.28	

TABLE 26 - DRYING CONDITION NO.3

Species	1. Dipterocarpus alatus Roxb.				
Control	Sample 1		Sample 2		
Aver.initial MC	24.6		23.7		Gentle drying
Reproduction rate	0.0446434		0.0443515		due to resin
Time(h)	Weight(g)	MC(%)	Weight(g)	MC(%)	which sweat at
1	2791	24.6	2758	23.7	any temperature.
24	2742	22.4	2718	21.9	It is necessary
46	2715	21.2	2699	20.6	to check the
72	2691	19.7	2660	19.3	installation
96	2657	19.6	2631	18.[illegible]	after each
120	2639	17.8	2613	17.2	charge with re-
144	2618	16.9	2598	16.1	gard of airtight
168	2589	15.6	2562	14.9	ing and automa-
192	2569	14.7	2542	14.02	tic air control
216	2549	13.9	2531	13.5	systems.
240	2532	13.02	2515	12.9	
256	2522	12.6	2499	12.1	

NOTE : Index of reproduction rate $(e) = \frac{MC_1 + 100}{g^t}$

TABLE 27 - DRYING CONDITION NO.2

Species	5.Lagerstroemia calyaclata, Kurz				
Control	Sample 1		Sample 2		
Aver.initial MC	26%		26.5%		
Reproduction rate	0.0354729		0.0353056		
Time(h)	Weight(g)	MC(%)	Weight(g)	MC(%)	
1	3552	26.0	3593	26.5	Drying proper
24	3476	23.3	3495	23.5	with no diffi-
48	3419	21.3	3444	21.6	culty
72	3374	19.7	3402	20.1	
96	3327	18.0	3348	18.2	
120	3278	16.3	3308	16.8	
144	3233	14.7	3263	15.2	
168	3200	13.5	3226	13.9	
192	3166	12.3	3192	12.7	
215	3140	11.4	3161	11.6	

TABLE 28 - DRYING CONDITION NO.2

Species	2. Aglaia sp.				
Control	Sample 1		Sample 2		
Aver.initial MC	25.1%		23.6%		Drying proper
Reproduction rate	0.0339371		0.0396152		with no dif-
Time(h)	Weight(g)	MC(%)	Weight(g)	MC(%)	ficulty
1	3217	25.1	3120	23.6	
24	3160	22.9	3042	20.5	
48	3122	21.4	3006	19.03	
72	3070	19.4	2971	17.1	
96	3032	17.9	2935	16.3	
120	2996	16.5	2921	15.7	
144	2955	14.9	2980	14.1	
168	2924	13.7	2850	12.9	
192	2890	12.4	2928	12.03	
215	2867	11.5	2807	11.2	

TABLE 29 - DRYING CONDITION NO.4

Species		3. Vatica sp.		
Control		Specimen 1	Specimen 2	
Aver.initial °C		26.9%	27.1%	Very gentle drying because the brands to split
Reproduction rate		0.02577403	0.0242242	
Time(h)	Weight(g)	°C(%)	Weight(g)	°C(%)
1	4930	25.9	5120	27.1
24	4864	25.2	5089	26.3
48	4853	23.6	5027	24.3
72	4830	23.02	4999	24.1
96	4802	22.3	4949	22.9
120	4758	21.2	4915	22.01
144	4727	20.4	4882	21.2
168	4696	19.6	4846	20.3
192	4680	19.2	4818	19.6
216	4652	18.5	4782	18.7
240	4521	17.7	4757	18.1
264	4605	17.3	4725	17.3
288	4574	16.5	4697	16.6
312	4539	15.6	4673	16.01
336	4515	15.0	4647	15.3
360	4484	14.2	4612	14.5
384	4456	13.5	4575	13.6
408	4433	12.9	4552	13.01
436	4413	12.4	4540	12.7

Table 30 - DRYING CONDITION NO.4

Species	4. Dialium cochinchinensis Pierre				
Control	Specimen 1		Specimen 2		Very gentle drying because high density and existence of gommes and mineral substances
Aver.initial MC	24.5%		26%		
Reproduction rate	0.0336668		0.0336668		
Time(h)	Weight(g)	MC(%)	Weight(g)	MC(%)	
1	3698	24.5	3743	26.0	
24	3659	23.2	3707	24.8	
48	3645	22.7	3671	23.6	
72	3621	21.9	3650	22.9	
96	3585	20.7	3626	22.1	
120	3558	19.8	3585	20.7	
148	3541	19.2	3558	19.8	
168	3520	18.5	3538	19.1	
192	3493	17.6	3517	18.4	
216	3478	17.1	3499	17.8	
240	3460	16.5	3469	15.8	
264	3448	16.1	3454	16.3	
288	3434	15.6	3429	15.4	
312	3417	15.1	3413	14.9	
336	3395	14.3	3387	14.1	
360	3350	12.8	3368	13.4	
384	3342	12.5	3348	12.7	
408	3321	11.9	3327	12.0	
436	3300	11.4	3324	11.9	

TABLE 31 - DRYING CONDITION NO.4

Species		6. Castanopsis tribuloides ADC			
Control		Sample 1		Sample 2	
Aver.initial MC		24%		25%	
Reproduction rate		0.0276292		0.0277777	
Time(h)	Weight(g)	MC(%)	Weight(g)	MC(%)	
1	4488	24.0	4500	25.0	Very gentle
24	4426	22.3	4424	22.9	drying because
48	4383	21.1	4374	21.5	of high density
72	4361	20.5	4370	21.4	and trends of
96	4332	19.7	4309	19.7	split
120	4318	19.3	4298	19.4	
144	4310	19.1	4280	19.9	
168	4285	18.4	4259	18.3	
192	4260	17.7	4237	17.7	
214	4249	17.4	4223	17.3	
240	4224	16.7	4198	16.6	
264	4209	16.3	4184	16.2	
288	4189	15.7	4172	15.9	
312	4177	15.4	4159	15.5	
336	4165	15.1	4136	14.9	
360	4122	13.9	4122	14.5	
384	4093	13.1	4075	13.2	
408	4075	12.6	4050	12.5	
436	4055	12.0	4021	11.7	

From the tests and experiments it results that drying conditions considered herewith can be applied for the drying of the said Vietnamese wood species properly and without defects.

The dry wood pieces have registered a dimensional variation when remained in either drier or more humid environments but these are below the permissible tolerances (under 1.5 mm).

The drying conditions elaborated and experiences in laboratory conditions must be tested in production, in the drying plants, and with large quantities of materials corresponding to loading capacity of driers since some differences may appear between the results obtained in production and pilot plant conditions regarding the effective drying time and the drying qualities, as much as the wood material may have structural characteristics differing from the materials received as samples.

For proper application of drying conditions the following steps are necessary:

a. utilization (preferably) of automatic air control systems in the driers,

b. organization of a laboratory properly equipped.

The dimensional variation of wood pieces can be reduced by observing the following steps:

a. drying can be applied down to 10% final moisture content,

b. dry pieces must be stored in closed spaces with temperature and relative air humidity corresponding to equilibrium moisture of wood determined in relation with the climatic conditions where the product is to be used.

5.2. Conditioning of the dry wood pieces

The behaviour of the wood species mentioned in this report under the climatic conditions specific to Viet Nam (rain and dry season) has been experimented in a climatic chamber where the respective conditions have been simulated.

The first condition has been experimented at air temperatures lying between 38°C and 26°C and 90% relative air humidity for a period of 168 hours. The second condition has been experimented at 36°C temperature and 30% relative air humidity for a period of 168 hours. The results of these experiments are given in the tables 32 and 32.1.

TABLE 32 - CLIMATISATION UNDER HUMID CONDITIONS (A)

Temperature T o1 = 36°C
T o2 = 26°C Relative air humidity = 90%

Wood species	INITIAL PARAMETERS				FINAL PARAMETERS/DIFFERENCES						Remark
	Weight g	Size and volume cm^3	Volume weight g/cm^3	Moisture content %	Weight g	Size and volume cm^3	Volume weight g/cm^3	Moisture content %	MC %	Weight	
Dipterocarpus alatus Roxb.	117.5	6.05x4.05x6.05= =148.24	0.793	12.2	127.9	6.23x4.07x6.28= =159.24	0.803	22.03	9.83	10.3	Surface exudati due to gomorez
Aglaia sp.	90.9	6.03x4.03x6.04= =146.59	0.611	9.5	104.7	6.33x4.08x6.32= =160.64	0.652	26.26	16.76	13.9	Behaves well
Vatica sp.	133.9	6.00x4.07x6.05= =147.74	0.906	12.1	146.0	6.20x4.07x6.32= =159.43	0.915	22.32	10.22	12.2	Fine sp on pith rays c
Dialium cochin chinensis Pierre	136.5	6.05x4.07x6.04= =148.73	0.918	10.5	143.6	6.17x4.07x6.28= =157.70	0.942	20.29	9.79	12.1	Slight formati of the cross s tion
Lagerstroemia calyculata Kurz	102.0	6.03x4.05x6.01= =146.77	0.695	11.3	115.6	6.19x4.05x6.15= =153.93	0.751	26.13	14.83	13.6	Behaves well
Castanopsis tribuloidesADC	116.1	6.05x4.10x6.04= =149.92	0.774	12.3	130.5	6.34x4.10x6.23= =159.24	0.819	25.26	12.96	13.4	Behaves well
Podocarpus imbricatus Bl	63.0	6.03x4.03x6.05= =145.03	0.433	8.1	74.3	6.15x4.00x6.40= =157.69	0.471	27.49	19.38	11.3	Fine sp on pith rays

TABLE 32.1. - B. CLIMATIZATION UNDER DRY CONDITIONS AT A TEMPERATURE
To = 36°C AND RELATIVE HUMIDITY = 30%

Wood species	INITIAL PARAMETERS										Remarks
	Weight g	Size and volume m^3	Volume weight g/cm^3	Moisture content %	Weight g	Size and volume m^3	Volume weight g/cm^3	Moisture content %	Dif. M.C. %	Dif. weight g	
Dipterocarpus alatus Roxb.	120.5	6.05x4.15x6.05= =151.90	0.793	12.2	114.3	5.94x4.15x5.96= =146.92	0.778	6.42	5.78	6.2	Surface exudation due to gummyresines
Aglaia sp.	92.2	6.04x4.11x6.05= =152.15	0.606	9.5	88.9	5.98x4.10x6.00= =147.11	0.604	5.58	3.92	3.3	Behaves well
Vatica sp.	135.0	6.04x4.08x6.02= =148.35	0.910	12.1	129.1	5.94x4.08x5.93= =143.71	0.898	7.20	4.90	5.9	Fine splits on pith rays
Dialium cochinchinensis Pierre	144.8	6.02x4.18x6.02= =151.48	0.956	10.5	137.5	5.93x4.17x5.90= =145.89	0.942	4.92	5.58	7.3	Fine splits on pith rays
Lagerstroemia calyculata Kurz	106.0	6.05x4.17x6.02= =151.88	0.698	11.3	103.6	6.00x4.17x5.98= =149.62	0.690	8.78	2.52	2.4	Fine splits on pith rays
Castanopsis tribuloidesADC	118.0	6.04x4.12x6.01= =149.56	0.789	12.3	111.0	5.92x4.11x5.88= =144.11	0.770	5.63	6.67	7.0	Behaves well
Podocarpus imbricatus Bl	65.3	6.05x4.14x6.07= =152.04	0.430	8.1	62.6	6.01x4.13x6.00= =148.93	0.420	3.63	4.47	2.7	Behaves well

The wood scantling that remained in the chamber, in a warm-humid-environment (see conditions A), have increased in weight by 8.7 to 17.9% compared with their initial weight, respectively, the increasement of moisture content by 9.8 to 19.4 depending on wood species (see table 33).

Table 33 - INDICES FOR INCREASE OF MOISTURE CONTENT AND WEIGHT

Crt. no.	Species	Increase in MC(%)	Increase in weight(%)
1.	Dipterocarpus	9.33	8.7
2.	Aglaia	16.76	15.3
3.	Vatica	10.22	9.1
4.	Dialium	9.79	8.8
5.	Lagerstroemia	14.83	13.3
6.	Castanopsis	12.16	11.5
7.	Podocarpus	19.38	17.9

The wood scantling that remained in the chamber in a warm-dry environment (see conditions B) have decreased in moisture content by 2.5 to 6.7% concomittent with the decrease in weight of 2.2 to 5.9% compared with their initial weight, depending on wood species, as can be seen in table 33.1.

Table 33.1. - INDICES FOR DECREASE OF MOISTURE CONTENT AND WEIGHT

Crt. no.	Species	Decrease in MC(%)	Decrease in weight(%)
1.	Dipterocarpus	5.73	5.1
2.	Aglaia	3.92	3.5
3.	Vatica	4.9	4.3
4.	Dialium	5.33	5.0
5.	Lagerstroemia	2.52	2.2
6.	Castanopsis	6.67	5.9
7.	Podocarpus	4.47	4.1

The above mentioned indices show that the species Podocarpus imbricatus and Aglaia sp. presented the most variation of the moisture content and weight.

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CHAPTER III

THE TECHNICAL REPORT

6. Methods of improving of the wood for production of shuttles and wood accessories

6.1. Densification by pressing
6.2. Improving the wood characteristics by densification
6.3. Wood impregnation

Code 86/37/RK

6. METHOD OF IMPROVING THE WOOD FOR PRODUCTION OF SHUTTLES AND WOOD ACCESSORIES

6.1. Densification by pressing

To improve the physical and mechanical characteristics of the wood scantlings were densified by hot pressing, taking into consideration a specific working time for each species.

The volume weight of the wood material was estimated so as to be about 0.900 g/cm^3 for wood species having a density ranging between 0.500 and 0.700 g/cm^3 and about 1.100 g/cm^3 for species having a density over 0.800 g/cm^3.

Figures 25 to 30 and tables 34 to 39 show the initial and final dimensions and the density, moisture content and pressing diagrams for the six wood species from Vietnam. The wood species Dialium cochinchinensis was not densified as unnecessary.

The volume weight (ρ) is established according to the formula :

$$\rho = \frac{m_n}{v_n} \quad (g/cm^3)$$

where:

m_n = the weight of the scantling, in g at a specific moisture content

v_n = volume of scantling, in cm^3 at a specific moisture content

The final thickness (after densification) of the scantling was about 42 mm, corresponding to that needed to produce the shuttles.

For the estimation of the initial thickness (h_i) of the scantlings, from which the final thickness of 42 mm and the required density shall result, the following formula is utilized :

$$h_{\rho i} = \frac{\rho_f \times h_{\rho f}}{\rho_i} \quad (mm)$$

where:

ρ_i = initial volume weight of wood, in g/cm^3.

ρ_f = final volume weight of wood, in g/cm^3

h = final thickness of scantling, mm

Wood densification was carried out in a laboratory single daylight press with the dimensions of heating plates of 500 x 500 mm.

The density of the scantlings of the wood species to be densified was previously determined. The initial thickness was estimated depending on this density.

Then scantlings were put together in a device - metallic framework (see figure 31) and introduced into the press.

The framework prevents the side deformations of scantlings; the wood is densified only in the thickness direction. The thickness of the framework has to be less by 1 mm than the final thickness.

When feeding the press, the temperature of the heating plates was about 120°C.

After press closed and pressure rose up to about 30 daN/cm^2, the temperature was gradually raised up to about 140°C.

Scantlings were heated at a constant pressure for about 30 minutes, then the pressure was raised up to 70 to 90 daN/cm^2 and was maintained for about 60 minutes till the wood pieces reached the final thickness. At this moment the pressure was reduced down to 20-30 daN/cm^2 and the heating of plates was stopped.

The test was followed by a period of cooling under pressure of the densified scantlings, respectively air cooling in this case; the wood pieces were kept in the press for about 10 hours (till the next day).

The pressing diagram varies depending on the density and moisture content of scantlings.

Pressures are established according to the formula:

$$p_m = \frac{S_p + p_p}{S_c} \quad (daN/cm^2)$$

where:

p_m = pressure at the pressure gauge of the press, (daN/cm^2)

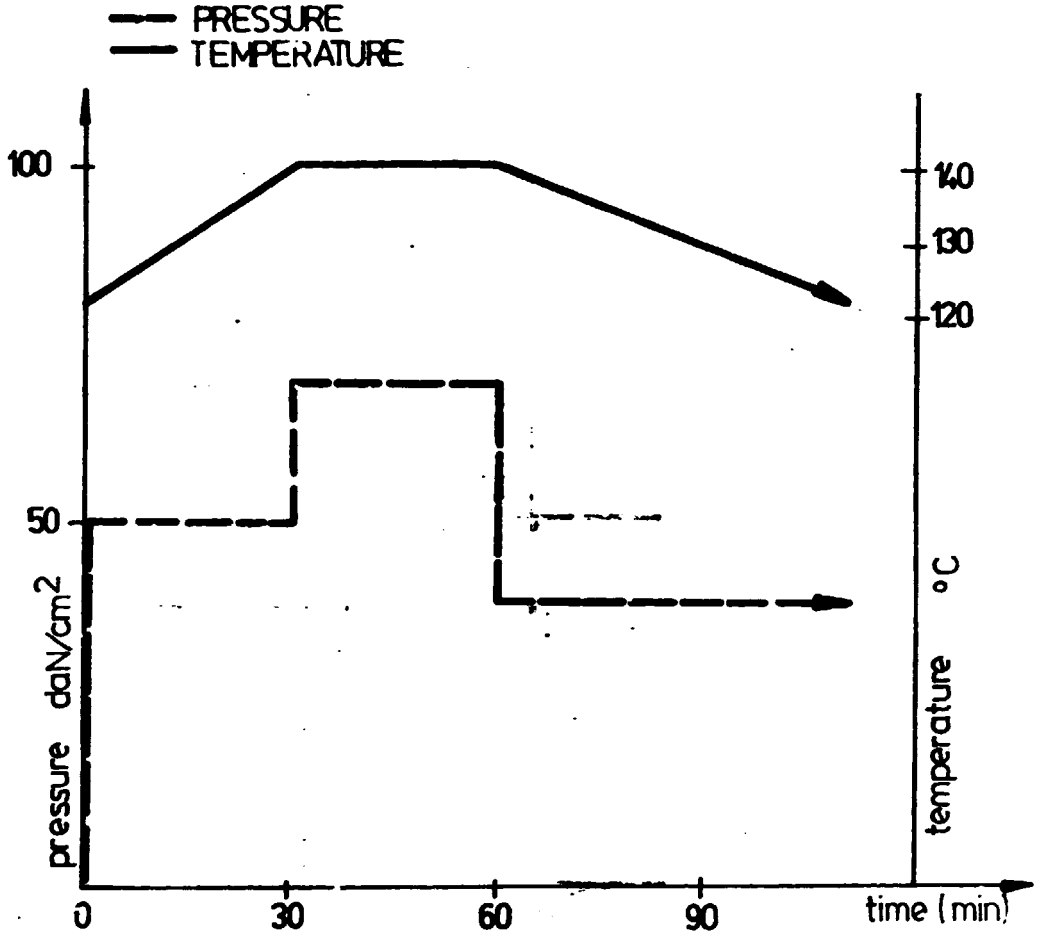
p_p = pressure onto wood pieces, daN/cm^2

S_p = total surface of wood pieces, cm^2

S_c = surface of press cylinders, cm^2

WOOD SPECIES: DIPTEROCARPUS ALATUS ROXB.
MOISTURE CONTENT: 13 %

PRESSURE DIAGRAM Fig. 25



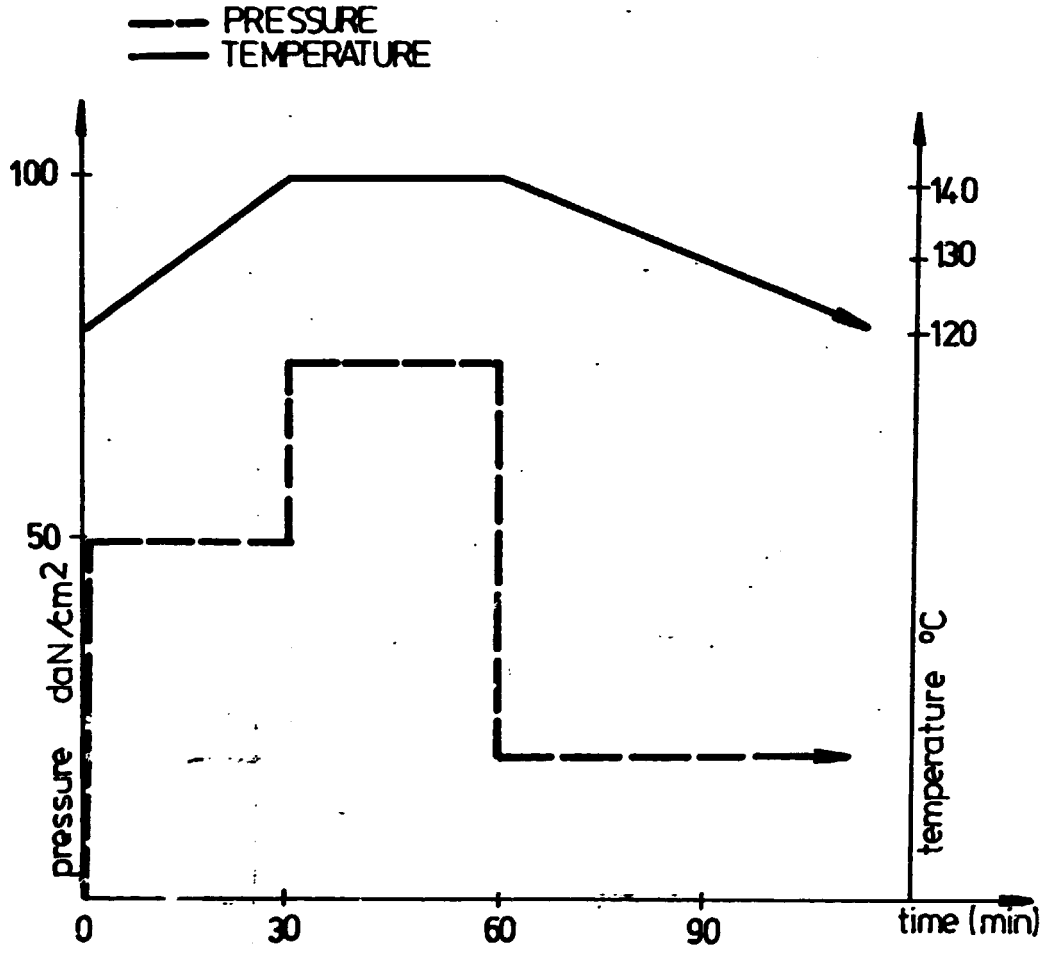
DIMENSIONS AND VOLUME WEIGHT

Table 34

	Dimensions (mm)			Volume weight g/cm3
	length	width	thickness	
INITIAL	498	68,5	57,0	0,916
FINAL	498	69,6	42,8	1,167

WOOD SPECIES : AGLAIA SP.
MOISTURE CONTENT: 10,5 %

PRESSURE DIAGRAM Fig. 26



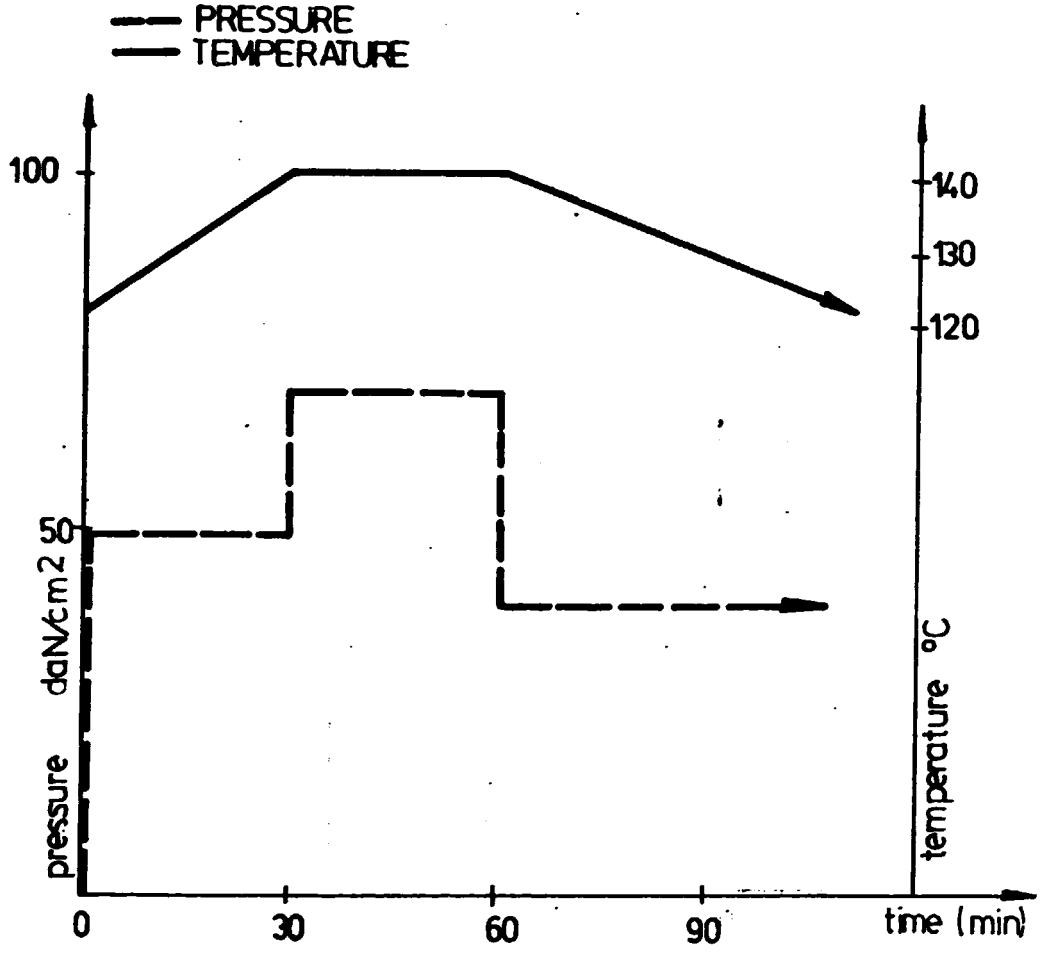
DIMENSIONS AND VOLUME WEIGHT

Table 35

	Dimensions (mm)			Volume weight g/cm3
	length	width	thickness	
INITIAL	499	70,7	64,0	0,590
FINAL	500	70,3	43,4	0,864

WOOD SPECIES: VATICA SP.
MOISTURE CONTENT: 13%

PRESSURE DIAGRAM Fig. 27



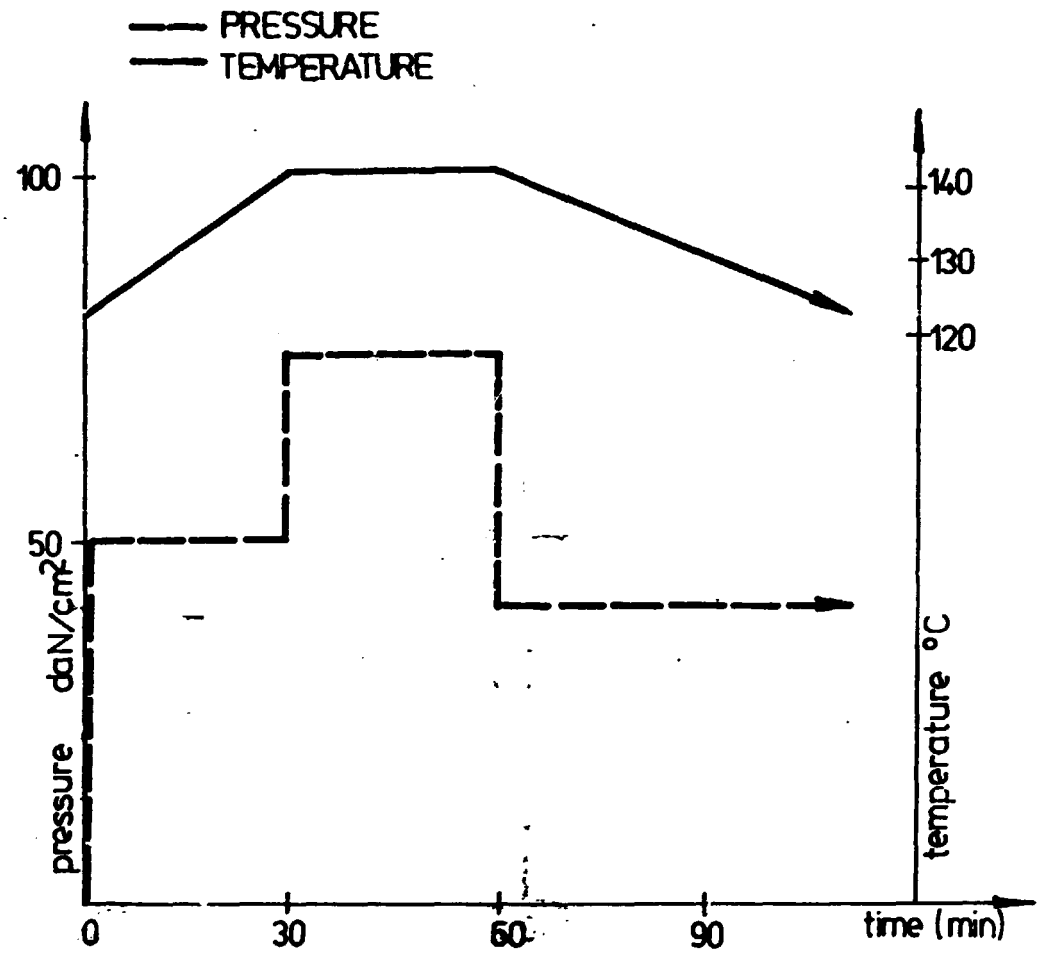
DIMENSIONS AND VOLUME WEIGHT

Table 36

	Dimensions (mm)			Volume weight g/cm3
	length	width	thickness	
INITIAL	497	66,5	57,0	0,906
FINAL	496	67,9	42,8	1,178

WOOD SPECIES : LAGERSTROEMIA CALYACLATA KURZ
MOISTURE CONTENT : 9%

PRESSURE DIAGRAM Fig. 28



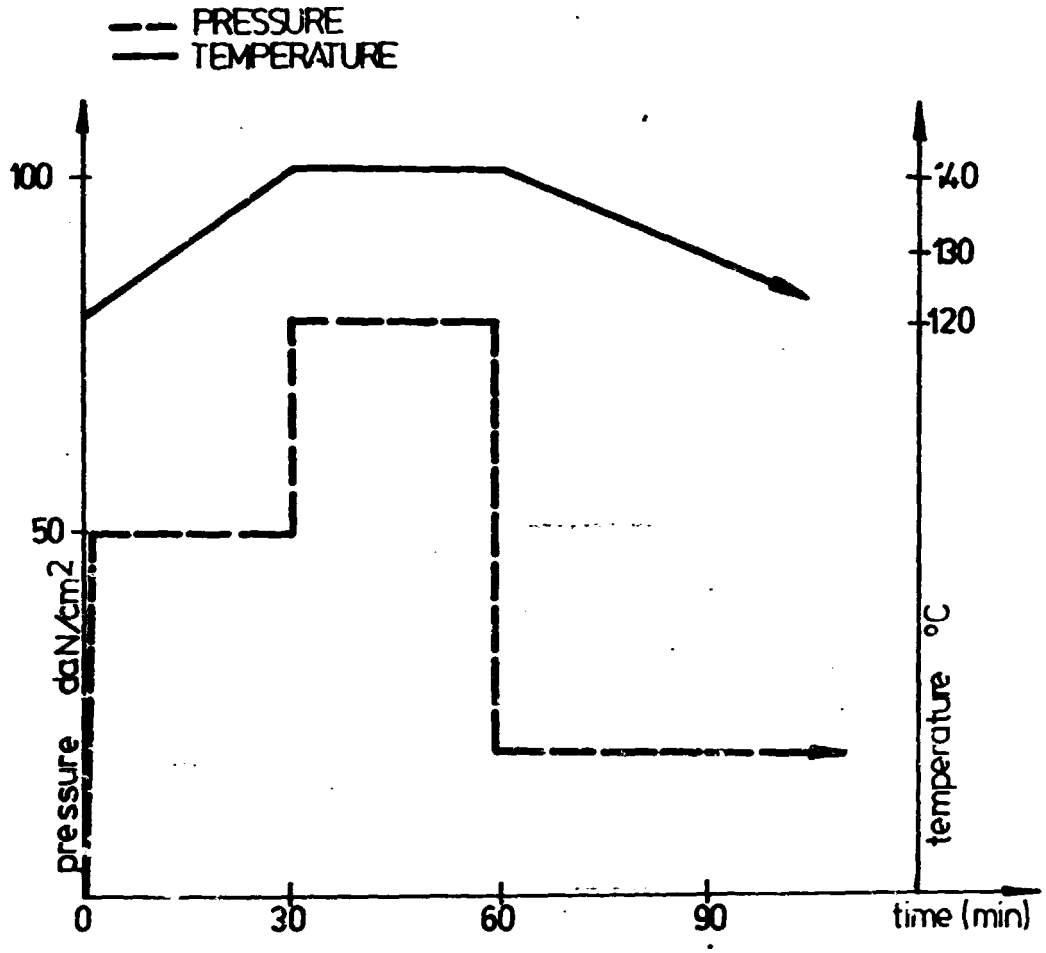
DIMENSIONS AND VOLUME WEIGHT

Table 37

	Dimensions (mm)			Volume weight g/cm³
	length	width	thickness	
INITIAL	498	69,4	57,0	0,676
FINAL	498	70,5	43,4	0,865

WOOD SPECIES: CASTANOPSIS TRIBULOIDES A. DC.
MOISTURE CONTENT: 13%

PRESSURE DIAGRAM Fig. 29.



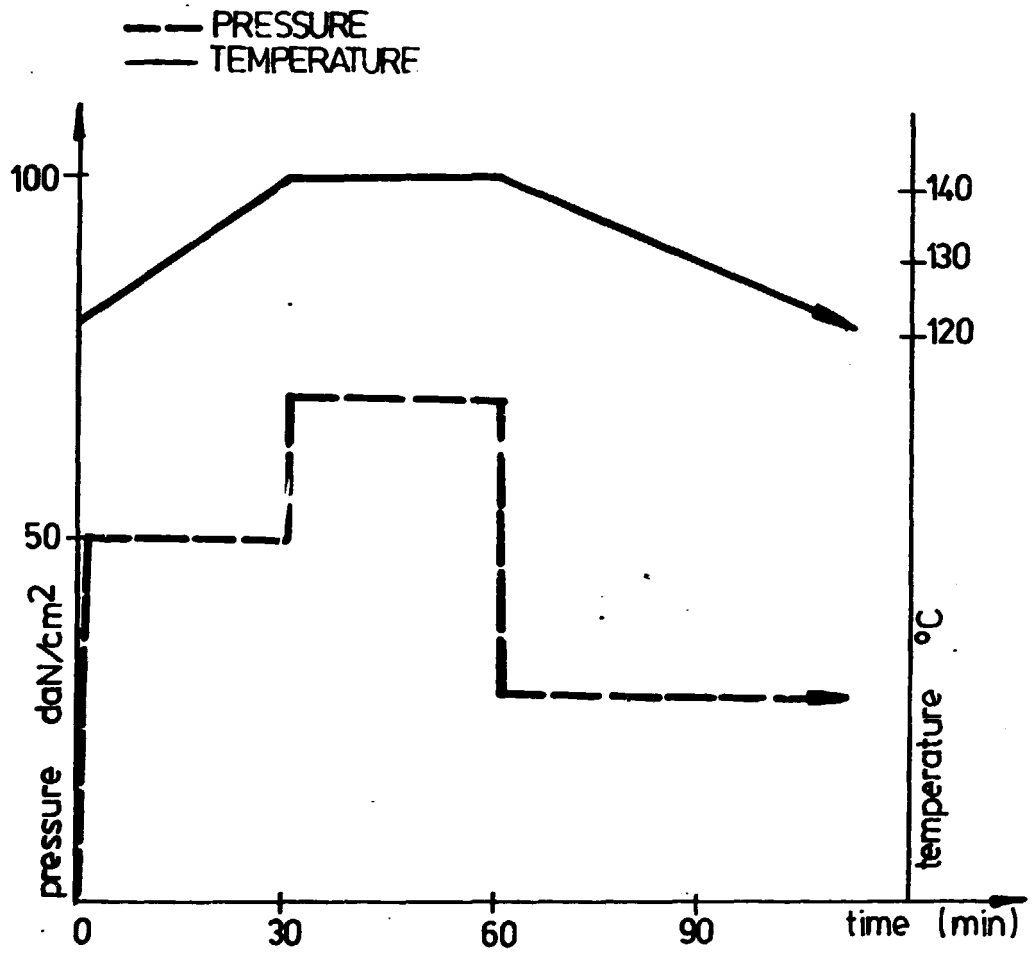
DIMENSIONS AND VOLUME WEIGHT

Table 38

	Dimensions (mm)			Volume weight g/cm3
	length	width	thickness	
INITIAL	498	69,4	74,6	0,584
FINAL	498	707	43,5	0,937

WOOD SPECIES: PODOCARPUS IMBRICATUS BL.
MOISTURE CONTENT: 7%

PRESSURE DIAGRAM Fig. 30

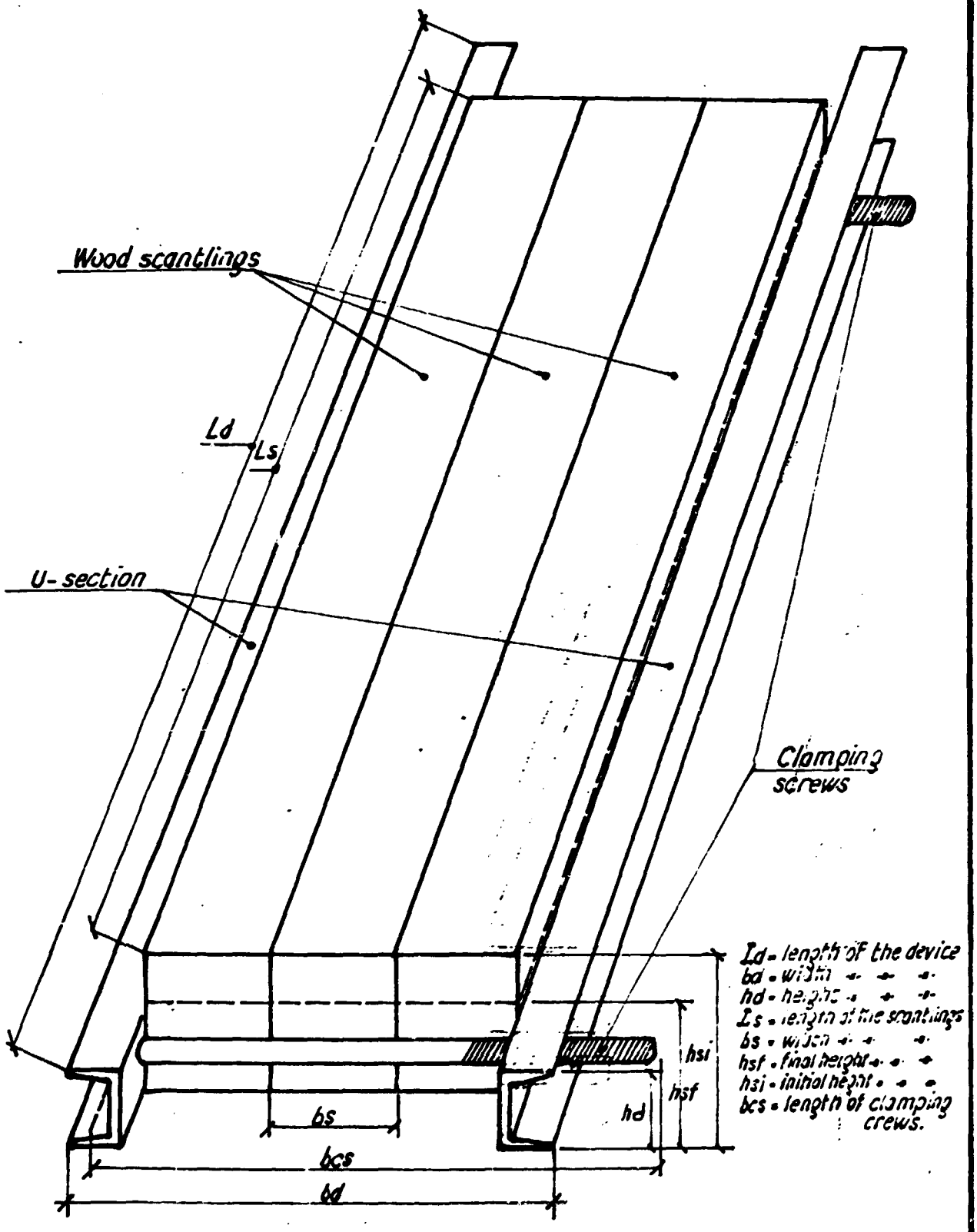


DIMENSIONS AND VOLUME WEIGHT

Table 39.

	Dimensions (mm)			Volume weight g/cm3
	length	width	thickness	
INITIAL	497	68,0	86,0	0,450
FINAL	497	71,5	43,5	0,870

Fig. 31. DEVICE FOR CLAMPING WOOD SCANTLINGS TO BE DENSIFIED



$hd = hsf - 2\ mm$
$Ld = Ls + 100\ mm.$
$bc.s = n.ls + 50\ mm.$
$bd = n.ls + 2U$

6.2. Improving the wood characteristics by densification

The following tests have been performed to check the characteristics of the species, after the densification.

- determination of volume weight,
- determination of resistance to static bending,
- determination of splitting resistance,
- determination of resilience to impact bending.

The analysis of microscopic aspect of test pieces has been also performed (see figures 32.1 to 32.4) notations:

- Dipterocarpus : slight pressing of fibrous tissue.
- Vatica: very slight deformation of tissue.
- Castanopsis: slight deformation of tissue.
- Lagerstroemia: deformation and pressing of tissue in isle shape, the rest of tissue, normally structured.
- Aglaia : deformation of tissue, including a slight waving of radius and a slight flattening and crushing of vessels; tissue unmodified.
- Podocarpus: deformation of the most part of cells, some of them being separated from the surrounding ones; the tissue broken along the radius.

Concerning the results of tests regarding some physical-mechanical and elasticity characteristics of wood as it shown in tables 40 and 41, we notice:

- Dipterocarpus and Vatica: after a 23% increase in weight, the bending resistance was increased by 50% and the splitting resistance between 170 and 200%.
- Aglaia and Lagerstroemia: after a 30-33% increase in weight the bending resistance was increased by 42-50% and the splitting resistance between 224 and 333%.
- Important upgrading can be noticed as well as for Podocarpus but the basic level being rather low compared with the other ones, the improved characteristics are not to take into consideration.

Fig.32.1 [illegible]

Cross section before and after [illegible]

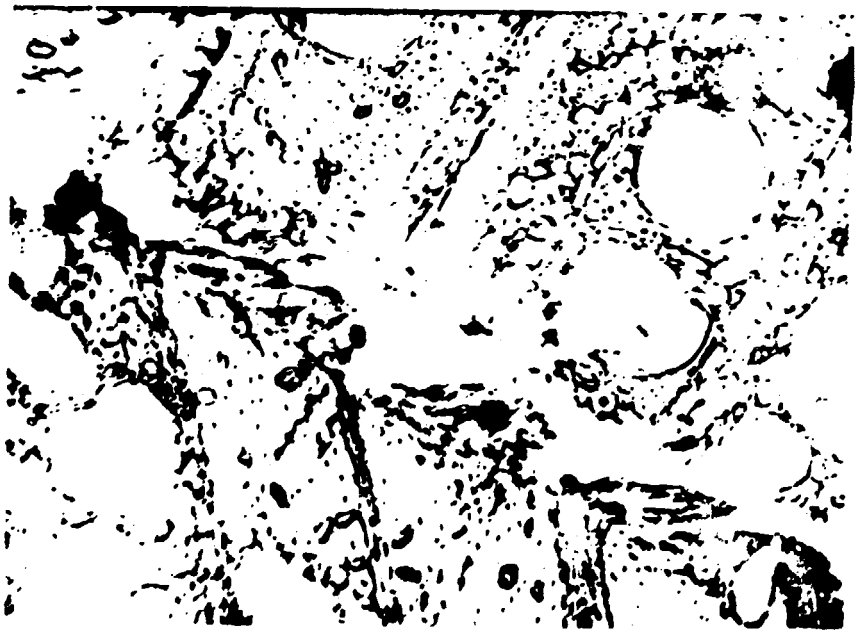


Fig.32.2 [illegible]

Cross section before and after [illegible]

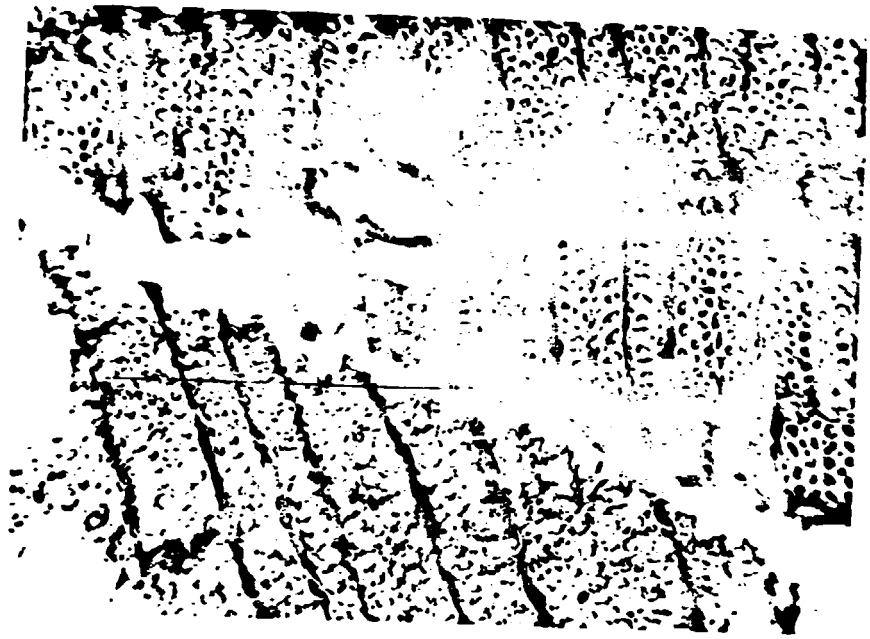


Fig. 32.3 [illegible]

Cross section before and after [illegible]

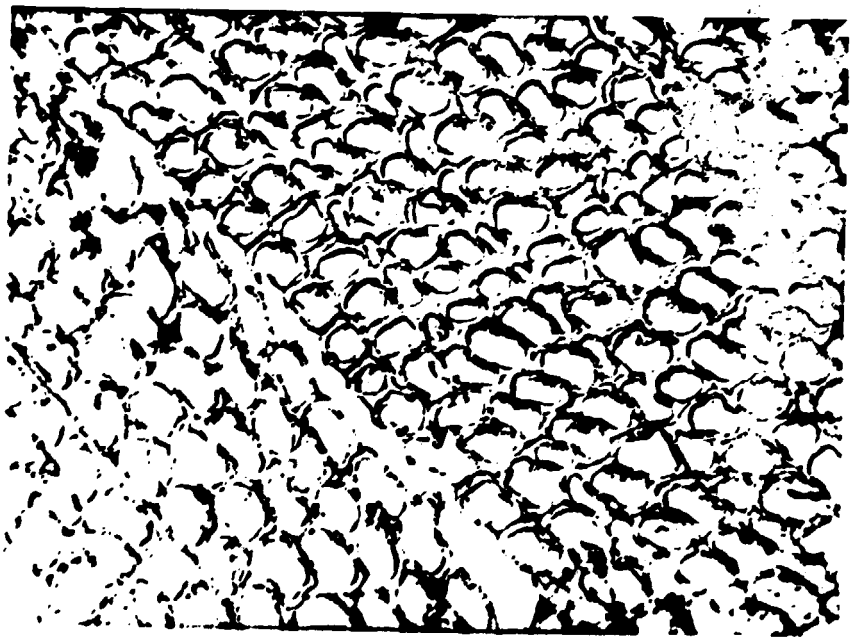


Fig. 32.4 **Podocarpus** [illegible]

Cross section before and after [illegible]

TABLE 12 [illegible]

Wood species	Volume weight kg/m³: Wood (W) min.	max.	mean	Densified wood (DW) min.	max.	mean	Static bending strength MPa: Wood (W) min.	max.	mean	Densified wood (DW) min.	max.	mean	Impact bending resilience J/mm²: Wood (W) min.	max.	mean	Densified wood (DW) min.	mean	max.
Podocarpus imbricarus -LD/LS	347	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	77.7	[illegible]	[illegible]	121.8	13?.?	[illegible]	[illegible]	[illegible]	0.028	0.039	0.0[illegible]
			17?.?						17?.?						193.3			
Dipterocarpus alatus Roxb. LD/LS	75?	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	11?.7	[illegible]	[illegible]	17?.?	[illegible]	[illegible]	[illegible]	[illegible]	0.104	0.131	0.1[illegible]
			1?1.?						15?.?						13?.1			
Aglaia sp. -LD/LS	531	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	11?.?	[illegible]	[illegible]	17?.1	1?4.?	[illegible]	[illegible]	[illegible]	0.062	0.071	0.0[illegible]
			1??.?						14?.?						?1.?			
Vatica sp. -LD/LS	74?	?21	[illegible]	[illegible]	1127	[illegible]	[illegible]	154.8	1?2.7	[illegible]	?27.5	274.7	0.07?	0.114	0.179	0.051	0.090	0.1[illegible]
			131.7						1??.?						78.?			
Lagerstroemia Calyculata Kurz -LD/LS	5??	75?	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1?3.1	[illegible]	187.5	?07.?	[illegible]	[illegible]	[illegible]	0.062	0.076	0.0[illegible]
			[illegible]						1??.?						1??.2			
Canthaceae? trifoliata? -LD/LS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	177.7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.067	0.0[illegible]
			[illegible]						[illegible]						[illegible]			

Wood species	Radial shrinkage (%)				Tangential shrinkage (%)				Volumetric shrinkage (%)				Basic density of dried wood (kg/m³)
	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	
Podocarpus imbricatus Bl. -LD/LS	1.33	1.33	0.37	0.48	2.33	1.00	0.17	1.33	0.30	0.36	0.50	1.25	372.1
Dinterocarpus alatus Vesq. -LD/LS	0.34	0.46	0.57	1.10	1.33	1.54	0.30	0.50	0.63	0.88	1.14	1.35	330.0
Aglaia sp. -LD/LS	0.33	0.36	0.42	0.75	1.33	1.77	0.30	0.40	0.52	0.74	1.29	1.62	322.5
Vatica sp. -LD/LS	0.50	0.88	1.07	0.72	1.63	2.04	0.20	1.07	1.21	1.19	1.85	2.57	172.8
Lagerstroemia calyculata Kurz -LD/LS	0.41	0.55	0.73	1.15	1.67	2.35	0.45	0.57	0.73	1.08	1.97	2.59	345.6
Castanopsis tribuloides A.DC -LD/LS	0.17	1.34	1.38	1.14	1.83	1.55	0.03	1.33	1.33	0.07	1.25	1.53	105.0

6.3. Wood impregnation

Improving the characteristics of the wood material can be also obtained by impregnation, reducing the shrinkage and swelling level by using certain methods:

- impregnation by immersion at atmospheric pressure in hot or cold baths,
- vacuum impregnation at atmospheric pressure,
- vacuum and pressure impregnation.

Due to the low cost of necessary equipment the first method has been selected - impregnation by immersion at atmospheric pressure in a hot bath.

This treatment assures a hygroscopic stability and an improvement of wear resistance, due to the increase of the slipping coefficient.

The tests were intended to establish the impregnation capacity and the absorption of oil solution for each species, after densification, in comparison with those obtained for densified hornbeam (Carpinus betulus).

6.3.1. Raw material and auxiliary materials used for tests.

Test pieces of densified wood from two species and hornbeam having 70 mm x 90 mm x 40 mm (abt.2 dm^3 volume and a side surface of 2 dm^2).

Linseed oil having :

- Engler viscosity at 20°C of 6.3 - 7.1.
- Index of refraction : 1.479 - 1.481
- Density at 15° = 0.930 - 0.935
- Freezing point = -18° to -27°C
- Saponification index= 187 - 197
- Iodine coefficient = 169 - 192

Linseed oil contains linolic acid (25-70%), linolaic acid (15 - 55%), oleo acid (15 - 25%), palmitic acid stearic (abt. 10).

- White spirit, having :
  - flamability point, Abel Pensch = 32 - 52°C
  - 0.15 - 1.7(-0.36 depending on aroma oil content

White spirit contains normal paraffine hydrocarbons, especially isoparaffin hydrocarbons, with molar weight between C9 and C 12, mixed with naphthenes and altilnaphthenes.

For impregnation, a mixture of linseed oil and white spirit (1:1 volume) having a flowing time in a Ford cup (for viscosity determination) with openings of 4 mm diameter of 15.5 sec.

6.3.2. The equipment and apparatus used for the test were :

- impregnation vat for laboratory of 320 x 90 x x 90 mm of stainless steel sheet (I.C.r 18),
- enclosed electric plate,
- laboratory thermometer,
- Ford cup with 4 mm openings,
- semiautomatic technical balance 1 g accuracy weighing,
- semiautomatic technical balance 0.1 g accuracy weighing,
- other measuring instruments.

6.3.3. Working method

The test pieces were weighed, measured, establishing the outer surface and the volume of each test piece.

The mixture of linseed oil and white spirit having the appropriate viscosity was heated up to 60 ± 2°C.

The temperature was kept constant during 20 min. while the test pieces were immersed in the bath. After 20 min. the test pieces were taken out to allow the evaporation of surplus solution.

Then the test pieces were weighed, establishing the absorption and adsorption levels/m^3 and /m^2 which were :

Volume weight kg/m^3	R 1100	V 1500	DA 1230	D 1130	C 1305	L [illegible]	A 535	P 710
Solution absorption kg/m^3	R 10.37	V 4.735	DA 3.030	D 4.930	C 4.720	L 7.375	A 4.165	P 50.10
Solution adsorption kg/m^2	R 96.6	V 44.1	DA 29.0	D 46.1	C 44.0	L 68.7	A 41.4	P 600.1

where :

- DA - Dipterocarpus alatus,
- A - Aglaia sp.
- V - Vatica sp.
- D - Dialium
- L - Lagerstroemia
- P - Podocarpus
- H - Carpinus betulus

RESULTS :

After the tests, the following results were established :

- Test pieces used for tests had a volume between 0.188 ans 0.192 dm^3, a total surface between 2.03 and 2.08 dm^2 and a weight between 128.3 and 250 g.

- Apparent volume weight between 0.635 kg/dm^3 and 1.332 kg/dm^3, the lowest density being recorded for Podocarpus imbricatus and the highest for Vatica.

Average solution absorption was between 4.2 and 5.2 kg/m^3 for Aglaia, Vatica, Castanopsis and Dialium, similar as impregnation capacity, between 6.2 and 7.2 kg/m^3 for Lagerstroemia very near to the values for hornbeam and between 47 and 55 kg/m^3 for Podocarpus, 5 times more than those for hornbeam.

- The lowest average solution absorption was recorded for Dipterocarpus between 2.6 and 3.6 kg/m^2, due to the high resin content.

- Average solution absorption ranged between 40 and 50 g/m^2 for Aglaia, Vatica, Castanopsis and Dialium, a half of adsorption value for hornbeam and 60 and 70 g/m^2 for Lagerstroemia near to this one for hornbeam. For Podocarpus there are recorded high adsorption values: 500-700 g/m^2.

For Dipterocarpus an average solution absorption of 24.2 - 33.7 g/m^2 (the lowest) has been recorded.

- The tests have been performed on plained surface. The shuttles having profiled surfaces, it is necessary to take into consideration a double amount of impregnation solution.

According to the results obtained, the lower absorption and the adsorption capacity values in comparison with those for hornbeam is justified by the Vietnamese woods

structure which contain to a large or little extent various gummy resines substances.

This characteristic can be slightly improved by preheating the wood before its immersion in the bath or by increasing the immersion time.

The vacuum or pressure impregnation methods have not been used because the advantages obtained do not justify the high cost of the necessary equipment.

Besides the high cost of the equipment, the impregnation process involves also synthesis materials, which have to be imported, which are more expensive than an eventually imported shuttles.

CHAPTER III

THE TECHNICAL REPORT

7. WORKABILITY OF VIETNAMESE WOOD SPECIES

7.1. General

7.1.1. The tests required for the demonstration of workability of Vietnamese wood species revealed valuable indications on the characteristics of cutting tools used for obtaining quality surfaces.

The tools recommended for various operations and the characteristics of these tools are shown in the tables stating also precisely for each of their workability.

The number of samples for laboratory experiments was not sufficient to allow the determination of the durability of the tools (effective working time between two sharpenings and the quantity of material processed with these tools).

7.1.2. The workability tests are intended especially to the establishment of the necessary indications for the production of shuttles and bobbins, and with this aim in view, we have selected for these tests the species Dalbergia, Pterocarpus, Aglaia, Vatica, Lagerstroemia and Castanopsis.

A part of wood material received as samples could not be taken into consideration for the purpose of tests, because of quality defects such as twisted grain, wavy grain.

The tests for the establishment of processing conditions have been carried out by the following categories of operations :

- ripping of wood material by saw (cutting lengthwise)
- thickness planing,
- moulding,
- turning,
- boring,
- mortising

The tests have been carried out on densified and undensified wood material.

7.2. Ripping test

This test has been carried out using the following cutting tools:

- plain sawblades,
- sintered carbide tipped saw blades (Fig.33.1)

We have selected four test pieces from each wood species of undensified material and some test pieces of densified material which have been cut in various directions.

The ripping by plain saw blades was difficult even with undensified wood material.

In case of densified wood material the saw blade wear appeared quite instantaneously and consequently we have eliminated the plain saw blades from the cutting tools intended to process the said wood species.

In conclusion the cutting tools for the ripping of these woods must be tipped with sintered carbides and shall have normal cutting and clearance angles but higher sharpening angles.

The machine used for this test was a joinery circular saw with hand and semi-mechanical feed.

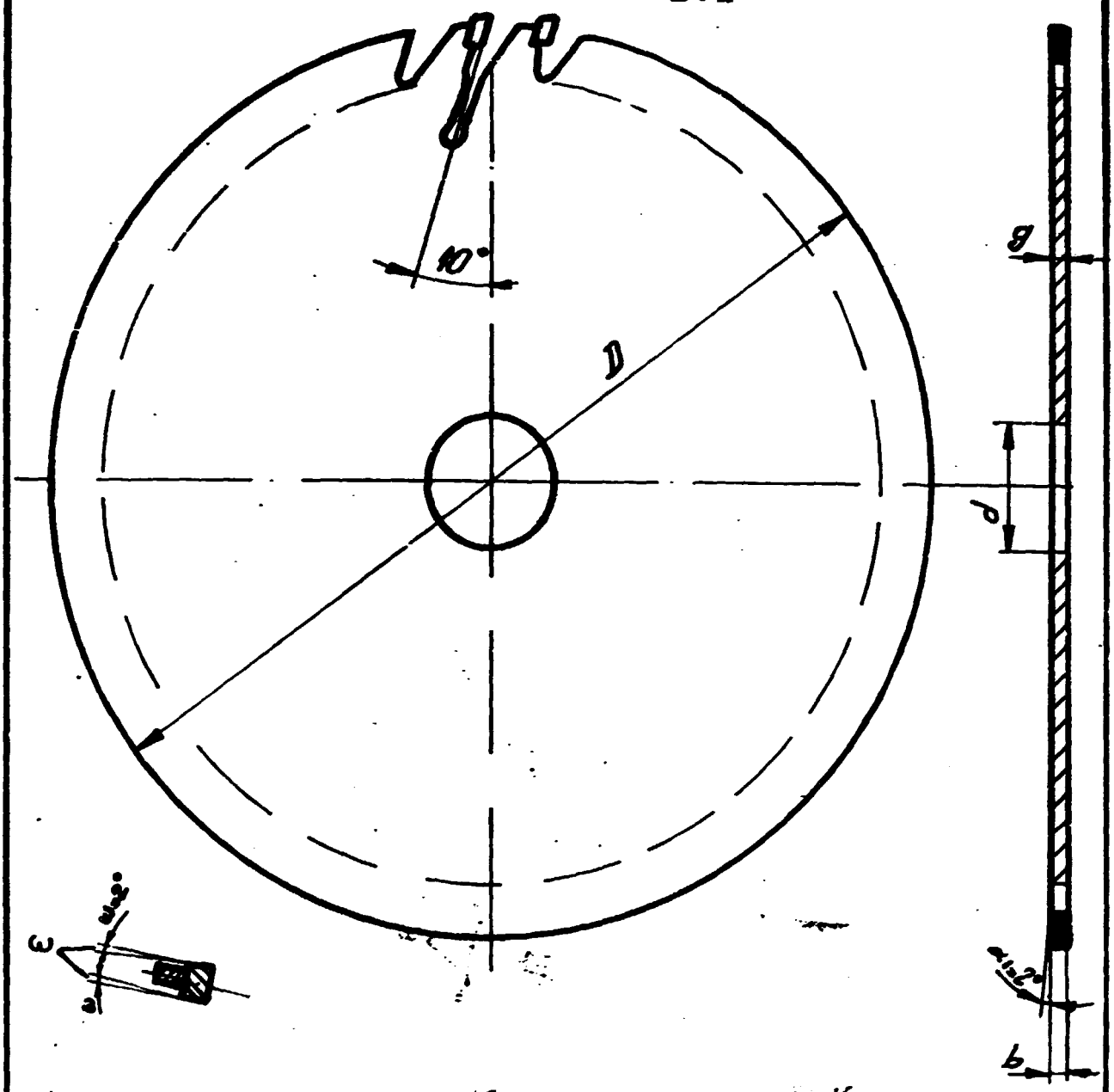
During the process we have inspected the aspect of worked faces, behaviour of test pieces and the apparition of woolings and tear-offs.

The above criteria were considered for the assessment of wood species, densified and undensified, as shown in the table 42.

TABLE 42 - INDICES OF WORKABILITY. RIPPING TEST

Working conditions: 3000 rpm;
54 mm depth of cut material

Saw blade	1	2	3
Material	plain	sintered carbide	sintered carbide
Dimensions diameter x thickness x bore (mm)	∅315 x 2 x x30	∅300x3.2x x30	∅400x4.2x x30
Number of teeth	58	54	96



$\alpha = 15°$ cutting angle
$\beta = 63°$ sharpening angle
$\gamma = 12°$ clearance angle
$D = 450$ mm
$d = 60$ mm
$g = 2{,}5$ mm
$b = 4$ mm

Fig. 33.1 SINTERED CARBIDE TIPPED SAW BLADE

Teeth type	Spring set	Alternative (bevel sharpened)	Alternative (bevel sharpened
Wood	Undensified	Undensified	Densified
Feed	Semimechanical 6 m/min.	Semimechanical 6 m/min.	Manual 2-3 m/min.
Cutting angle	18°	12°	15°
Sharpening angle	60°	63°	63°
Clearance angle	22°	15°	12°
Podocarpus	smooth face .normal to work	very smooth .very easy to work	smooth .easy to work
Dypterocarpus	.very heavy to work .quick wear of tools	.smooth .heavy to work	.very heavy to work .tool is rapidly charged with resin
Aglaia	.very heavy to work .quick wear of tools	rough .easy to work but with larger side clearance angles .repels the material	rough with tear-offs heavy to work
Vatica	.very heavy to work .quick wear of tools	.from rough to smooth .easy to work but with larger clearance angles	.from rough to smooth .easy to work

Dialium	. very heavy to work . quick wear of tools	. from rough to smooth . easy to work . visible traces of silica	-
Lagerstroeria	. very heavy to work . quick wear of tools	. smooth . easy to work	. rough . easy to work
Castanopsis	. very heavy to work . quick wear of tools	. smooth . easy to work	. smooth . easy to work

7.3. Thicknessing test

We have used two planing heads tested with different feed speeds for densified and undensified materials.

Test results for each wood species have been assessed by the following criteria:

- condition of surface: (smooth or rough);
- process method,
- apparition of tear-offs on worked surface.

Machine: thicknessing planer with n=6000 rpm.

Table 43 - [illegible]

Tool size	Z 140	Z 140
Material	high speed steel	sintered carbide tool
Number of knives	4	4
Rotational speed	6000 rpm	6000 rpm
Wood	undensified	densified
Cutting angle	15°	12°
Sharpening angle	47°	54°
Clearance angle	28°	24°
Feed	manual	manual

Podocarpus	-smooth, marked tear-offs -easy to process
Dipterocarpus	-smooth -easy to process -visible resin traces along the grain
Agldia	-smooth -easy to work
Vatica	-smooth -heavy to work -repels the material
Dialium	-rough to smooth -heavier to process because of trends of material to raise
Lagerstroemia	-smooth -easy to process
Castanopsis	-smooth -easy to process

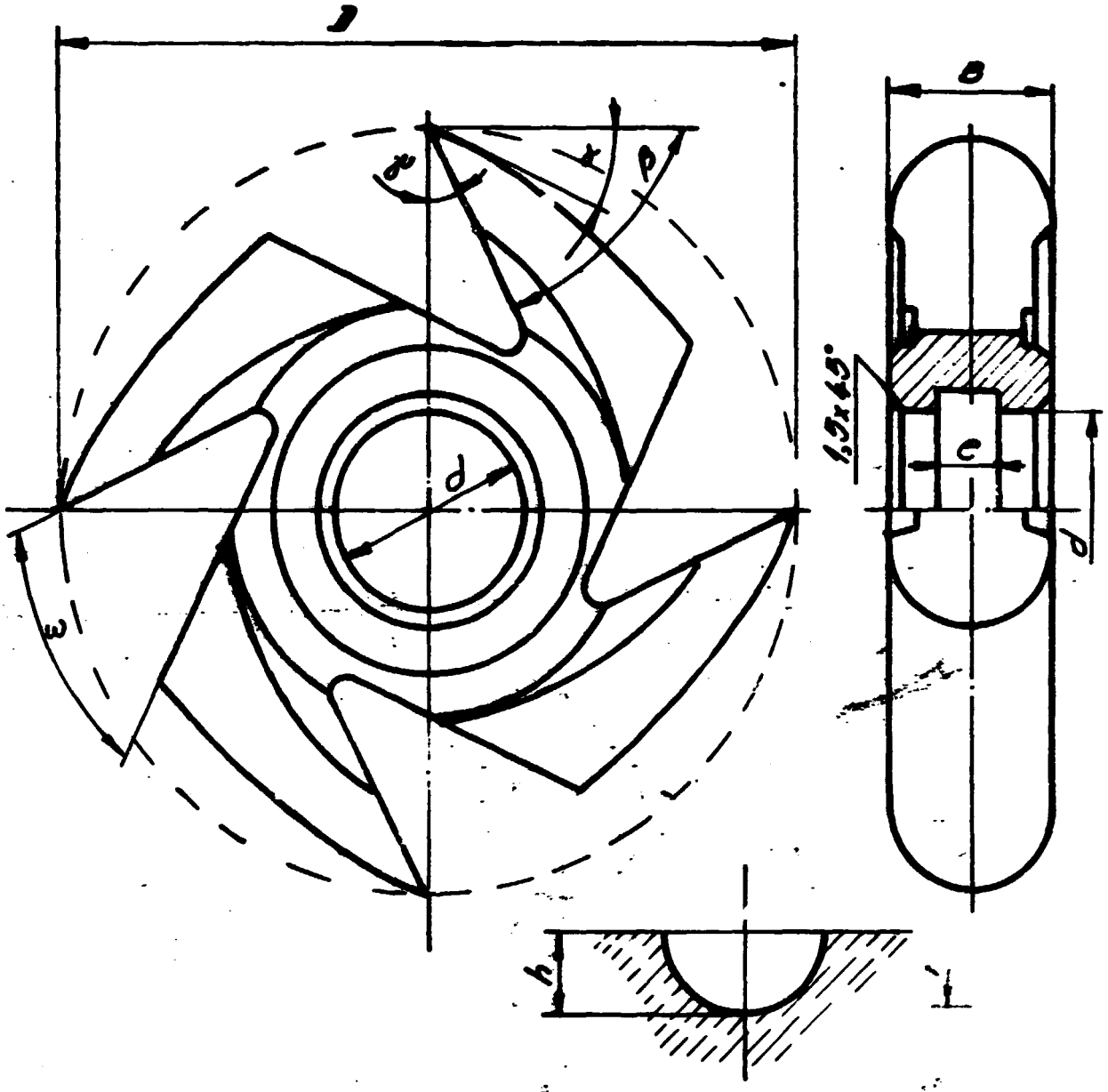
7.4. Moulding test

This test has been carried out by processing densified and undensified materials with two types of tools: one of them with cutting edge of high speed steel and another with cutting edge of sintered carbon (See fig. 33.2)

To emphasize the influence of processing direction there have been made longitudinal and tangential processes without using stocks left against tear-offs at the end of test pieces.

The results are shown below :

Machine : Spindle moulder with n=9000 rpm and automatic feed of 6 m/min.



$\alpha = 10°$ cutting angle
$\beta = 60°$ sharpening angle
$\gamma = 20°$ clearance angle

D - 125 mm
d - 30 mm
B - 20 mm

The profile of piece

Fig. 33.2 KNIFE CUTTER FOR SPINDLE MOULDER

TABLE 44 - INDICES OF WORKABILITY : MOULDING TEST

Tool size		∅ 80 x 63 x 30		
Number of teeth		4		
Depth of cut		3 mm		
Material		high speed steel	sintered carbon CMS	
Cutting angle		α=10° β=60° γ=20°	α=10° β=65° γ=15°	
Process direction		longitudinal	longitudinal	tangential
Undensified material				
Podocarpus	-Aspect	-smooth	-fine	-fine
	-Quality of cut	-good	-very good	-very good
	-Woolings, Wavings	-tear offs	-without tear offs	-
Dipterocarpus	-Aspect	-fine	-smooth	-smooth
	-Quality of cut	-very good	-good	-good
	-Woolings, wavings	-marked wavings		
Aglaia	-Aspect	-fine	-fine	-smooth
	-Quality of cut	-very good	-very good	-good
	-Woolings, wavings	-ease wavings		
Vatica	-Aspect	-fine	-fine	-fine
	-Quality of cut	-very good	-very good	-very good
	-Woolings, wavings	-ease wavings	-	-
Dialium	-Aspect	-fine	-fine	-smooth
	-Quality of cut	-very good	-very good	-good
	-Woolings, wavings	-easy wavings	-	-easy tear-offs
Lagerstroemia	-Aspect	-smooth	-fine	-smooth
	-Quality of cut	-very good	-very good	-good
	-Woolings, wavings	-without wavings	-ease wavings	-ease wavings

Castanopsis	-Aspect	-smooth	-rough to smooth	-smooth
	-Quality of cut	-very good	-good	-good
	-Woolings, wavings	-case wavings	-tear-offs -case wavings	
Densified material				
Polociarus	-Aspect	-	-smooth	-smooth
	-Quality of cut		-good	-good
Aglaia	-Aspect	-	-smooth	-smooth
	-Quality of cut		-good	-good
	-Woolings, wavings			-case tear-of
Vatica	-Aspect	-	-smooth	-smooth
	-Quality of cut		-good	-good
Lagerstroemia	-Aspect		-smooth	-smooth
	-Quality of cut		-good	-good
Castanopsis	-Aspect	-	-smooth	-smooth
	-Quality of cut		-good	-good
Dipterocarpus	-Aspect		-smooth -good	-smooth -good

7.5. Turning test

This test has been carried out by processing undensified and densified material, longitudinal and transversal as in normal production of shuttles.

The test species are used also for rimming, planing and moulding.

Both undensified and densified materials have been turned easily with a minimum power consumption.

Machine: wood turning lathe with cutting speed of 2.5 - 3.5 m/s.

TABLE 45 - INDICES OF WORKABILITY : TURNING TEST

Cutting direction/ Wood species	Performances checked	Longitudinal	Transversal
		Undensified material	Densified material
Podocarpus	-Aspect	-rough	-smooth
	-Quality of cut	-good	-very good
	-Woolings tear-offs	-marked tear-offs	-neo woolings
Dipterocarpus	-Aspect	-rough	-rough-to-smooth
	-Quality of cut	-good	-good
	-Woolings tear-offs	-no tear-offs	-no tear-offs
Aglaia	-Aspect	-rough	-smooth
	-Quality of cut	-good	good
	-Woolings tear-offs	-no tear-offs	-no tear-offs
Vatica	-Aspect	-smooth	-smooth
	-Quality of cut	-good	-good
	-Woolings, tear-offs	-no tear-offs	-no tear-offs
Dialium	-Aspect	-rough	-not testing
	-Quality of cut	-good	-
	-Woolings tear-offs	-ease woolings	-
Lagerstroemia	-Aspect	-smooth	-smooth
	-Quality of cut	-good	-good
	-Woolings tear-offs	-no woolings or tear-offs	-no woolings or tear-offs
Castanopsis	-Aspect	-rough	-rough
	-Quality of cut	-good	-good
	-Woolings, tear-offs	-ease tear-offs	-no woolings or tear-offs

7.6. Boring test

This test has been carried out by processing undensified and densified materials, with two types of tools:

- plain drill with center bit and pre-cutting teeth ∅ 8;
- sintered carbide tipped drill with center bit and pre-cutting teeth ∅ 8;
- carbide tipped drill with taper countersink bit, centre bit, and pre-cutting teeth ∅8/∅ 10.

Machine: Horizontal slot borer with n=2000 rpm and manual feed 1-5 m/min.

TABLE 46 - INDICES FOR WORKABILITY: BORING TEST

Tool size		∅ 8	∅8	∅5/∅ 10
Material of tools		plain metal	sintered carbide	sintered carbide
Densified material				
Podocarpus	Performance checked			
	-Aspect	-smooth		-smooth
	-Quality	-good	-good	-good
	-Woolines tear-offs	-some tear-offs	-ditto tear-offs	-ditto tear-offs
Dipterocarpus	-Aspect	-smooth	-smooth	-smooth
	-Quality	-good	-good	-good
	-Woolines tear-offs	-un-densified tear-offs	-without woolines or tear-offs	-without woolines or tear-offs
Kalafa	-Aspect	-smooth	-smooth	-smooth
	-Quality	-good	-good	-good
	-Woolines, tear offs	-undensified tear-offs	-without woolines or tear-offs	-without woolines or tear-offs
Vatica	Ditto	Ditto	Ditto	Ditto
Dialium	Ditto	Ditto	Ditto	Ditto
Lagerstroemia	-Aspect	-smooth	-ditto	-ditto
	-Quality	-fine		
	-Woolines tear-offs	-without tear-offs		

Castanopsis	-Aspect	-rough	-rough	-rough
	-Quality	-fine	-good	-good
	-Woolings tear-offs	-without woolings	-woolings	-woolings
Densified material				
Podocarpus	-Aspect	-rough	-rough	-smooth
	-Quality	-good	-good	-good
	-Woolings, tear-offs	-woolings and tear-offs	-ease woolings and tear-offs	-ease woolings and tear-offs
Dipterocarpus	-Aspect	-smooth	-smooth	-smooth
	-Quality	-good	-good	-good
	-Woolings, tear-offs	-ease tear-offs	-without woolings	-without woolings
Aglaia	-Aspect	-rough	-smooth	-smooth
	-Quality	-good	-good	-good
	-Woolings tear-offs	-woolings and tear-offs	-without woolings and tear-offs	-ease woolings and tear offs
Vatica	-Aspect	-relatively smooth	-smooth	-smooth
	-Quality	-good	-good	-good
	-Woolings tear-offs	-ease tear-offs	-without tear-offs	-marked tear-offs
Lagerstroemia	-Aspect	Ditto	Ditto	-smooth
	-Quality			-good
	-Woolings, tear-offs			-without tear offs
Castanopsis	-Aspect	-smooth	Ditto	-smooth
	-Quality	-good		-good
	-Woolings tear-offs	-without tear-offs		-ease tear-offs

7.7. Mortising test

This test has been carried out by processing undensified and densified materials with two types of tools :

- cylindrical shank plain cutter ∅ 8;
- cylindrical shank sintered carbide tipped cutter ∅ 8

Mortices were 31 mm in depth and 10 mm wide.

Machine: Router with n=7000 rpm with manual feed.

TABLE 47 - INDICES OF WORKABILITY: MORTISING TEST

Tool size		∅ 8	∅ 8
Material of tool		high speed steel	carbide tipped
Undensified material			
	Performances checked		
Podocarpus	-Aspect	-smooth	-rough
	-Quality	-good	-good
	-Woolings tear-offs	-ease woolings	-marked woolings and tear-offs
Dipterocarpus	-Aspect	-rough	-ditto
	-Quality	-good	
	-Woolings tear-offs	-marked woolings and tear-offs	
Aglaia	-Aspect	-smooth	-smooth
	-Quality	-good	-good
	-Woolings, tear-offs	-without woolings and tear-offs	-ease tear-offs
Vatica	-Aspect	-smooth	-smooth
	-Quality	-good	-good
	-Woolings tear-offs	-without tear-offs	-ease tear-offs
Dialium	-Aspect	-smooth	-smooth
	-Quality	-good	-good
	-Woolings, tear-offs	-without tear-offs	-without tear-offs

Lagerstroemia	-Aspect	-smooth	-smooth
	-Quality	-good	-good
	-Woolings, tear-offs	-without tear-offs	-ease tear-offs
Castanopsis	-Aspect	-rough	-rough
	-Quality	-good	-good
	-Woolings, tear-offs	-marked woolings and tear-offs	-marked woolings and tear-offs
Densified material			
Podocarpus	-Aspect	-smooth	-smooth
	-Quality	-good	-good
	-Woolings tear-offs	-ease woolings	-ease woolings
Lagerstroemia	-Aspect	-smooth	-smooth
	-Quality	-good	-good
	-Woolings, tear-offs	-without woolings	-without woolings
Aglaia	-Aspect	-smooth	-smooth
	-Quality	-good	-good
	-Woolings tear-offs	-without woolings	-ease woolings
Vatica	-Aspect	-rough	-rough
	-Quality	-good	-good
	-Woolings, tear-offs	-ease tear-offs	-ease tear-offs
Lagerstroemia	-Aspect	-rough	-rough
	-Quality	-good	-good
	-Woolings, tear-offs	-ease woolings	-ease woolings
Castanopsis	-Aspect	-smooth	-rough
	-Quality	-good	-good
	-Wooling tear-offs	-without woolings	-ease woolings

7.8. Conclusions

Based on the physico-mechanical properties of wood species, on the specialised literature as well as on the results obtained from the production of shuttles, the following conclusions can be drawn :

Podocarpus

It is a wood which develops woolings when processed in wet conditions. When dry, it can be worked suitably. It can be easily ripped, planed, moulded and bored with a good surface quality. It can be also easily turned but the turned surface is coarse.

Dipterocarpus

It is a high density wood, with deposits of mineral substances in the form of oval pockets which wears either plain or carbide tipped tools rapidly and for these reasons it has been worked only with carbide tipped tools. Tipping is difficult.

For planing, moulding, turning, boring and mortising it behaves well but the worked surfaces are coarse, with woolings and tear-offs. When bored and mortised the cutting edges of tools are rapidly charged with resins.

Aglaia

It is an interlocked grain wood, medium difficult to process, lucking alike mahogany. Tipping is difficult but behaves well for other processes.

Vatica

It is high density wood with spiral grain and resin pockets, with increased tendency to split during and after the processing.

It wears rapidly planing knives and circular saw blades. Durability of cutting tools is lower than normal. During the process it develops irritant dust. In the shuttles it shows splits along the grain due to processing.

Dialium

It is a spiral grain wood with reddish points in the vessels and white mineral substances with a circular crystalization and water dissolution. The wood hardness is lesser than Vatica but is heavy to process.

It shows splits along the grain and can crack during the process. When planing and moulding tear-offs appear.

Lagerstroemia

The wood is like walnut and can be processed with no difficulty. It is lighter and not hardner than other Vietnamese wood species. The shuttles show splits. When planed tear-offs appear. Moulding against the grain produces breakings and boring develops woolings.

Castanopsis

Even grained wood (homogenous) without twisting. Due to its high density the tools wear out more than oak. The shuttles have no tear-offs.

Some of the results have been influenced partly because the samples received by us did not comply with the conditions requested for the processing of the wood pieces to be used as accessories in the textile industries.

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CHAPTER III

THE TECHNICAL REPORT

8. Operating process diagram for the manufacture of shuttles, pirns and picking sticks.

8.1. Storing of scantlings.
8.2. Kiln drying
8.3. Densification of wood
8.4. Machining
8.5. Finishing, assembling, checking, final reception

Code 86/37/RK

8. OPERATING PROCESS DIAGRAM FOR THE MANUFACTURE OF SHUTTLES, PINS AND PICKING STICKS

Considering the results obtained during tests of the species from Viet Nam for obtaining wood accessories for textile industry, the flow chart of the process shall be as follows :

- storing of scantlings under shelter for air drying till the moisture content decreases to under 30%;
- kiln drying of scantlings from initial moisture content down to 10-12% moisture content and conditioning after drying;
- densification of the wood material and post-densification conditioning;
- machining operations for obtaining finished products;
- finishing, assembling, checking operations and reception.

The main stages of the process are as follows:

9.1. Storing of the scantlings

Scantlings of the wood species used for the manufacture of wood accessories intended for the textile industries (which are supplied by sawmills to the dimensions and quality according to technical norms) shall be stored preferably on wooden pallets under cover with lateral protections against bad weather.

Stacking of scantlings on the pallets shall be carried out on strips.

The dimension of the stacks on the pallets opening between scantlings and the thickness of the strips shall be established during the implementation of the project taking into account climatic conditions, wood species and dimensions of the scantlings.

Wood material must be stacked within 24 hours from cutting or from its receiving from the supplier.

Before stacking, the scantlings shall be cleaned from sawdust and the ends paste coated to prevent sudden drying and end cracking.

The stacking of the wood material shall be carried out in scantlings cut from the same wood species and having similar dimensions.

Dimensions of the stacks shall comply with the dimensions of the trucks of the dryers to eliminate the need for yet another hand stacking operation.

The intensity and direction of air current will be taken into account, in locating the sheds, stacks and the spaces necessary for the circulation under the sheds.

Each stack shall have labelled the following:

- Supplier
- Wood species
- Scantling dimensions and stack volume
- Storing date

8.2. Kiln drying

After the sheds have air dried the wood to a moisture content under 30% the stacks are transported from the sheds and placed on trucks to be transported to the drying kilns.

These trucks are introduced into the drying kilns, bearing wood material from the same wood species, the scantlings having uniform dimensions.

Depending on the initial moisture content and parameters of the heat carrier as well as of the ventilation plant the person in charge of the drying shall establish the drying diagram so that the wood material should reach a moisture content of 10 - 12%.

Detailed records shall be kept for each batch of material to be dried.

After taking out the trucks from the drying kilns the dried material shall be conditioned for 72 hours in order to balance the internal tensions.

8.3. Densification of wood material

Dried and conditioned scantlings are brought into the manufacturing hall for such operations as: lengthwise cutting and preliminary processing on two faces on a 2-side planer.

After these operations, the scantlings are weighed piece by piece and sorted by weight.

The densification cycle is established by groups having similar weight and taking into account the dimensions of the pieces.

Pressing takes place in a multi-daylight hydraulic press using overheated water as heat carrier.

The densification process takes place in three stages :

- heating of the material at constant pressure,
- densification at a high pressure and constant temperature,
- conditioning of the material in the press to the environmental temperature.

Thermal and pressure cycles are established depending on species and necessary densification level.

8.4. Machining

After leaving the press, scantlings are stored for 48 hours to balance the internal tensions; then the actual machining operations can be performed:

- processing of one face and one edge is carried by the surface planer;
- thicknessing,
- cutting to nominal length on a double cross cut saw,
- boring at both ends for introducing the metallic points on a slot borer,
- boring for removing the air and extra glue resulted from the pressing of metallic points,
- moulding of exterior sides and of internal holes performed on specialized moulders.

8.5. Finishing, assembling, checking, final reception

After machining the shuttles are sanded on special sanders with different granulosity in order to obtain a perfectly smooth surface.

After sanding the shuttles pass into the assembling section where accessories are mounted: then they are led to the impregnation plant operating at atmosphere pressure.

At the end of the operating process technical checking (quality control) and final reception take place. This includes sorting by weight.

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CHAPTER IV

CONCLUSIONS AND RECOMMENDATIONS

1. Conclusions
2. Recommendations

IV. CONCLUSIONS AND RECOMMENDATIONS

The data from the bibliographical research, the analysis carried out in the project area concerning shuttle production and other wood accessories for the Vietnamese textile industry as well as the tests on the seven species mentioned above, allow the following conclusions and recommendations to be made:

1. Conclusions

1.1. The wood species analysed permit the production of shuttles and other wood accessories using the wood densification method and the technology presented in this study.

1.2. The most appropriate wood species for shuttle production are considered to be the following :

- Tatura sp.
- Castanopsis
- Dipterocarpus
- Lagerstroemia

For the production of bobbins:

- Lagerstroemia
- Aglaia

For the production of picking sticks:

- Castanopsis
- Vatica
- Dialium

1.3. Taking into account the existing equipment in the factories and its conditions and the existing tools it is not recommended to utilize densified wood of the existing machine and tools.

1.4. Besides the setting up of the processing technology, it is necessary to solve also the problem of metallic accessories or accessories made of other materials, which are fixed onto shuttles, pirns, picking sticks as well as the problem concerning processing tools to be ensured for the existing machinery.

2. Recommendations

2.1. To finalize the project in good conditions, it is proposed to create a section for the production of shuttles and pirns to be established by the Vietnamese authority taking into account the raw material sources and location of the users. The present situation, mainly the great transport distances between textile mills, between the North and the South of the country could justify the location of two sections.

The specification of the main equipment for the creation of this section is given in annex 6.

Both for the new section and for the existing plants it is necessary to draw up and to get the approvals for the technical norms on the basis of which to produce, transport, store and accept the semi-finished wooden products (squared strips) for the manufacturing of shuttles and other wood accessories.

This is considered to be the main condition to improve the production and to increase economic efficiency in the textile industry.

With this in view, a new proposal for the technical norm is presented in Annex 7.

2.2. Having this view it is necessary to draw up the standard or technical norms for products (shuttles, pirns, picking sticks) as well as for the accessories made of metal or other materials which are mounted on the mentioned products.

2.3. To improve the present situation until the creation of the new section it is proposed.

- to ensure that the raw material provided for shuttles conforms to the technical conditions proposed in Annex 7
- to ensure proper operations of the equipment following a strict periodic checking,
- compulsory drying of wood material and checking of moisture content before manufacturing;
- organization of quality check by stage of manufacturing as well as the checking of cutting tools necessary to the degree of operating accuracy;

- production of multi-layered wood from veneer of a single wood species and the ensurance of the uniform weight by different densification diagrams depending on the species,

Annex 3 includes the proposals for a programme concerning the section for shuttles, pins and similar sticks.

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A N N E X E S

Code 86/37/RK

LIST OF CURRENTLY AVAILABLE TIMBER SPECIES IN VIET NAM

Item No.	Local Name	Botenical Name
1.	BANG LANG	Legerstromis loudoni - Teijm
2.	BANG LANG NUOC	Legerstromia flos-Reginal - Retz
3.	BINH LINH	Vitex pubescens - Vahl
4.	CANG LO	Betula enoides - Buch
5.	CHAI	Shorea vulgaris
6.	CHO CHI	Pereshorea stellata - Kury
7.	DAU	Dipterocarpus sp.
8.	DAU SONG NANG	Dipterocarpus dyeri - Pierre
9.	GIE GAI	Castenopsis chinensis - Hance
10.	GIE GAI BAC BO	Castenopsis tonkinensis - Seem
11.	GOI NEP	Aglaia gigantea - Pellegrin
12.	GOI TE	Aglaia sp.
13.	GU MAT	Sindora cochinchinensis - Baill
14.	HOANG DAN GIA	Decrydium pierrei - Hick
15.	LAU TAU	Vatica cochin
16.	LIM VANG	Peltophorum tonkinensis - Pierre
17.	LONG MANG	Pterospermum
18.	MO	Manglietia conifera - Dandy
19.	MUONG	Cassia sp.
20.	MUONG DEN	Cassia siamea - Lanik
21.	MY	Lysidice rhodostegia - Hance
22.	SANG	Sapindus oocarpus
23.	SANG LE	Legerstroemia calyculata - Kurz
24.	SANG MAY	Segerea elliptica
25.	SAU DEN	Hopea odorata

Item No.	Local Name	Botanical Name
26.	THI RUNG	Diospyros
27.	THONG BA LA	Pinus kesiys - Royle
28.	THONG NANG	Podocarpus imbricatus-BI
29.	THONG NHIRA	Pinus mercusii
30.	TRAM	Melaleuca leucandendrom - Linh
31.	TRAM HONG	Canarium sp.
32	TRAM TRANG	Canarium album - Raeusch
33.	TRUONG MAT	Paviesia
34.	VANG TRUNG	Endospermum sinensis - Benth
35.	VEN VEN	Anisoptera cochinchinensis - Pierre
36.	XOAN DAO	Pygeum arboreum - Endl & Kurz
37.	XOAY	Dialium cochinchinensis - Pierre

NOTE : According to the point of view of the representatives of the Ministry of the Light Industry Hanoy, compared with the 37 species above mentioned included as annex to the contract only 7 species are available for the production of shuttles and accessories namely:

- **Castanopsis cochinchinensis (Gia Goi)**
- **Dacridium pierrei (Hoang Dau Gia)**
- **Lagerstroemia calyaclata (Sang Le)**
- **Betula alnoides-Buch (Cang Lo)**
- **Anisoptera cochinchinensis (Ven Ven)**
- **Peltophorum dasirachis (Lim Xet)**
- **Podocarpus imbricatus (Thang Nang)**

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Annex 2.

LIST OF ORGANISATIONS/FACTORIES VISITED AND PERSONS MEET

A. HANOI	
1. Ministry of Light Industry (MOLI) and Union of Textile Enterprises (UTE)	- Mr.Nguyen Hieu Manager of foreign services department - Mr.P.T.Do - MOLI - Mr. P.T. Tien International Department - Mr.Trau Thi Duang Deputy General Manager UTE - Mr. Chiem - UTE - Mr. Do Van Gian Wood processing specialist - Mr. Hung Research Institute of Wood Industry
2. U.N.D.P. Office	- Mr. Terence Jones Deputy Resident Representative - Mrs. Joana Merlin Scholtes - Deputy Resident Representative - Mr.Patrick Coeur Bisot Deputy Resident Representative - Sietze Vander Werf Programme officer
3. 8 March Textile Mill and Shuttle Plant (25th of July and 8th of August 1986)	- Mrs. Truc Technical manager of the Enterprises - Mrs. Thiem Manager of tool section
4. Cau Dong plywood-laminated shuttle blocks-section (26th of July 1986)	- Mr. Dao Duo Thanh General Manager - Plywood Manager of factory
B. NAM DINH	
5. Nam Dinh Combined Textile Mill and shuttle Plant (28th of July 1986)	- Mr. Nguyen Van Tuyen Deputy manager - Mr. Nguyen Trong-Son Manager of weaving section - Mr. Nguyen An Lien Weaving specialist - Mrs. Le Thi Huong Finishing engineer - Mr. Tran Huu Thuc Manager of shuttle plant
C. HO CHI MINH CITY	
6. The Union of Textile Enterprises	- Mr.Duong Minh Anh Lan

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of the South (12th of August 1986)	Deputy General Manager - Mr. Nguyen Van Giang Technical staff - Mr. Toan administration service
7. Viet Thang Textile Mill and Shuttle Plant (13-th of August 1986)	- Mr. Trau Van Nho Deputy Manager - Mr. Phe Duc Dien electric.engineer - Mr. Ho Si Linh UTB spedalist - Mr. Vu Duy Huong Shuttle plant manager
8. Hoa Binh paper complex (end laminated shuttle) blocks section	- Mr. Ton That Nghinh Manager - Mr. Le Van Truong Plywood factory Manager

NOTE FOR THE FILE VIE/80/027

1. On July 24,1986 I had a meeting at MOLI with Messrs Do and Tiem (experts MOLI) Messrs, Chiem and Giang (experts UTE) and Messrs Teodorescu and Popa (Rom Consult - Subcontractor).

2. Mention was made of the unexpected arrival of the subcontractors team on Saturday 19 July, resulting in the loss of several workingdays, due to other commitments of MOLI/UTE experts.

3. Mr. Teodorescu gave a short outline of the foreseen activities during the team's stay in Viet Nam (as discussed with me on 21 July)

Act. I. meeting with experts of Forest Inventory and Wood Industry, covering

a.o. - the suitability and availability of species of wood for testing
- total amount of wood necessary for production
- technical conditions and requirements for products
- prices of various species

then a decision on the species to be tested could be taken.

Act II. Visits of textile factories, 4 shuttle production sites 2 shuttle block production sites and saw mills, discussion with production managers of the standards for wooden accessories used in Viet Nam, equipment in use, production condition and circumstances etc. If there were no standards set, he would suggest to use Rom Consult standards.

4. Mr. Chiem (UTE) mentioned the production problem in the textile factories, which were often caused by locally made shuttles.

The program proposed by Mr. Teodorescu overlapped to a great extend Mr.Boretti's visit and report.

The species already preselected would be reviewed and discussed with the subcontracters team.

Production in most factories was done according to same production methods as in the 8 March Factory in Hanoi. He questioned the use of visiting HCMC factories

5. I stated that Mr Boretti's report was a general situation report.

It should be discussed by the team and UTE experts and the team should visit those sites it thinks important in view of its activities.

The fellow ship nomination forms shall be prepared by Moli as soon as possible. The team and Moli/UTE should contact Aeroflot to discuss the transportation charges for the material to be tested in Bucarest I was informed that Mr. Heimburgers visa was issued and promised to send a telex to UNIDO and request them to field Mr. Heimburger and Basiuki asap in order to overlap with the subcontractors team. Further more I promised to send a request to UNIDO to pre-arrange placing of the fellows with Rom Consult, pending the finalazation of the nomination forms.

SW/T

Annex 3.2

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ROMCONSULT

Hanoi, 29th July 1986

Ministry of Light Industry
Hanoi, Viet Nam

Ref : PROJECT D.P./VIE/80/027

Dear Sirs,

Please find enclosed the following documents :

-Chapter III of the ROMCONSULT offer : contents of the services to be performed, including time schedule. These contents are part of the contract 86/37 RK concluded between UNIDO and ROMCONSULT.

-Bibliographic research on the Vietnamese wood species, carried out by ROMECONSULT, according to the provisions of the contract.

-Specification of the conditions which have to be observed in the preparing of solid wood samples.

Due to the fact that the carrying out of the testing is conditioned by the existence of the wood samples, we kindly ask you to take every measure you consider necessary to ensure the early delivery by air freight of the above-mentioned samples.

I remain,

Yours faithfully,

Alexandru Teodorescu

Specification of the Conditions which have to be observed in the preparing of the Solid Wood Samples

1. The list of species for which it is necessary to prepare the samples is attached to the present (see Annex 1).

2. According to Annex F of the contract, concluded between UNIDO - Vienna and ROMCONSULT, Bucharest, the quantity and dimensions of solid wood for samples of each species are the following :

- 90 pieces : 400 mm x 60 mm x 60 mm = 0.130 m^3
- 100 pieces : 400 mm x 70 mm x 70 mm = 0.200 m^3
- 45 pieces : 680 mm x 70 mm x 70 mm = 0.150 m^3
- 20 pieces : 500 mm x 80 mm x 80 mm = 0.070 m^3
- 20 pieces : 600 mm x 80 mm x 80 mm = 0.080 m^3

3. The quality conditions of wood pieces will be as follows :

3.1 The wood pieces will be obtained by radial conversion of timber (for large log diameters, partial, semiradial conversion is accepted). Due to existing conditions (the logs are now in the logyards of some factories), the samples (wood pieces) will be taken from these logs. To ensure medium figures of the results, from one log with a length of 6-8 m and a diameter of 80 cm, a maximum number of 24 pieces will be taken as samples.
At the same time, it is recommended to take samples from logs harvested in different areas.

3.2 The wood pieces shall have longitudinal surfaces parallel to one another and the ends cut perpendicularly to longitudinal edges.

3.3 The wood shall be sound, with homogeneous structure and uniform densit

3.4 Defects permitted shall be as follows :

- stains : not allowed.
- core : not allowed .
- sapwood : not allowed.
- slopping grain : allowed in radial section if does not pass from one edge to another.
- fissures : allowed in maximum 2 mm depth.
- waves : not allowed.
- knots : not allowed.
- cracks : not allowed
- imbarks : not allowed

3.5 The wood pieces shall be naturally dried at maximum 60 % moisture content (minimum 30 % M.C)

3.6 For each piece, the surfaces at both ends shall be protected (covered) with paraffin or some glue or adhesive.

4. The wood pieces for samples will be marked as is shown in the sketch (Annex 2) :

- Name of species	(Vatica .....)
- factory from which the logs are taken	(Cau Duong ....)
- number of the log	(I....)
- length and diameter of the log	(6 m ; 640 mm)
- part A, B from the log	(A)
- number of pieces	(1...)

For each log, a segment (as is shown in "a") of the traverse section will be delivered with wood pieces.

The quality and quantity control for the total number of pieces (piece by piece) will be done in the presence of the subcontractor's representative before the packing.

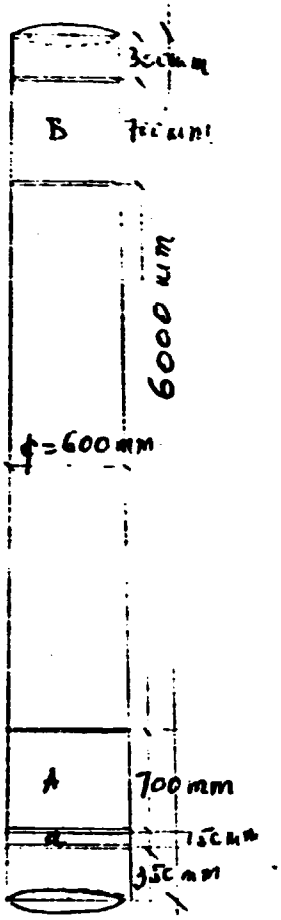
5. The wood pieces will be packed as follows :

-Each piece will be wrapped in newspaper ;
-A number of pieces so wrapped will be packed in wax paper and cardboard and fastened with a metal belt. The number of pieces in a parcel and the total weight will be established according to the conditions of the carrier.

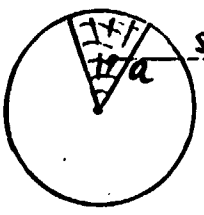
ANNEX 1

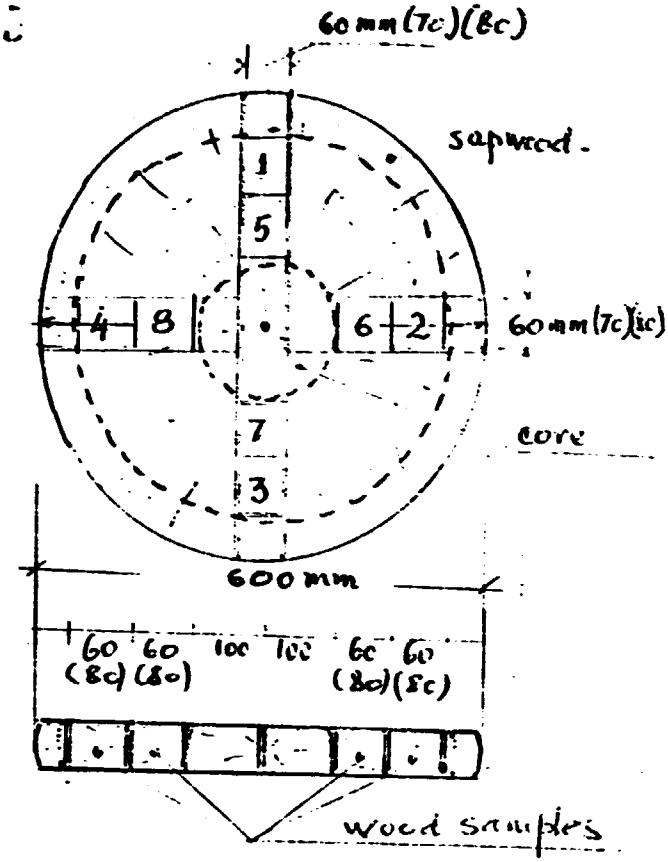
LIST OF THE SPECIES FOR WHICH SOLID WOOD SAMPLES MUST BE PREPARED AND DELIVERED FOR TESTING

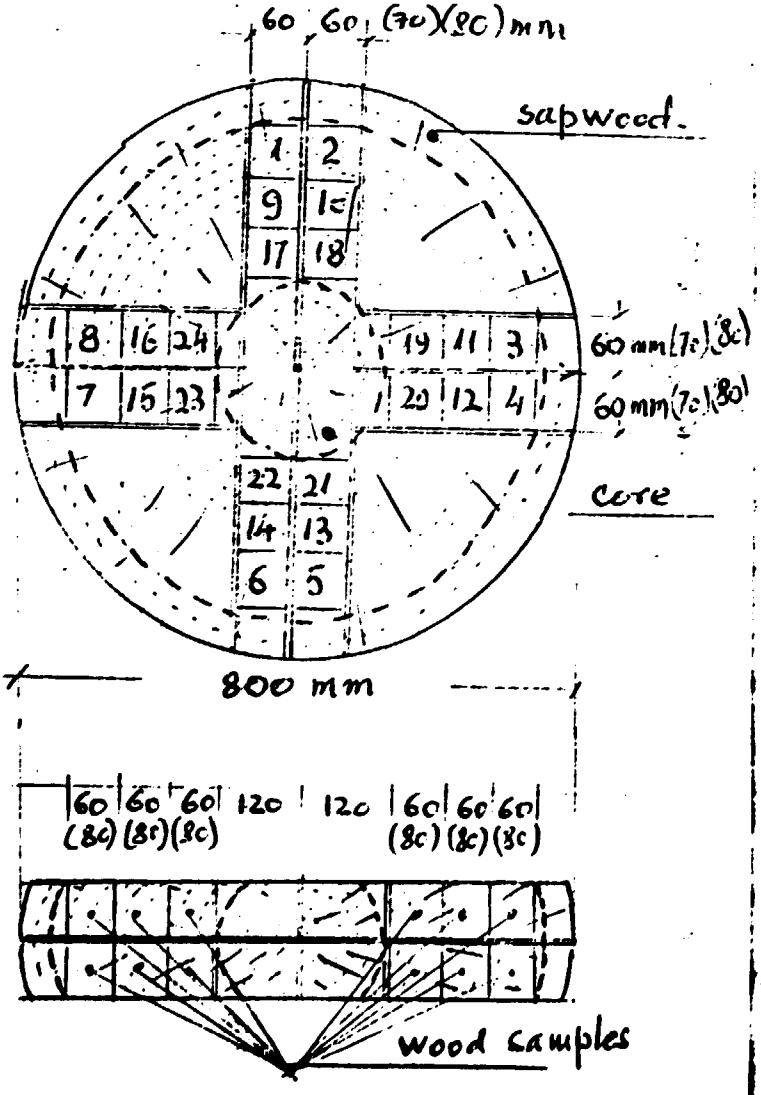
1. Dipterocarpus alatus	-	Dau
2. Vatic cochinchinensis	-	Lau Tau
3. Lagerstroemia calyadata	-	Kur - Sang Le
4. Sageraea elliptica	-	Sang May
5. Aglaia sp	-	Goite



A, B = part from log out of which wood samples shall be taken.







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Annex 3.3

30th of July 1986

TO: UNITED NATION DEVELOPMENT PROGRAM

The Resident Representative of the U.N.D.P.

Ref : Project No. D.P./VIE/80/027; Contract No. 86/37/RM

Dear Sirs,

We wish to inform you, that the team of ROMCONSULT (i.e. Mr.Alexandru Teodorescu and Mr.Constantin Popa) arrived in Hanoi on 19th of July 1986.

Since our arrival up today, we have two meetings with the representatives of the Ministry of the Light Industry (on 24-th of July and 29th of July 1986) and we visited the factories:

- 8 March textile mill including the shuttle manufacturing section (on 25th of July).
- Cau Dong plymill including shuttle blocks manufacturing section (on 26th of July).
- Nam Dinh textile mill including shuttle manufacturing section (on 28th of July).

During our visits, the first two factories did'nt work due to the lack of the energy and chemicals.

From the beginning we handed over to the our counterpart (MOLI):

- chapter III-" CONTENT OF THE SERVICES TO BE PERFORMED" of the ROMCONSULT's proposal (part of the contract concluded between UNIDO and ROMCONSULT)
- bibliographic search of the Vietnamese wood species.

According to the provisions of the contract and the briefing in Viena, also from the beginning, on the base of the bibliographic search, we were presenting proposal for the selected species for which it is necessary to be prepared the wood samples for testing.

(The species were selected from "the list of currently available timber species in Vietnam" included in the annexe "2" of the constract).

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Opposite to our proposal, the MOLI representatives asked us to test only the species slected by them, species which characteristics do not recommend them that the most suitable species for shuttle manufacturing.

Due to this demand which is outside of the requirements of the contract, our work cannot be in progress and the preparing of the wood samples cannot begin.

As the dispatch of the samples before our departure is conditioning the carrying out of the tests in terms of the contract we consider to ask you to be so kindly to inform the HEAD PAC, for written decisions.

We remain,

Yours faithfully

Annex 3.4

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4th of August 1986

Ministry of Light Industry
Hanoi - Vietnam

Ref. Project No. DP/VIE/80/027

Dear Sirs,

Please find enclosed the specification of the conditions which have to be observed in the preparing of wood veneer samples (Annex 1)

We remind to you that the carrying out of the testing is conditioned by the existence of the veneer samples and we kindly ask you to take every measures you consider neccessary to ensure the prompt delivery by air freight of the samples.

In the same time, samples, for the chemicals and auxiliary material produced in Vietnam, that could be used for the subsequent industrial production in Vietnam, is neccessary to be prepared, packed and air freighted. For each material characteristics and using instructions shall be given.

Also hardware for 20 pieces (shuttles, pirns and picking sticks) of each shall be dispatched.

Taking into consideration that the last working day in the project area of our team is on 13th of August 1986, we propose to you the subsequent program (see annex 2).

In annex 3, we have indicated the adress to which the samples shall be by air freight delivered.

I remain.

Yours faithfully

Alexandru Teodorescu

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Annex 34

Project No. MP/VIE/80/027
Contract 86/37/BK

Specification of the conditions which have to be observed
in the preparing of the veneer samples

1. The list of species for which it is necessary to prepare the samples is the same as for solid wood samples (see our letter of 29th of July 1986).

2. According to Annex F of the contract, the quantity and dimensions of veneer samples of each species are:

6,000 sheets: 700 mm x 100 mm (0,7 mm thickness) = 420 m2. It is to be mentioned that the width of the sheets may be multiple of 100 mm (taken as module)

Tolerance: for the length: + 20, - 5 mm
for the width : + 5, - 2 mm

3. The quality conditions of the veneer will be as follows:

3.1 The sheets of veneer will be obtained radial sliced veneer (tangential sliced veneer can be accepted)

The sheets of veneer have to be obtained from logs harvested in different areas.

From one log, a maximum number of 500 sheets will be taken as samples.

For maximum a third of the quantity, peeled veneer (1 mm thickness) can be accepted.

3.2 The sheets shall have the same thickness on the whole surface and the edges cut perpendicularly one to another.

3.3 The wood shall be found, with homogeneous structure and uniform density. The surface of the veneer shall be fine, without snatched grain, scratch, rough surface.

3.4 Defects of the veneer is not permitted as follows:

- stains, rottenness: not allowed
- cone: not allowed
- spinning or slopping grain: not allowed
- fissures, cracks: not allowed
- sapwood: not allowed
- knots: not allowed
- insects boring: not allowed
- imbarks: not allowed.

.../-

3.5 The veneer shall be dried and delivered with a moisture content of 8 - 12 %.

4. The veneer samples will be marked as follows:

- name of species
- factory from which the logs are taken
- number of the log
- number of the sheets

5. The sheets of veneer will be packed as follows:

A number of sheets will be packed in wax paper and after that will be tightly laid in wood boxes, fastened with a metal belt. The total weight of one box will be in the limit established by the carrier.

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Annex 3.4/2

Program of the Work

Mo. 04.8.86 - Meeting to M.O.L.I and Wood Research Institute.
Tu. 05.8.86 - Visit to the 8 March factory
Wd. 06.8.86 - Visit to the Cau Dong ply mill
Th. 07.8.86 - Meeting for economical data
Fr. 08.8.86 - Departure to Ho Chi Minh - visit to Viet Thang factory
Sa. 09.8.86 - Visit to Hoa Binh ply mill
Su. 10.8.86 - Departure to Hanoi
Mo. 11.8.86 - Reception of the solid wood samples
Tu. 12.8.86 - Reception of the veneer samples
Wd. 13.8.86 - Conclusion and protocol
Th. 14.8.86 - Departure to Moscow-Bucarest.

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Annex 3.4

Adress

To: INSTITUTUL DE CERCETARI SI PROIECTARI PENTRU
INDUSTRIA LEMNULUI I-ICPIL
SOS. GLUCOZEI No 7
SECTOR 2
BUCURESTI
AEROPORT INTERNATIONAL
BUCURESTI - OTOPENI

ROMCONSULT
Romanian Consulting Institute

Annex 3.5

VIE/8o/o27

5 August 1986

Your Excellency,

VIE/8o/o27 - Production of Wooden Textile Industry Accessories

In the Preparatory Assistance to this project certain activities are to be undertaken under subcontract (ref. page 5 of PA document, Annexe I). The subcontractor's team consisting of Mr. Teodorescu and Mr. Popa arrived in Hanci on 19 July. Unfortunately, until today no substantial activities have been undertaken by the subcontractor's team. The reasons appear to be the followings

1. A programme for visits to factories and workshops suggested by Mr. Teodorescu could not be implemented mainly because the representatives of MOLI/UTF believed the visits were unnecessary.

2. The selection of wood species to be tested in the subcontractors institute in Bucharest could not be finalized, because no agreement had been reached identifying the wood species potentially suitable for production of loom shuttles. In a meeting which Mr.S. Van Der Werff, UNDP Programme Officer had with a.o. Mr. Hieu, Deputy Director, Department of International Relations of MOLI and Mr. Teodorescu, agreement was reached that the next day, all experts should work together and prepare a list of species to be selected. This list should include all proposed species with substantive information on characteristics, available quantities etc. I was, however, informed on the 4th of August that no substantial progress has been made due to the fact that information necessary for the selection of appropriate wood-species was still unavailable .

.../...

Mr. Nguyen Huu Vu
Minister
Ministry of Light Industry
Hanoi

3. On the same day the programme officer urgently requested Mr. Do (MOLI) to arrange a new meeting with Mr. Teodorescu, which was promised by Mr. Do. Later Mr. Teodorescu informed me that he still had not been contacted by a representative of MOLI or UTE.

As you will understant the report on the testing of the wood species is of crucial importance for the implementation of the future project of establishing a pilot production unit where good quality loom shuttle and wooden accessories can be produced from locally available materials. It is therefore absolutely necessary that the subcontractors experts receive all the information which they believe, is necessary.

In order to avoid any further delays in the activities of the experts and therewith in the implementation of the preparatory assistance's activities, I would urgently ask you kindly to take all necessary steps to make sure that:

- the team can visit factories and workshops as suggested in the attached work programme (Annex II);

- a proper selection of appropriate wood species for testing can be made;

- all arrangements for shipment of the wood species to Bucharest are made.

I sincerely hope that with your help it will be possible to finalize this stage of the project so that there will be a sound basis for further assistance to the improvement of the operative efficiency and productivity of the weaving industry.

With best personal regards,

Anders Roejkjeer

Resident Representative

cc. Mr. Nguyen Van Ich
Vice Chairman
CERPC
Hanoi

Mrs. Phan Thi Minh
Director
Department of International
Relations
Ministry of Foreign Affairs
Hanoi

ROMCONSULT
Romanian Consulting Institute

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Annex 3.6
6th of August 1986

TO UNITED NATIONS DEVELOPMENT PROGRAM
The Resident Representative of the U.N.D.P.
Ref: Project No. DP/VIE/80/027; Contract 86/37/R.K.

In continuation of our letter of 30th of July 1986, we want to inform you again, about the work team in the project area, as follows:

1. According to the what it has established in the meeting of 30th of July (which took place in the presence of your representative, Mr. S.V.D. Herff) it was following that on 31st of July, to receive the reply to our proposals, handed over by the letter of 29.7.86.

In the meetings of 31.7., 05.8 and 06.8.86, we were continueing to try to reach an agreement about the species selected for testing, but unfortunately, we failed.
The last proposals (ours and theirs) are included in "the table with comparative characteristics" (annex 1).

We want to specify that we consider the species: Heltopharum dasivachis Kurz and Podocarpus imbricatus unsuitable species for shuttle manufacturing, while the Castanopsis tonchinensis Hance, can be tested moreover as a six species.

2. Regarding the solid wood samples (for which from the first meeting we paid attention) which have to be prepared by thanks to our counterparts, and which we wished to be receptioned and freighted before our departure to Bucharest, UTC representatives have informed us, that two months will be necessary for this purpose.

3. During our discussions, we were asked by UTC representatives to inform us about the chemical and auxiliary materials produced in Vietnam that could be used for subsequent industrial production in Vietnam and at the same time to prepare the samples of these .
The reply which we received was that there are not such materials available for our testing.

4. Because at the first visit in the 8 March Textile Mill and Cau Dong plymill, these factories didn't work we were proposing in our program new vizit to see the shuttle blocks section and shuttle manufacturing section in full activity.
We didn't receive any reply .

5. To ensure the faster preparing of the wood samples, we propsed to go together to the sawmill to explain and to discuss with the management the specification and the conditions of these.
Our proposals were not accepted.
In such situation our works in the project area, also at home in our research institute, couldn't be carried out in the terms and according to the time schedule, provided in the contract.
For this reason and because the next week our working time in the project area is finished, we are coming back to our letter and we are wishing to ask you to be so kindly to inform UNIDO Viena- The HADRAC, for written decisions.
At the same time we wish to ask you to assist our team intervening to the Ministry of the Light Industry for a better and more operative co-operation in [illegible]xion of the performance of the works.
Waiting your reply , we [illegible]

[illegible] faithfully
Alexandru Teodorescu

with comparative characteristics by species

Crt. No.	Specification of the species	Phisico-mechanical characteristics									Grain structure	Aspects	Uses
		Density kg/m³	Shrinkage V - %	Crushing St. MPa	Bending St. MPa	Modulus of elasticity MPa	Shearing St. MPa	Seasoning natural / artificial	Condition of impregnation	Splitting			
0	1	2	3	4	5	6	7	8	9	10	11	12	13
1	Dipterocarpus sp. D dyeri Dau Dausong n.	640-915	18	63	154	13500	10	n.s.d. / a.m.d.	w.i.	T.C	streight light interlocked	coarse but even	1, 2, 4, 5, 6, 7, 9, 12, 13, 16
2	Vatica cochinchinensis Lau Tau	700-1000	13.5	70	152	17500	16	n.s.d / a.s.d	D.I.	T.C	streight light interlocked	fine	1, 2, 4, 5, 6, 7, 8, 9, 12, 13, 16, 18
3	Laperstroemia calyaclata Sang Le	550-900	11	50	92	12400	13	n.s.d. / a.m.d	—	T.C.	streight and interlocked	Fine, rough	1, 2, 4, 5, 6, 7, 8, 9, 11, 12, 16
4	Saperaea elliptica Sang may	530-920	—	49	106	16500	—	n.s.d	—	n.Tc.	streight	medium ro coarse	1, 2, 4, 6, 8, 9, 10, 15
5	Aplaia sp; A dipantea Goi Te Goi Nep	560-700	—	62		14200	15	n.m.d / a.m.d	—	—	interlocked	Fine to coarse	1, 2, 4, 5, 6, 7, 8, 9, 12, 16
	CARPINUS BETULUS	710-940	18	60	143	16600	16	n.m.d / a.m.d	D.I.	n.Tc	interlocked	fine	1, 2, 5, 7, 8
1	Aplaia dipantea Goi Te	560-730	14	56	103	—		n.m.d	—	1,42 MPa	rather streight	smooth	
2	Castanopsis tonkinensis Gie Gai	650-740	12	54	98	7300	12	n.f.d.	—	—	streight	smooth	1, 4, 6
3	Peltophorum dasirachis Lim xet	600-720	7	58	116	13500	—	n.m.d	—	1,49 MPa	interlocked	rather smooth	1, 4, 6
4	Manglietia conifera Mo	480	11	61	123	—	—	n.f.d	—	0,98	streight	smooth	1, 6, 10, 15, 16, 18, 17
5	Podocarpus imbricatus Thông Nàng	560	13	37	102	9600	—	n.f.d	—	1,77	streight	very smooth	6, 8, 9, 15

n.f.d. = Natural fast drying
n.m.d. = Natural medium drying
n.s.d. = Natural slow drying
a.f.d. = Artificial fast drying
a.m.d = Artificial medium drying
a.s.d. = Artificial slow drying
w.i. = Well impregnation
D.I. = Difficult impregnation
T.C. = Trend to
n.Tc. = no trend to

USES

1. Structural timber
2. Flooring
3. Mine timber
4. Ship, boat building
5. Vehicle body
6. Furniture
7. Handles, ladders
8. Sporting goods
9. Veneer, plywood
10. Boxes crates
11. Interior trim
12. Joinery
13. Sleepers
14. Carrings
15. Toys
16. Turnery
17. Food containers
18. Accessories for text. ind.

The representatives of U.T.E. proposed for testing:

1 Dipterocarpus sp
2 Laperstroemia calyaclata
3 Aplaia sp.
4 Castanopsis tonkinensis
5 Peltophorum dasirachis
6 Podocarpus imbricatus

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Annexe 3.7

PROTOCOL
concluded at Hanoi on 15th of August 1986

Ref: Project No D.P./VIE/8o/o27; Contract 86/37 RK

Participants: ROMCONSULT team (Mr. Alexandru Teodorescu and Mr. Constantin Popa)
Ministry of the Light Industry: Nguyen Hieu and P.T. Tiem
Union of the Textile Enterprises: T.T. Duong and Chiem

I. In the period of the work in the project area, ROMCONSULT team has visited the following factories:

- Textile Mill including shuttle manufacturing sections 8 March Hanoi, Nam Dinh and Viet Thang-Ho Chi Minh
- Plywood including shuttle block manufacturing section: Cau Dong Hanoi, Hoa Binh Ho Chi Minh City

During the visit, the attention was pointed out to the following aspects:

- the raw material actually utilized for wooden accessories
- the technological flow in the production sections
- the machines and equipments, tools and hardware.

At the same time, during the discussions with the factories management, was drawn out the most frequent defects of the shuttle and other wooden accessories, in the weaving section.

II. On the base of the bibliographic search carried out by ROMCONSULT and UTE proposals regarding wood species selection, in the last meeting organised in the presence of Mr. Patrice Jeaur Bisot, Deputy resident representative of the UNDP Hanoi, one agreement was concluded as follows:

- The species selected for the testing are: Dypterocarpus alatus (Dau), Vatica Fleuriana (Lau Tau), Lagerstoemia calyculata (Bang Le), Dialium cochinchinensis (Xoay), Aglaia species (Goi Tia) and moreover Castanopsis chinensis (Gie Gai) and Podocarpus imbricatus (Thong Nang).

- The samples will be air freighted in the conditions of the specification, given to the Ministry of the Light Industry - UTE by the ROMCONSULT team, not later than maximum two months.

III. Regarding the chemical and auxiliary materials produced in Vietnam that could be used for subsequent industrial production in Vietnam, which also needed preparing the samples , because such materials are not available, it is following that the tests shall be carried out with the existing of such materials in Romania.

ROMCONSULT TEAM

Alexandru Teodorescu
Constantin Popa

Ministry of Light Industry

UTE specialist

ROMCONSULT
Romanian Consulting Institute

Annex 3.8
15th August 1986

REPORT
Project No. DP/VIE/86/027

Testing the suitability of selected Vietnamese species for the manufacturing of wooden accessories for the textile industry in the Socialist Republic of Vietnam - Services carried out by the ROMCONSULT team in the project area (19th of July - 15-th of August 1986)

I. In the mentioned time the ROMCONSULT team has visited the following factories:
- on 25th of July and 8th of August - The 8 March Textile Mill Hanoi-)including shuttle manufacturing sectuon)
- on 26th of July - Cau Dong Plymill, including shuttle blocks manufacturing section
- on 28th of July - Nam Dinh Textile Mill, including shuttle manufacturing section
- on 13th of August - Viet Thang Textile Mill and Hoa-Binh plywood factory including shuttle manufacturing section and shuttle blocks manufacturing section.

During the visit, the attention was pointed to the following aspects:

- the raw material actually utilized for wooden accessories
- the technological flow in the production sections
- the machines and equipment existing
- the conditions of the wood seasoning
- the tools and hardware.

At the same time, during the discussions with the factories management were drawn out the most frequent defects of the shuttle in the wearing section.

II. At the first meeting at the Ministry of the Light Industry (24th of July 86) the ROMCONSULT team handed over to the MOLI representatives:

- Chapter III of the ROMCONSULT offer-part of the contract
- bibliographic search of the Vietnamese species.

After them, the specification of the conditions, which have to be observed in the preparing of the samples was handed over by letters.

On the base of these documents, in the meetings of 24, 29, 30, 31 of July and 05, 09 August 1986, it was discussed the selection of the Vietnamese wood species but it didn't reach any agreement.

Due to the fact that the species Dalbergia cochinchinensis (trac lai), Hopea odorata (Hien-kien) and Sindora cochinchinensis (Sepetir) according to the point of view of the UTE representatives, are not available for the shuttle manufacturing, it was necessary to propose for selection other species from the enclosed list to the contract taking into consideration of the UTE proposals also.

In this situation a new meeting was organized in the presence of Mr. Patrice Coeur Bisot, Deputy resident representative of UNDP Hanoi, at the 15th of August, which has permitted to conclude an

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agreement as follows:

- The species which will be tested are:
- Dypterocarpus alatus (Dau)
- Vatica fleuriana (Lau Tau)
- Lagerstroemia calyculata (Cang Le)
- Dialium cochinchinensis (Xoay)
- Aglaia species (Gaitia)
- Canarcpsis chinensis (Gie gai)
- Dalbergia imbricatus (Trong mang)

- The samples will be air freighted in the conditions of specification given to the Ministry of the Light Industry - UTL by the ROMCONSULT team, not later than maximum two months.

Accordingly, the time schedule of the contract will be amended during the debriefing at UNIDO - Vienna.

It is to be mentioned that during our services in the project area, we had the possibility to see samples of wood species for the five species - UTL proposals, Aglaia argentea, Dypterocarpus alatus, Dypterocarpus obtusifolius and Vatica fleuriana only.

III. Regarding the chemical and auxiliary materials produced in Viethom that could be used for subsequent industrial production and which also needed the preparing of the samples, because , after the point of view of our counterpart (UTL), such materials are not available, it is following that the tests will be carried out with existing of such materials in Romania.

IV. In connection with the wood samples preparing, because it wasn't possible to be receptioned by our team as we asked at the beginning, we are considering that is necessary to be receptioned accordingly to the specifications given by the ROMCONSULT team, by a specialist in the wood industry (Research Institute for the wood industry).

We shall reserve ourselves the right to reception the wood samples at to their arrival in Bucharest- and to inform you about this.

ROMCONSULT TEAM

M.Sc.Eng. Alexandru Teodorescu

M.Sc.Eng. Constantin Popa

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Annex 4.1

N O T E

concerning the visit at the "Textile factory 6 Martie", section of shuttles, pirns and picking sticks, made on 25-th of July and 8-th of August 1986

1. Raw material

The section of shuttles is fed with raw material - blocks of stratified and densified wood supplied from plywood factory Cau Dong.

The size of 4 side planes scantlings shall be according to the shuttles types respectively 4cc x 5c x 4c mm and 3cc x 5c x x 4c mm and to the picking sticks of 1cco x 7c x 2c mm.

The scantling quality is rather low, mainly due to the following:

- sheets of veneer composing the scantlings are not of same species and their arrangement does not assure a homogenous semifinished product
- overlining of the extremities of veneer sheet pack leads to the formation of inner waves
- unappropriate densification of wood and low glueing quality of veneers of various species have as result nonhomogenous structure which brings about even detachments of scantlings during the machining process.

For pirns, strips of Vatica, having 1ooo x 4c x 4c mm are supplied from sawmills, cut to the necessary dimension, pre-dried.

The strips are kept in a small store from where they are manually overtaken and directly stacked in a drying chamber, from where they are also overtaken by hand.

The drying quality is checked out by experiments, lack of laboratory apparatus.

2. Operating process and equipment

The machining of scantlings for shuttles and strips for pirns is in two distinct sections.

The operating process takes place on individual equipment.

Due to the high wear rate of equipment after each machining operation it is necessary manual retouching.

The intraplant transport is almost performed by hand.

The main operation to obtain shuttles and pirns are:

- 4 side planing of blocks/strips
- cross-cutting on single circular saw
- boring of two heads for spindle mounting
- routing of recess with routers
- turning of shuttle ends
- sanding on narrow belt sanding machine
- rectifying of edges, sanding of rough surfaces, operations made by hand after machining
- lacquer coating of shuttles
- fittings mounting
- checking and acceptance.

Due to the simple shape of picking sticks the necessary operations are reduced.

Part of equipment are made in China, other ones being produced in the own workshops.

The main equipment within the section for shuttles and pirns are:

a. <u>For shuttles</u>

- Planing machine, 250 mm working width, 2 knives rotor
- Single circular saw
- Horizontal boring machine
- 2 side planing machine, 2 discs, 8 knives on each disc
- Spindle moulder
- Turning lathe
- Narrow belt sanding machine
- Grooving machine

b. <u>For pirns</u>

- Axial boring machine for one end boring of strips before turning
- Centering axel machine for pirn

- Turning lathe for outer profile
- Boring and moulding machine for final operations
- Moulding machine for side grooves
- Sanding and rectifying device for side groove edges
- Device for paint brushing.

The equipment have been running for more 2o years, so they are reaching low performances due to the unappropriate clearances. More than that the low quality of tools made and sharpened in own workshops, having no possibilities to check out the machining accuracy besides the bad quality of raw material create difficulties in obtaining of good result of machining operations.

The effects of the above mentioned problems have repercussions on the weaving section where it is necessary a large consumption of shuttles, which due their defects affect the quality of woven material, lowering at the same time the efficiency of production.

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Annex 4.2

Note concerning the visit to the plywood factory CAU-DUCING (shuttle block section) on 25 July 1986

1. Raw material

The plywood factory includes also the section for laminates intended for shuttle production and uses as raw material the logs of various wood species depending on availabilities (Aglaia, Lagerstroemia, Canarium etc).

The logs are floated by river and are kept in water untill they are brought to, the thermal treatment vats.

2. Technology and equipment

The manufacturing process is that known for the production of plywood, by successive processings with individual machinery such as:

- log peeling by the two peelers (CSR)
- veneer drying partly in the open and partly in a roller-jet drier
- veneer pressing in a 15 daylight press and a six daylight press (Kralovopolska).

As a general practice, for plywood production it can be used only full sheets (not jointed).

Jointed strips can be used for the production of laminates to be processed further for the production of shuttles.

For the production of laminates the factory is provided with two four-daylight hydraulic presses having plates of 1000 x 800 mm.

From the information received it results that factory produces laminates at a pressure of 40 - 60 kg /cm2 and a temperature of 140 - 150°C.

The equipment of the factory is over 30 years old and besides that it suffered the bombardements which altered the performances.

Consequently, the veneer thickness has allowances of ± 0.4 - 0.5 mm which result in densified laminates with uneven structure.

The production of laminates started 10-12 years ago with the equipment available on local market at this date.

The laminates with dimensions of 1000 x 800 x 50 mm, made of 70 veneer sheets of 1.1 mm, are converted by means of a carbide tipped saw into scantlings with the dimensions of 1000 x 50 x 45 mm.

The densified laminates are produced using veneer sheets of various wood species without sorting by quality which impedes on the quality of scantlings.

Annex 4.3

Note concerning the visit to the textile factory NAM DINH (section of shuttles, bobbins and picking sticks) on 28 July 1986

1. Raw material

This section uses both the laminated shuttle blocks received from the plywood factory CAU-DONG and the scantlings received from its sawmill.

This sawmill converts logs of Aglaia and Vatica species by means of a band saw Gillet (type 1930) equipped with a hand operated carriage which effects adversely both the cutting accuracy and the productivity.

It results planks having thickness suitable for the production of wood accessories intended to textile industry. After cutting, the planks are edged and then dried in the driers provided with psychrometers down to 10-12% M.C.

This section supplies the wood material for the production of shuttles with suitable dimensions and quality.

2. Technology and equipment

The manufacturing process is similar with that for 8 March factory but producing also shuttles of sound wood.

The machinery system is the same as for the factory visited previously but the most machines are made in the machine shop of textile factory which is equipped for both maintenance and repair operations and production of steel accessories.

The problems encountered by 8 March factory are found also in the NAM-DINH factory.

Annex 4.4

Nota concerning the visit to shuttle section of textile factory VIET THANG on 12 August 1986

1. Raw material

This shuttle section uses as raw material both laminated shuttle blocks and wood scantlings.

The laminates are supplied as scantlings of 600 x 50 x 45 mm.

As regards the solid wood it is supplied in various sizes depending on the type of products (shuttles, pirns, picking sticks).

Wood species used for above utilization were:

- Anisoptera cochinchinensis (Ven Ven)
- Dipterocarpus alatus (Dau)
- Dialium cochinchinensis (Xoay) for sticks
- Vatica sp (Lau Tau) for bobbins.

The wood scantlings are air dried in the hall (this section is not provided with driers) so that moisture content of process wood is not at the level of technical requirements.

2. Technology and equipment

The section for shuttles has been established 10 years ago and is equipped with individual machines. Consequently, the manufacturing process is by operations.

The processing accuracy is imperfect due to the quality of cutting tools and to their maintenance conditions making necessary operations manually executed for the mending of processing defects.

The transport between operations is only by hand.

The production is organized by flows:

- for shuttles
- for pirns and picking sticks.

The process sequence is the same as for shuttles section in Northern factories excepting the protection of shuttle surfaces which is executed by paraffine coating instead of lacquer coating.

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Annex 4.5

Nota concerning the visit to plywood factory Hoa Binh (shuttle block section) on 12 August 1986

1. Raw material

This factory converts green logs supplied directly from the forest exploitations.

The technology is apt for processing softwoods but is unsuitable for hardwoods since the lack of thermal treatment incudes unproper quality of peeler veneer.

In case the wood cannot be transported immediately after the felling the quality of veneers obtained from untreated logs is deficient.

Species processed at the time of visit were:

- Anisoptera cochinchinensis (Ven Ven)
- Dipterocarpus alatus (Dau).

2. Technology and equipment

The manufacturing technology is like the other plywood factories equipped with individual machines.

The veneers are dried in roller-jet driers which ensure quality drying.

For the production of laminates the factory uses the small size veneer sheets and the strips resulted from the peelers.

The veneers are pressed by two presses (CSR) intended initially for the pressing of plastics resulting laminates of 600 x 500 mm.

These presses works at a temperature of 140°C and a pressure of 35 kgf/cm2.

For the production of laminates the factory uses phenolic resins which are prepared within the glue room of this section.

Because of laminates production from veneers of 1.0 mm thickness the glue consumption is high enough (750 g/1.1 kg product) which result in higher production costs.

The problems with the production of laminates are similar with these mentioned for the factory CAU-DUONG.

Annex 4.6

Nota concerning the actual production of shuttles, pirns and picking sticks

Based on the ascertainments and on the discussions with the management of factories which include the respective production sections it have resulted the following problems:

1. Troubles with the quality of wood accessories (specially shuttles) occuring during the production and in operation.

1.1. Splitting of shuttles and breaking of materials which result in no longer utilization and even accidents

1.2. Coarse shuttles which result in hitching of yearns affecting adversele the quality of products and the productivity.

1.3. Loosening of steel tip of shuttles which takes the shuttle out of work.

1.4. The shuttles and pirns are not in the limit of tolerances allowed and the dimensions are altered by machining and for these reasons these shuttles and pirns are removed from the clamping devices.

1.5. The spring which keeps the pirn in shuttle axle loses the elasticity and the pirn does not remain in the axle.

1.6. The screw for steel or plastic accessories mounted on shuttles, pirns and picking sticks are loosened, putting these out of operation,

1.7. Breaking of picking stick body.

Above troubles have significant effects on the consumption of wood accessories per looo m of weavings and at the same time affect adversely the quality of products and the productivity.

2. Main causes standing at the origin of above troubles

2.1. As regards the wood species, the necessary amounts of wood material for the production of wood accessoreis cannot be ensures and for this reason the manufacturing technologies specific to each product cannot be established.

2.2. Minimum technical norms (specifications) necessary for selection, handling and processing of raw material are not

established and for this reason some troubles occur either in the manufacturing process or in operation which are costly and difficult to repair.

2.3. Conditions for the storing, air drying and protection of scantlings are not satisfactory. Furthermore, the drying capacity (kiln drying) is not satisfactory to reach the moisture content necessary in the process of shuttles and other accessories.

2.4. Weaving sections are not provided with air conditioners which induce major variations of humidity.

2.5. The most suitable wood species by product assortments and the economical conditions for the utilization of these species for the production of shuttles, pirns and picking sticks are not established.

2.6. In the production of laminates there are no technical norms concerning the condition of raw material, processing accuracy, drying conditions.

2.7. For, the process of wood material in the sections for shuttles and other accessories there have not been established permissible deviations and tolerances and the control of compliance with these tolerances in various process stages.

In correlation with above deviations and tolerances it is to be mentioned that permissible deviations and characteristics of steel and plastic accessories mounted on shuttles are not established.

2.8. The woodworking machinery system is at the level of years '6o (machines for individual operations with low speed and with processing accuracy depending on the skill of workers).

2.9. In the production of shuttles and bobbins some operations such as sanding and finishing are not carefully executed (sanding with a single granulation does not provide sufficient fineness).

2.1o. The manufacturing technologies are established without sufficient care for the manual devices used in some hand

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operations. Furthermore, there is a lack of gauges for the control of equipment operation and of tool sharpening.

2.11. There will be necessary to provide stores with air conditioners for the keeping of shuttles till they are put into operation.

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Annex 4.7

Nota concerning the structure of production cost

I. Data supplied by UTE on 05.8.1986

Structure of costs for 1000 shuttles

Raw material - shuttle blocks laminated: 0.644 m3	51.540 dong	37.0%
Auxiliary materials		
- steel accessories mounted on shuttles		
- finishing lacquers		
- sanding paper		
tools etc	53.300 dong	38.3%
- energy consumption	1.250 dong	0.9%
- wages (3.5 shuttles/8 h)	51.500 dong	3.7%
- other expenses	8.760 dong	6.3%
Total	120.000 dong	86 %
Income	19.200 dong	13.8%
Total delivery price	139.200 dong	100%

II. Data received in the visit of Viet Thang

- The laminated shuttle blocks cost	30000 dong/m3
- The strips for pirns - cost	5470 dong/m3
- The scantling for picking sticks cost	9020 dong/m3
- The cost for peeling logs of species Anisoptera, Dipterocarpus	3200 dong/m3
- The cost of shuttle consumption in the cost of cotton weaving products	1.65%.

III. Specifically shuttle consumption per 1000 m cotton weaving products

- Shuttle al made by laminated shuttle blocks	3.5 pcs/1000 m
- Shuttle imported	1.1 - 1.5 pcs/1000 m

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Annex 5

P R O T O C O L

concluded at the headquarter ROMCONSULT-ICPIL
Bucharest today 06.04.1988

Participants:

- Vietnamese side:

eng. Do Van Gian - Specialist in wood accessories - Union of Textile Enterprises

eng. VU TRONG HUAN - Manager of Shuttle Section - Textile Enterprise NAM-DINH

- Romanian side:

eng. Petre Grozuţă - ROMCONSULT
eng. Alexandru Teodorescu - Project Manager - ICPIL
eng. Constantin Popa - Specialist in woodworking industry

Object: Study tour of the two Vietnamese specialists for training by assisting to the testing of the seven species of Vietnamese wood, in order to establish the most appropriate ones for manufacturing the wood accessories for textile industry in Vietnam (shuttle, pirns).

The training activity took place within the Reseerch and Design Institute for Wood Industry, Bucharest observing the following program:

- delegation arrival in Bucharest: 06.02.1988
- drafting meeting: ROMCONSULT and PNUD 08 and 09.02.1988
- training sessions: 10.02.1988 - 06.04.1988 based on the attached training program which was drawn up in accordance with the laboratory tests for test pieces of the seven species received from Vietnam within the contract VIE/80/027.

The training program was sequenced on the following activities:

- lecturing on different fields specific to wood testing works in order to determine all the wood properties.
- attendance and direct participation in research works held in the institute laboratories in order to settle the appropriate workability degree of the seven wood species for manufacturing of

wood accessories intended for textile industry.

The mentioned activity was sequenced on the following fields:

- determination of physical and mechanical properties of wood
- natural drying, and acclimatizing, of wood
- wood storing
- kiln drying of wood
- protection and preservation of wood
- improvement of wood properties by densification, impregnation and finishing
- conditions for wood processing and attendant tools.

The training program ended by a summary session concerning some of the first results of the tests.

Between the 7th and the 8th of April 1981 the Viet-namese team visited a factory for wood accessories intended for textile industry.

The training works were friendly held observing the main aim of this program; namely the thoroughly assimilation by the two specialists of the main principles for the selection of appropriate wood species and wood material; a special attention was paid to the main testing works necessary to establish and select the suitable wood species complying with the main acceptance manufacturing of shuttles and pirns .

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ANNEX 6

LIST OF MAIN EQUIPMENT FOR THE PILOT PLANT

Crt. no.	Specification	MU	Quantity	Estimated value US $
1	2	3	4	5
1.	Thermo-ventilation equipment for drying kilns (2 kilns)	global to[illegible]	12	50000
2.	Ten-stages hydraulic press -size of stage:1200x600 mm -maximum force: 850 to -specific sizing force:150 daN/cm^2 -heating agent -temperature of heating agent: 160°C	pce.	1	115000
3.	2 sided planer -max.working width:600 mm -planing thickness:10-140 mm -speed of cutter spindle:5000 rpm	pce.	1	12000
4.	Four side moulding machine -max.working width: 140 mm -min.working thickness:115 mm -speed of cutter spindle:6000 rpm	pce.	1	75000
5.	Spindle moulder -max.moulding thickness:100 mm -moulding spindle dia.:25;30; 40 mm -speed of moulding spindle: 3000;4500;6000 and 9000 rpm	pcs.	2	35000
6.	Router -stroke of cutter spindle:150 mm -speed of cutter spindle:18000rpm	pce.	1	14000

1	2	3	4	5
7.	Automatic wood turning lathe -max.length : 900 mm -max. diameter:210 mm -speed of spindle(variable): 1500,2000,2500,3000,4000 r/m	pce.	1	25000
8.	Boring machine -max.hole diameter:150 mm -travel of table: 200 mm -drill speed: 5000 rpm	pcs.	2	6000
9.	Two belt dry sander -dimensions of sand belts: 3900 x 120 mm -speed of sand belts:28 m/min.	pcs.	3	9000
10.	Different control device for checking the quality of production	global	-	12000
11.	Transport means (forklift, trucks,roller conveyors, carriages, others)	-	-	8000
12.	Testing equipment(universal machine for testing,semiautomatic technical ballances, psychrometers, micrometers, and others)	-	-	15000
		-	-	386000

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ANNEX 7

TECHNICAL DATA FOR SOLID WOOD SEMI-FINISHED PRODUCTS FOR SHUTTLES AND PIRNS

Execution. The solid wood semi-finished products for shuttles and bobbins are made only of round trees having diameters of 30 - 80 cm and length over 0.5 m.

Related to the quality the wood shall be round, normal conformation, straight, without curly grain, knotless, the tree being cut 1.0 - 1.5 m from the ground.

The round wood is continuously transported from the felling area to the semi-finished product sections,to avoid wood degradation.

The whole quantity of round wood intended to the production of semi-finished products for shuttles and pirns shall be provided on its ends with steel clamp,S-shaped over which some flexible protection paste shall be applied (bitumen,paraffine) to assure the proper wood condition during the transport to the place of wood conversion into semi-finished products.

The semi-finished products shall be sawn on,saws having radial and semi-radial cutting.

The longitudinal opposed faces of semi-finished products shall be parallel and planed perpendicularly to the longitudinal faces. The deviations from the face parallelism is allowed for max. 2 mm.

The protection against fungi and other insects shall be made by chemical substances(xilotoxine)immediately after cutting.

After cutting, to avoid cracking,the semi-finished products are coated with a paraffine film on the end faces, on a length of 20 mm from each end.

The semi-finished products for shuttles shall not have defects over the allowed ones, specified in vietnamese standards ,to be drawn up.

The dimensional qualitative conditions of the semi-finished products (scantlings and strips) for shuttles and

pirns shall comply compulsorily with the dimensional qualitative conditions of the finished product.

These conditions are specified below:

a. Qualitative conditions:

Defect	Permissible conditions	
	Semi-finished products for shuttles	Semi-finished products for pirns
1	2	3
Colours	-allowed,2 mm deep no decomposition	- ditto
Inclined grain	-allowed on the radial section, only on an edge	- ditto
	-accentuated local deviations of grain not allowed	- ditto
	-grain pattern is not considered defect	-grain pattern on a length of 22 mm is not considered a defect
Fissures	-are allowed max.2 mm deep	-ditto
Spring and bend	-allowed,max. deviation 5 mm	-max.deviation,2 mm on a length of 220 mm
Wane	-allowed,max.length 75 mm	-allowed,max. length 180 mm
	From each end	
	-on the all edges	-on a single edge
	On the condition not to reduce the sawn side of faces with defects with more than:	
	12 mm which is left,reduction is performed on each face	5 mm

1	2	3
Sawing traces	Allowed on the condition no to reduce the piece section	
Other defects	-are not allowed	-are not allowed

b. Dimensional conditions and shapes

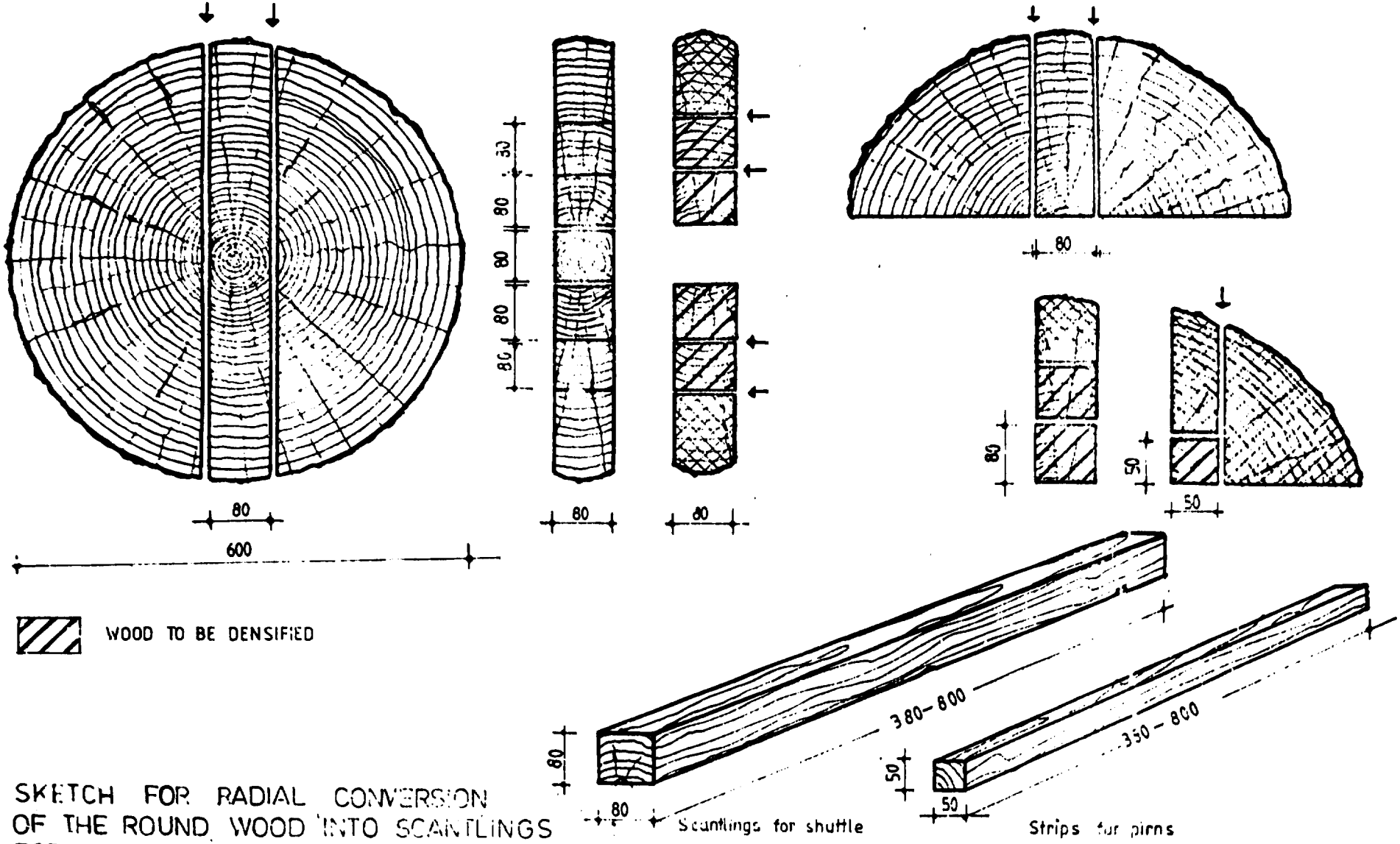
The solid wood semi-finished products for shuttles and bobbins are parallelepiped shaped; they are usually sawn according to the following table:

Symbol of semi-finished product (size)	Length	Nominal section n= 12-15%		Section green state U=50%	
		width	thickness	width	thickness
S 1	380	55	55	60	60
S 2	420	60	60	65	65
S 3	440	60	60	65	65
S 4	460	65	65	70	70
S 5	500	80	80	87	87
S 6	560	85	85	92	92
S 7	600	80	100	85	106
S 8	650	80	100	85	106

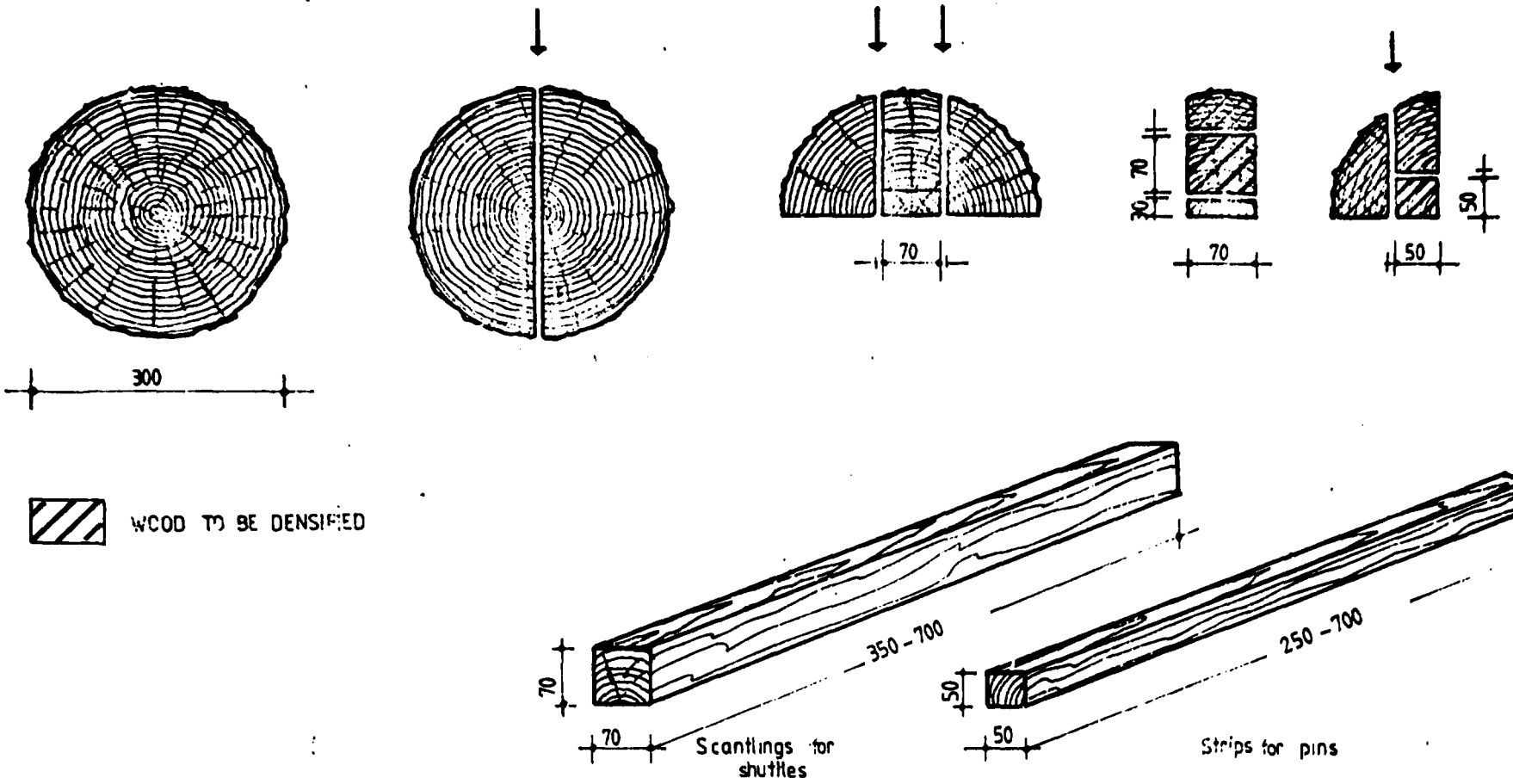
NOTE : The dimensions of the above mentioned semi-finished products are dimensionally correlated with the dimensions of the shuttles.

The semi-finished products for pirns of solid wood are made having a cross section of 32 x 32 mm for U = 12 - 15% respectively 35 x 35 mm in the green state and lengths of 250, 400, 500 and 700 mm.

NOTE : The dimensions in the green state are increased with the over-dimensions for shrinkage, established for each species.
Admissible deviations of the wood dimensions, green state:
- on length ± 20 mm
- on width and thickness : + 2 mm
  - 1 mm



SKETCH FOR RADIAL CONVERSION OF THE ROUND WOOD INTO SCANTLINGS FOR SHUTTLES



SKETCH FOR RADIAL CONVERSION
OF THE ROUND WOOD INTO SCANTLINGS
FOR SHUTTLES

Draft program and time schedule for implementation of the shuttle pilot plant

Ord. nr.	Specification	Spreading out								Remarks
		1st year				2nd year				
		I	II	III	IV	I	II	III	IV	
1.	UNIDO acceptance of drawn up studies and documentation	○								
2.	Elaboration of the study for implementation of the shuttle pilot plant in Vietnam, drawn up by a specialized institute, as technical assistance granted by UNIDO.	———								
3.	Drawing up of the specification necessary to purchase the process equipment intended for project.	·	—							
4.	Elaboration of execution project to set up the respective shuttle pilot by the specialized institute, as technical assistance granted by UNIDO.			———	———					
5.	Checking out and acceptance of the offers for equipment received to UNIDO on the basis of the presented specification.		—	—						
6.	Carrying out of works on the site for equipment and installation erection, for which technical assistance shall be granted by specialists of the institute.					———	———	———		
7.	Operating instructions for process line, drawn up by the specialized institute.					—				
8.	Training of the personnel for the new process line.							———		
9.	Putting into operation of the shuttle pilot plant							▶		
10.	Technical assistance granted by the specialists to ensure the manufacturing of products with a high quality in accordance with the international standards.								———	

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Annex 1.2

UNIDO PROJECT DP/VIE / 80/027

BIBLIOGRAPHIC SEARCH OF THE VIETNAMESE WOOD SPECIES

Code 86/37/RK

1986

TABLE OF CONTENTS

I.P.C./M. C.N. 1981-9773. 20.000 ex.

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TECHNICAL REPORT

I. General

1. Specification : Bibliographical search on wood species occuring in Vietnamese forests

Searcher : ROMCONSULT-ICPIL
Indicative : UNIDO PROJECT DP/VIE/80/027
Code : 86/37/RK
Base : Contract between UNIDO-Viena and ROMCONSULT-Bucharest

This bibliographical search has been drawn up for preselection of wood species occuring in Vietnamese forests and suitable for the production of wood accessories to be used in textile industries (shuttles, reels, picking sticks).

The elaboration of this search is based on :

- speciality works carried out worldwide
- speciality works carried out in Romania
- searches of ROMCONSULT-ICPIL on various tropical woods
- data concerning Vietnamese forests, supplied with the inquiry N V P. 86/2

For the above purpose, respectively the preselection of wood species suitable for production of accessories to be used in textile industries, the following aspects have been studied:

- conditions of raw material required for production of wood accessories
- wood species available in Vietnam with properties ensuring the possibilities for taking into account of these species for production of wood accessories
- analysis by comparation of these species with other species growing in Europe and used for production of wood accessories.

II. Contents

Wood pieces for the production of accessories required by textile industries shall have parallelepiped shape and variable dimensions corresponding to the specification of said accessories.

For example, the wood pieces for the production of shuttles and pirns shall have the following dimensions (MC = 15 - 18 %):

- lengths : 370 - 650 mm, permissible deviation ± 20 mm
- widths : 55 - 85 mm, permissible deviation between + 2 and - 1 mm
- thicknesses : 55 - 100 mm, permissible deviation between +2 and -1 mm

The wood pieces for the production of accessories will be obtained by radial (accepted also partly semiradial) conversion of timber.

These wood pieces shall have longitudinal surfaces parallel one another and the ends cut perpendicular to longitudinal edges.

The wood shall be sound, with homogeneous structure an uniform density.

Defects permitted shall be :

- stains : allowed to max 2 mm depth if no decay is observed
- heart : not allowed
- slopping grain : allowed in radial section if not passes from an edge to another
- fissures : allowed in max 2 mm depth
- waves: allowed in limited number in zones to be removed by processing
- knots: not allowed
- cracks: not allowed
- inbarks: not allowed.

Wood for production of accessories must be dry, protected against deterioration of any kind and shall be stored suitably for keeping intact the dimensions and quality.

Herewith are attached a piece of wood to be used for production of accessories (annex 1) and a shuttle (annex 2). sketch of

The preselection of Vietnamese wood species is based on the data supplied in FAO Assistance for Forest inventory and planning - report of Mr. B. Rollet.

From this work it results that Vietnamese forests include more than 40 commercial species (see annex 3). A large number of these species are softwoods not suitable for production of wood accessories.

The search has taken into consideration only species of quality class NG.1, NG.2 and NG.3 (see annex 4).

For a number of 16 species we have drawn up data sheets (annexes 5-20).

At the same time, we have drawn up data sheets for two European wood species used on the production of wood accessories (annexes 21 and 22).

Analysing the date in these sheets and in the studied works the following conclusions can be drawn:

- Vietnamese forests like other forests in Asia between 10^{o} and 20^{o} North latitude are characterized by a multitude of species of which only a small number (about one third) are commercial wood.

- Trees of these species are tall and large in diameter so that stems can be used on a sufficient length. The felling can be made mechanical with high economic efficiency.

- A sensible amount of trees in these forests are Dipterocarpaceae which is strongly represented on world markets.

The Diptercarpaceae has a large number of sorts and species differentiated by geographic area and geologic- climatic conditions which make difficult to establish an unitar treatment and consequently these species must be used considering the conditions for each of them.

As an example we can show the differences between densities for:

Lagerstroemia	- from 500 to 800 kg/m3
Parashorea	- from 450 to 630 kg/m3
Dipterocarpus	- from 640 to 915 kg/m3
Vatica	- from 660 to 1050 kg/m3
Hopea	- from 700 to 1100 kg/m3

3. The preselection of Vietnamese wood species is carried out by comparation of wood properties with the European species used for production of wood accessories required by textile industries.

The analysis is based on the following elements:

- macro and microscopic irternal wood structure
- physico-mechanical properties
- natural and artificial drying conditions
- wood workability
- actual utilization.

Based on the above considerations the following eight wood species (groups) are preselected, namely:

- Dipterocarpus alatus, diery (cheruing) (Tro, Dau)
- Hopea adorata, H. Sp. (merawan) (Sao, K.en-Kien)
- Vatica tonchinensis (resak) (tau, lau-tau)
- Dalbergia , cochinchinensis (indochinese rosewood) (trac, trac-lai)
- Lagerstroemia caliculata, L. Flos (bungur) (bang lang)
- Sindora cochinchinensis (sepetir) (Gomot)
- Dialium cochinchinensis (Xaoy)
- Sageraea elliptica (chooi) (sang may)

The five species for searching and testing will be selected from above species based on the analysis carried out further by specialists in Vietnam.-

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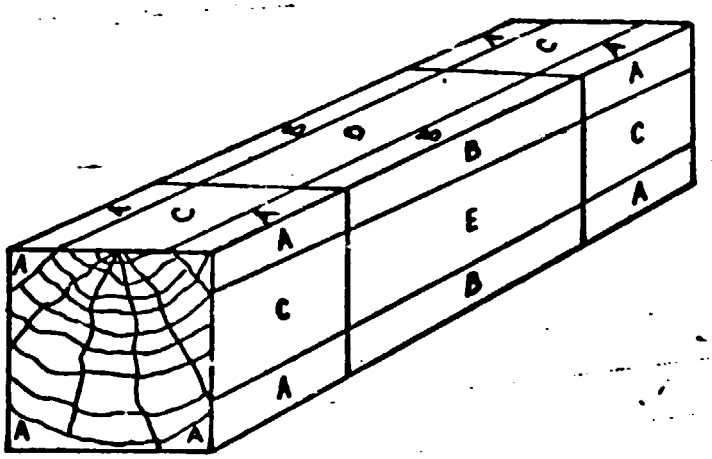
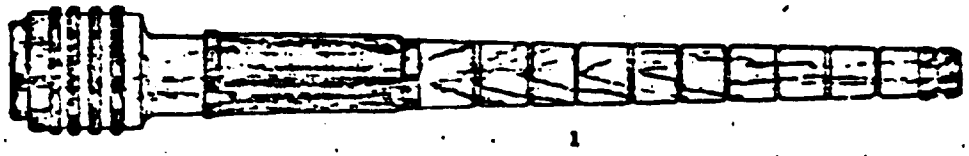


WOOD SEMI-MANUFACTURED FOR SHUTLES,
COPS, PICKING STICKS

A, B, C, D - Different zones in which some defects are permitted



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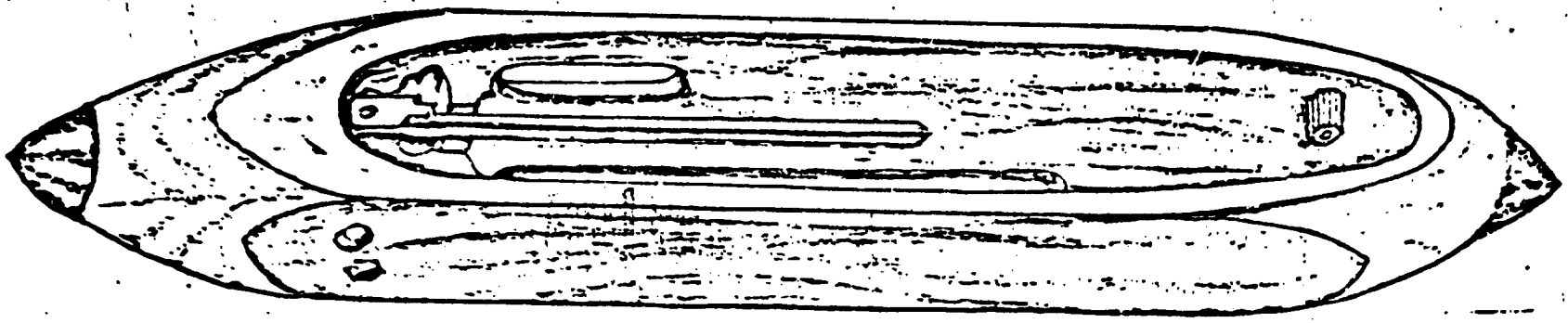

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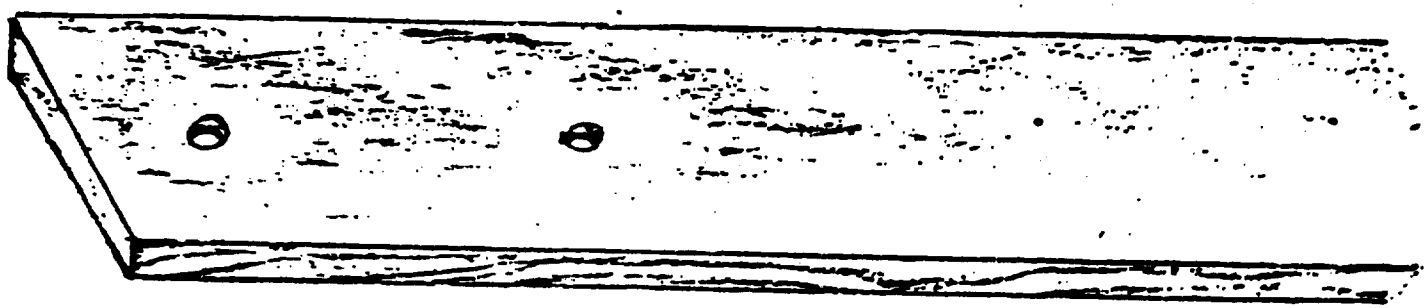

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1 - Cop
2 - Shuttle
3 - Picking sticks

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ANNEX 3 42

LIST OF CURRENTLY AVAILABLE TIMBER SPECIES IN VIET NAM

Item No.	Local name	Botanical name:	ATIET name:
1.	Bang Lang	Lagerstromia loudoni-Taijm	Bungur
2.	Bang Lang Nuoc	Lagerstromia flos-Regional-Retz	
3.	Binh Linh	Vitex pubescens - Vahl	Leban
4.	Cang Lo	Betula anoides - Buch	
5.	Chai	Shorea vulgaris	White Meranti
6.	Tro	Shorea atrinervosa	Balau
7.	Cho Chi	Parascherea stellata-Kury	White Seraya
8.	Dau	Dipterocarpus sp.	
		Dipterocarpus alatus	Cheruing
9.	Dau Song Nang	Dipterocarpus dyeri-Pierre	
10.	Mai-Don	Pthercarpus	Burma Padauk
11.	Gie Gai	Castanopsis chinensis-Hance	
12.	Gie Gai Bac Bo	Castanopsis tankirensis-Seem	
13.	Goi Nep	Aglaia gigantea - Pellegrin	Tasua
14.	Goi Te	Aglaia sp.	
15.	Gu Mat	Sindora cochinchinensis-Baill	Sepetir
16.	Hoang Dan Gia	Dacrydium pierrei-Hick	
17.	Lau Tau	Vatica cochin.	Resak
18.	Lim Vang	Peltophorum tonkinensis-Pierre	
19.	Long Mang	Pterospermum	
20.	Me	Manglietia conifera - Dandy	
21.	Muong	Cassia sp.	
22.	Muong Den	Cassia simea - Lanik	
23.	My	Lysidica rhodostegia-Hance	
24.	Sang	Sapindus oocarpus	
25.	Sang Le	Lagerstroemia calyaclata-Kur	
26,	Sang May	Sageraea elliptica	Chooi
27.	Sau Den	Hopea odorata	Merawan
28.	Kien-Kien	Hopea ferrea	Giam
29.	Gia-Ti	Tectona grandis	Teak

Item No.	Local name	Botanical name	ATIBT name
30.	Thi Rung, Mun	Diospyros	Ebène Noire d'Asie
31.	Thong Ba La	Pinus kesiys - Royle	
32.	Thong Nang	Podocarpus imbricatus-Bl	
33.	Thong Nhira	Pinus mercusii	
34.	Tram	Melaleuca leucandendrem-Linh	
35.	Tram Hong	Canarium sp.	
36.	Tram Trang	Canarium album - Raeusch	
37.	Truong Mat	Paviesia	
38.	Vang Trung	Endospermum sinensis-Benth	
39.	Ven Ven	Anisoptera cochinchinensis-Pierre	Mersawa
40.	Xoan Dao	Pygeum arboreum - Endl & kurz	
41,	Xoay	Dialium cochinchinensis-Pierre	Xaoy
42.	Cong	Calophyllum	Bintangor
43.	Dao-Leo	Tetrameles nudiflora	Binung
44.	Mit Nai	Artrocarpus	Keledang
45.	Cam Lai	Dalbergia cochinchinensis	Palisandru indochinez
46.	Gon Uoc	Intsia (afzelia)	Merbau
47.	Cam Lien	Terminalia	Laurel indian

TIMBER CATEGORIES

Gr. N.G. 1	Luxurious species (class I)
	Sindora cochinchinensis (Gu mat)
Gr. N.G.2	Very hard and hard species (class II and III)
	Hopea odorata (Sao don)
	Lager stoemia (Bang lang)
	Vatica cochinchinensis (Lau teu)
	Vitex pubescens (Binh linh)
	Paviesia (Truong mat)
Gr. N.G. 3	Medium hard and red species (class IV, V and VI)
	Eugenia sp.. (Tram)
	Diospyros (Thy rung)(Nho noi)
	Pterospermum (Long mang)
	Dipterocarpus alatus (Dan rai)
	Shorea vulgaris (Chai)
	Anisoptera cochinchinensis (Ven ven)
Gr. N.G. 4	Other species (only firewood) (class VII and VIII)
Gr. N.G. 5	Unknown species

Crt. no. BIBLIOGRAPHIC SEARCH OF THE PROPERTIES OF THE MOST COMMON SPECIES OCCURING IN THE VIETNAMESE FORESTS

1 a. Botanical name: Lagerstroemia Sp. Calyculata Kurz, L. Flos Reginae Retz, L. Speciosa

b. ATIBT name: Burgur

c. Standard name: Bang-Lang

d. Local name: Bang-Lang

2. General description: Large size wood, stem with grooves and swellings, sapwood and heartwood differentiated by species; light grey sapwood, light red heartwood, reddish brown, visible growing rings, straight grair wood, often wavy or knitted; grain structure from fine to rough depending on the size of glossy pores, decorative aspect; alike to nut tree, oak tree or teak.

3. Physico-mechanical properties:

density: R_{15}=550-800 kg/m3 ; R_v = 900 kg/m3

shrinkage and swelling ratio: medium α_v = 10.7 %

tensile strength : -

compression strength: R_{c_i}=50 MPa

bending strength : Ri =92 MPa

modulus elasticity: E = -

shearing strength: -

splitting resistance: -

hardness: -

4. Other properties:

Natural hardness: high enough; sapwood is easily treated with preservative while the heart wood is not.

- Slow and difficult natural drying; trend to cracking and deformation.
- Artificial drying: requires special attention
- Workability; appropriate for straight grain wood; for sawn timber cross-cutting, log steaming is recommended to avoid deformation and cracking; bending and easy screw and glueing, assembling, lacquer and paint finishing without any difficulty.

5. Use:

Manufacturing of veneer, furniture, indoor arrangements, doors, windows, ladders, floorings, parquetry, ship buildings, waggons, car bodies, barrels, cabinets, handles (tools, household items, roof framings, bridges, cross-members, weapon stocks, sport sticks, turned wood elements, panels for electrical components mounting; it corresponds to the range of utilization of teak

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ANNEX 6

Crt. no. BIBLIOGRAPHIC SEARCH OF THE PROPERTIES OF THE MOST COMMON SPECIES OCCURING IN THE VIETNAMESE FORESTS

1. a. Botanical name: Shorea Sp., Shorea vulgaris -Pierre

b. ATIBT name: White Meranti

c. Standard name:-

d. Local name: Chai (Shorea vulg.)

2. General description:

White sapwood, white brown heartwood up to grey red, with glossy stripes; medium hard-wood, with straight grain but often with wavy and knitted grain, conferring decorative aspect, medium and uniform grain structure.

3. Physico-mechanical properties (for Shorea vulgaris)

density(for U=12): d=700 kg/m3

shrinkage and swelling ratio: α_{tg}=7.5 %; α_v = 13.5 %

tensile strength: Rtv= 2.9 MPa

compression strength: Rcp= 60 MPa

bending strength: Ri = 155 MPa

modulus elasticity: E= 12600 MPa

shearing strength: Rfp 8.9 MPa

splitting resistance: -

hardness (Janka) : -

4. Other properties:

Medium natural hardness, green sapwood is attacked by blue stains and insects, weather non resistent; sapwood is permeable, hartwood is not permeable;

- appropriate natural drying, deffectless
- difficult to be processed with cutting tools wearing quickly the sharpness because of the silicon content, good cross-cutting into veneer even after a reduced thermal treatment, good nail and screw assembling; glueing and finnishing without difficulties.

5. Use: Manufacture of decorative veneer, especially for plywood, formworks, waggons, containers, interior veneer (in furniture production) doors and windows, floorings, roof framings, columns, ship building and boats, car bodies, barrels; resin is utilized for lacquer preparation.

Crt. no.

BIBLIOGRAPHIC SEARCH OF THE PROPERTIES OF THE MOST COMMON SPECIES OCCURING IN THE VIETNAMESE FORESTS

1. a. Botanical name: Para Shorea Stellata- Kurz

   b. ATIBT name: White Seraya
   d. Local name: Che-Chi
   c. Standard name: -

2. General description:

   High size wood up to 16 m height, ∅ 100 - 150 cm, sapwood scarcely differentiated from heartwood, light-brown-pink, tinted; straight grain wood, oftenly knitted, providing decorative strips on radial section.

   Rather coarse and uniform grain structure wood; contains gummiresins and intracellular chanels.

3. Physico-mechanical properties: U=15% c

   density: (d) = 450...540...630 kg/m3 (780 acc. to ATIBT)
   shrinkage and swelling ratio: low
   tensile strength: medium, alike to African mahogany
   compression strength: medium, alike to African mahogany
   bending strength: medium, alike to African mahogany
   modulus elasticity: -
   shearing strength: medium, alike to African mahogany
   splitting resistance: medium, alike to African mahogany
   hardness (Brinell): medium, alike to African mahogany

4. Other properties:

   Low hardness (when green is fungi and insects attacked producing abnormal tints and black galleries; easily cured with preservatives.
   Good natural drying; careful arficial drying; well hand and mechanical workability; appropriate for veneer peeling after intensive steaming; very slight bending; well nail and screw assembling; easy glueing and finishing.

5. Use:

   Mainly for plywood manufacturing; used for standard and period furniture, doors, windows, panelings and parquetry, light roof frame, indoor arrangements, replaces teak.

Crt. no. BIBLIOGRAPHIC SEARCH OF THE PROPERTIES OF THE MOST COMMON SPECIES OCCURING IN THE VIETNAMESE FORESTS

1. Botanical name: Dipterocarpus Dyeri Pierre, D. Spp.

b. ATIBT name: Cheruing (previous Yang)
c. Standard name: -
d. Local name: TRO North (north area) and DAU South (south area)

2. General description:

Large size wood with h = 50 m, ∅ = 80 - 150 mm with straight stem. Sapwood slightly differentiated from heartwood which is pinkish brown or redish brown becoming dark in air; seldom with darken strips. Wood with straight grains seldom poor knitted, coarse but even grain structure; rarely with decorative aspect. Sweat out gommy resins at the leg ends, more aburdent in the sapwood.

3. Physico-mechanical properties:

density: (d) = 640...735...915 kg/m3 (for U = 12 %)
shrinkage and swelling ratio: ( ) r=6.6; t=12.1; v= 18.1 %
tensile strength: Rtp= 9.2...120 MPa
compression strength: Rcp= 63 MPa
bending strength: Ri= 154 MPa
modulus elasticity: E=13.500, MPa
shearing strength: Rfp= 9.8 MPa
splitting resistance: -
hardness: (Janka, trett J cross)= = 64 MPa

4. Other properties:

Natural hardness: good for heartwood ard even for sapwood in dry condition; poor for sapwood just after felling; medium resistant to xylophagous fungi; medium resistant to weather; well impregnated. Difficult natural drying with trend to cracking at the ends. Artificial drying is good but gommy resines appear. on the surfaces.

Difficult sawing because of gemmy resines and silice. Long time steaming is required before peeling; mean warpings; easy assembling by nails and screws. For finishing it requires a previous treatment at 82-88°C during 24 h; the dust produces dermatites and iritations.

5. Use:

Large utilization for buildings (preservated or not preservated) roof framings, bridges, piers, poles, sleepers, pit props, floorings, ladders, windows, pannelings, boats, waggons, car body, period furniture, cultural items, wood turnings, cabinets, handles, knives, gommaresines are sold as gorjun (bolao, being used for stuffing of boats and for medicines.

Crt. no BIBLIOGRAPHIC SEARCH OF THE PROPERTIES OF THE MOST COMMON SPECIES OCCURING IN THE VIETNAMESE FORESTS

1. a. Botanical name: Sindora Sp., S.Cochinchinensis - Baill

   b. ATIBT name: Sindoer(presently Sepetir)

   c. Standard name: -

   d. Local name: Gu, Gemat, Go

2. General description:

Large size wood h = 30.- 40 m ; Ø = 60 - 120 cm with straight, cylindrical stem.

Wide sapwood, brown grey or light grey, and heartwood redish brown, coffee teinted brown with dark brown strips having decerative aspect.

Visible growing rings;

Straight grain, seldom lightly knitted , fine even grain structure, without gloss, oily touch, sweads out oily substances at surface.

3. Physico-mechanical properties: (U = 12 %)

density: (d)=700-890 kg/m3

shrinkage and swelling ratio: v= t0 12.9 %

Tensile strength: Rtp = -

compression strength: Rcp =45.4 MPa ... 70.4 MPa

bending strength : Ri = 98.5...179 MPa

modulus elasticity: E = -

shearing strength: Rfp : -

splitting resistance: -

hardness (Janka for U= 15 %)
HJr=50 MPa; HJtg =53 MPa

4. Other properties:

Natural low-hardness; sapwood severely attacked needing preservation; heartwood heavily impregnated; rapid air drying without defects; the sawn timber 37.5 mm thick is dried well in no more than 5 months under conditions existing in Malaysia. Good workability with any type of tools despite of rapid wearing of cutting edges. Darker wood requires higher effertrs. Veneers are produced easier by peeling. Sliced veneers have trend to cracking. Nail and screw assemblings are strong enough; reduced warpings; easely finished but with pore filling, problems seldom arise with oleoresine finishes.

5. Use:

Mainly for furniture production, plywood, doors-windows, floorings, indoor arrangements, radio and Tv cabinet, trays, brush covers, frames, stick, shelvings, structural timber for medium loads.

Crt. no. BIBLIOGRAPHIC SEARCH OF THE PROPERTIES OF THE MOST COMMON SPECIES OCCURING IN THE VIETNAMESE FORESTS

1. a. Botanical name: Sageraea Sp., S.Elliptica Hook

   b. ATIBT name: Chooi

   c. Standard name: -

   d. Local name: Sang May

2. General description: (for various species of Sageraea)
   Medium size wood, ϕ 60 - 80 cm.
   Sapwood lighter than hearthwood, yellow-tinted, light brown up to olive - yellow, greenish brown yellow.
   Straight grain wood, medium grain structure up to coarse grain , without smell and taste, glossy, on the radial section.

3. Physico-mechanical properties: (for U = 12 % - 15%;
   density (d): 530...670...920 kg/m3
   shrinkage and swelling ratio : r=1.4; αtg = 2.3 %
   tensile strength : Rtp = -
   compression strength: Rcp= 49 MPa
   bending strength: Ri = 106 MPa
   modulus elasticity: E=16,500 MPa
   shearing strength: Rfp = -
   splitting resistance: -
   hardness (Janka) : -

4. Other properties:
   Good hardness on dry wood; and poor hardness on the green sapwood, low weather resistance.
   Easily cured with preservatives.
   Natural drying - slowly and defectless
   Workable with any type of tools, appropriate for veneer peeling; easy and resistant nail and screw assembling; well lacquer and paint finishing.

5. Use:
   Manufacturing of matches(box and sticks), plywood, cases, shelvings packing boxes, office and drawing articles , reels and toys. Used in buildings for structure elements under medium loads and floorings.
   Heavier wood intended for sport articles, sculls and boats; replaces mapple wood.

ANNEX 1.2 / II

Crt. no. BIBLIOGRAPHIC SEARCH OF THE PROPERTIES OF THE MOST COMMON SPECIES OCCURING IN THE VIETNAMESE FORESTS

1. a. Botanical name: Hopea Sp., H. Odcrata Roxh

   b. ATIBT name: Merawan; Giam d.Local name: Sao, Kich-Kien

   c. Standard name: -

2. General description:

   - Medium size wood ϕ 60 - 80 cm
   - Sapwood - light yellow, narrow, slightly different as to heartwood - dark yellow up to dark brown
   - Wood with straight grain, fine grain structure, homogeneous, rather high density.

3. Physico-mechanical properties: (U = 15 %)

   density (d): 700-950-1100 kg/m3 (heavy wood)

   shrinkage and swelling ratio rd = 4.2; tg 8.2-9.6; v-12.6-13.9%

   tensile strength Rtp = 262 MPa

   compression strength Rcp = 70 MPa

   bending strength Ri = 165 MPa

   modulus elasticity E = 15,700 MPa

   shearing strength Rfp = 17 MPa

   splitting resistance: -

   hardness (Jankai-Brinell)
   HB cross = 97; rd = 30; tg = 40 MPa

4. Other properties:

   - High natural hardness; dry heartwood, cannot be attacked by xylophagous insects, fungi and weather resistant.
   - Hard to be treated, so it is used untreated or surface treated;
   - Slow natural drying;
   - Heavily workability by sawing with high energy consumption.

5. Use:

   - Multi-used even chemical untreated;
   - For buildings submitted to high loads, bridges, dams, piles, columns for high voltage electric mains, cross elements floors, bases for heavy installations, ships buildings, car bodies, waggons, barels, acid resistant vessels for chemical industry, weapon stocks; it sweats dammar resins.

Crt. no. BIBLIOGRAPHIC SEARCH OF THE PROPERTIES OF THE MOST COMMON SPECIES OCCURING IN THE VIETNAMESE FORESTS

1. a. Botanical name: Vatica Sp., V. Tonchinensis A.chen

b. ATTAT name: Resak

c. Standard name: -

d. Local name: Tau, Lau-Tau

2. General description:

Medium size, up to large wood (h = 50 m), Ø 80 - 150 mm.

- Large sapwood (up to 10 cm), yellow, white-pink or yellow light-brown, scarcely different from heartwood yellow brown or red-dark-brown, sometimes with green stripes or spots;

Straight grain or lightly knitty wood; fine and uniform grain structure, glossless; greasy on cross section; it has calcium oxalate crystals; alike to locust tree colour.

3. Physico-mechanical properties: (U = 12 - 15 %)

Density(d) = 660-800 kg/m3 (high-very high)

tensile strength: Rtp = 173-224 MPa

Bending strength: R = 126-152 MPa

shearing strength: Rfp = 14.2-18.0MPa

hardness: H(B) cross = 79-103 MPa

shrinkage and swelling ratios: α_t = 4.8%, α_r = 2.8 %; α_v = 13.2 %

compression strength Rcp = 60-80 MPa

modulus elasticity: E = 18,400-19,900 MPA

splitting resistance: -

4. Other properties:

Perishable sapwood, heartwood, resistant even in contact with the soil and weather exposed, difficult to be chemically treated.

- Slow natural drying, without large defects; hard to be kiln dried.
- Sawing hard to be performed due to gumoresins; planing and turning not easily performed but provide smooth faces.

Nail and screw assemblings need for previous borings.

- Easy glueing and finishing.

5. Use:

Multi-uses in buildings for external, internal and hydraulic works, for bridges, dams, pontoons roofing frames, pilons, cross elements, doors and windows, parquetry, waggons, light boats, barrels; turned articles, reel and beaters for textile industry, office articles, furniture and art works. It is used within special works as veneer and plywood.

Crt. no. BIBLIOGRAPHIC SEARCH OF THE PROPERTIES OF THE MOST COMMON SPECIES OCCURING IN THE VIETNAMESE FORESTS

1. a. Botanical name: Anisoptera Sp., A. Cochinchinensis-Pierre

b. ATIBT name: Mersawa(previous Kokrak)

c. Standard name:

d. Local name: Ven Ven

2. General description:

Large size tree (h = 30 - 40 mm) and Ø = 90 - 120 cm, recently felled tree has an excess in gomoresin on the surface, light pink yellowish sapwood, light yellow heartwood or brown yellow turning into dark colour to air contact, having gum channels and silicon in cell walls; straight grain wood but also twisted consequently having decorative aspect.

Medium and uniform grain structure without figure of the wood; aromatic smell.

3. Physico-mechanical properties (U = 12 - 15 %)

Density (d) = 520-740 kg/m³ (green=1000-1100 kg/m³)

shrinkage resistance: α_r = 3.1...4.4%; α_t = 8.2-10.1%, α_v = 12 - 16.5 %

tensile strength Rtp = 2.6 MPa

Compression strength R_{c_1} = 51 MPa

bending strength: R = 85...108 MPa

modulus elasticity E = 9100-12000MPa

shearing strength: Rfp= 6.4...8.2MPa

splitting resistance: -

hardness (J, B) = -

4. Other properties: Natural durability; inexistent for sapwood, reduced for heartwood and even dry sapwood; lack of durability in contact with the ground and to bad weather; it necessitates protection treatments even from logging and then differentiated by utilizations; very difficult antiseptic treatment.

Slow natural drying requiring piling in stick; artificial drying without difficulties; conditions: initial : t_0 = 30°C, t_u = 47°C, air relative moisture content 85 % final t_0 = 75°C; t_u = 57°C, relative moisture content 40 %.

Dry wood is stable to moisture variations. Appropriate processing but with tool wear; because of silicon.

It is well cross-cut into veneer by peeling and flat cutting after thermal treatment at 90°C; reduced bending, excess in gomoresin when steaming, resistent assembling, easy finishing.

5. Use:

In buildings only under roof and indoors; for framings, floors, parquetry, doors windows, wall panelling, packing boxes, plywood (interior layers because of gomoresin); ship building; furniture for dwellings, school furniture, waggons, car bodies.

Crt. no. BIBLIOGRAPHIC SEARCH OF THE PROPERTIES OF THE MOST COMMON SPECIES OCCURING IN THE VIETNAMESE FORESTS

1. Botanical name: Diospires Ebenum-Koenig, D. Spp.

a. ATIBT name: Ebène Noire d'Asie d. Local name: Mun
b. Standard name: -

2. General description:

Medium - small size wood up to 25 m height, Ø 50 - 70 cm, the stem has shape defects being utilizable up to max. 12 m length.
Sapwood white, grey yellow, sometimes with black strips; heartwood black seldom with lighter narrow strands; nonvisible rings.
The wood has straight, sometimes woven grains, fine even grain structure without smell and taste; gummy inclusions brown or black.

3. Physico-mechanical properties: (U = 12 %)

density (d) = 815-890 kg/m3 (1350 kg/m3 green)
shrinkage and swelling ratio: i i, i
tensile strength: Ftp = 3.7 MPa
compression strength Rcp = 45-63 MPa
bending strength Ri = 83-164 MPa
modulus elasticity E = 10300 MPa
shearing strength Rfl = 12 MPa
splitting resistance : -
hardness (HJ cross) 94)
(HJ perp. = 82 MPa

4. Other properties:

The sapwood is not durable and generally is removed. The heartwood is very strong and does not require preservation. Large cracks occur when drying naturally so that it is recommended gentle drying. The artificial drying will be initially to = 40°C, tu = 37.5°C (relative humidity U = 85 %) and finally to = 65°C tu = 48.5°C (relative humidity U = 40 %).
The sapwood can be easely processed compared with the heartwood which can be processed only with high energy consumption and severe wearing of cutting tools; easy for planing and turning. The slicing is possible only after intensive thermal treatment; high finish with good aspect. Nailing is possible only after predrilling. The dust can produce irritation.

5. Use:

The utilization of this wood is ruled by the decorative aspect, durability, stability to humidity variations but generally can be used for solid wood furniture, veneers, carvings, turnings, chestmate pieces, musical instruments, handles, office furniture, sticks, golf clubs, parquetry. The wood is similar to african-
ebony.

Crt. no. BIBLIOGRAPHIC SEARCH OF THE PROPERTIES OF THE MOST COMMON SPECIES OCCURING IN THE VIETNAMESE FORESTS

1. a. Botanical name: Vitex Sp.

   b. ATIBT name: Leban

   c. Standard name: -

   d. Local name: Chan Vit

2. General description:

   Very had wood, with high density, durable and resistent to moisture.

3. Physico-mechanical properties:

   density (d) = 930 kg/cm3 U=15%)

   tensile strength Rtp : -

   bending strength Ri : -

   shearing strength Rfp : -

   hardness H (E,J) : -

   shrinkage and swelling ratio : -

   compression strength Rcp : -

   modulus elasticity E: -

   splitting resistance : -

4. Other properties:

   -

5. Use: -

Crt. no. BIBLIOGRAPHIC SEARCH OF THE PROPERTIES OF THE MOST COMMON SPECIES OCCURING IN THE VIETNAMESE FORESTS

1. a. Botanical name: Dialium Cochinchinensis-Pierre

b. ATiBT name: Xaoy

c. Standard name: -

d. Local name: Xaoy, Xay

2. General description:

Dark brown, redish brown wood.
Fine grain structure; very hard; heavy weight.
Straight grain wood.

3. Physico-mechanical properties:

density(d) =930-1000 kg/m3(U=15%)
tensile strength Rtp: -
bending strength R: -
shearing strength Rfp : -
hardness H (E,J) : -
shrinkage and swelling ratio : -
compression strength Rcp : .
modulus elasticity E: -
splitting resistance: -

4. Other properties:

Good resistance to fungi and insects, water and weather.
Difficult to process being very hard (like guaipe).

5. Use:

Timber suitable for ship building, fine furniture, cylinders for crushing of sugar cane, wheels, tillers etc.

Crt. no. BIBLIOGRAPHIC SEARCH OF THE PROPERTIES OF THE MOST COMMON SPECIES OCCURING IN THE VIETNAMESE FORESTS

1. a. Botanical name: Ameora syn., Aglaia Sp., A. Giganteea, A. Pierre

   b. ATIBT name: Tasua

   c. Standard name:

   d. Local name: Goi

2. General description:

   Wood Ø = 70 - 100 m .

   Pink turned brown to air-contact.

   Wood with high density, hard smelling.

3. Physico-mechanical properties:

   density d= 560-700 kg/m3(U=15%)

   shrinkage and swelling ratio : -

   tensile strength Rtp : -

   compression strength Ecp : -

   bending strength Ri : -

   modulus elasticity E : -

   shearing strength Rfp : -

   splitting resistance: -

   hardness H (B,J) : -

4. Other properties:

   Workable wood.

5. Use:

   For furniture, buildings, railway waggons, wheels and spindles for carriages; special use: weapon stocks.

Crt. no. BIBLIOGRAPHIC SEARCH OF THE PROPERTIES OF THE MOST COMMON SPECIES OCCURING IN THE VIETNAMESE FORESTS

1. a. Botanical name: Cassia Sp. Stamea Lamk

b. ATIBT name: Djohar

d. Local name: Muang Ten (South Vietnam)

c. Standard name: -

2. General description:

- White sapwood, with high density, black heartwood, sometimes with lighter strips.
- Fine grain structure; high density, hard and heavy

3. Physico-mechanical properties:

density (d) : 700 kg/m3 (U = 15 %)

shrinkage and swelling ratio : -

tensile strength : Rtp -

compression strength Rcp : -

bending strength Ri : -

modulus elasticity E : -

shearing strength : Rfp : -

splitting resistance: -

hardness II (B,J): -

4. Other properties:

Good natural hardness - resistant to biological agents.

5. Use:

External use, joinery, roof framing, buildings.

Crt. no. BIBLIOGRAPHIC SEARCH OF THE PROPERTIES OF THE MOST COMMON SPECIES OCCURING IN THE VIETNAMESE FORESTS

1. a. Botanical name: Artocarpus elasticus, A. spp.

b. ATIBT name: Keledang

c. Standard name: -

d. Local name: Mit-nai

2. General description:

Tree up to 30 m height, ∅ 80 - 120 cm, straight, cylindrical trunks, 15-22 m usable length.

Sapwood - grey white or yellow; heartwood - goldish brown up to dark brown (as nut tree) light sensitive turning the colour.

Easy visible growth rings; wood with knitty grain; grain structure - rough and homogeneous; smooth faces are glossy.

3. Physico-mechanical properties:

density (d) 500-800 kg/m3

shrinkahe and swelling ratio -- v = 8.5 - 11 %

tensile strength Rtp :

compression strength Rcp=35-53

bending strength Ri : 69-100

modulus elasticity E : -

shearing strength Rfp = 9.3-11.3

splitting resistance:

hardness HJrd=27-55 MPa

HJtg = 21-57 MPa

4. Other properties:

Dry heartwood - resistant to insects and termite attack. Weather resistant. Sapwood can be chemical treated, heartwood - hard treatable under pressure and vacuum.

Gentle natural drying, the thin elements are deformed.

When processing wear out the tools.

The nail, screw and glue assembling are resistant and easy to be performed.

5. Use:

For the manufacturing of: plywood, decorative veneer, doors and windows, indoors arrangements, turning and carving works, weapon stocks, tool handles, musical instruments , reels.

Crt. no. BIBLIOGRAPHIC SEARCH OF THE PROPERTIES OF THE MOST COMMON SPECIES OCCURING IN THE VIETNAMESE FORESTS

1. a. Botanical name: Dalbergia cochinchinensis-Pierre

b. ATIBT name: Pallisandre de Cochinchine

c. Standard name: -

d. Local name: Cam Lai, Trac Lai

- General description:

Tree up to 30 m height (15 - 30 m), 12- 15 m usable length, Ø 40 - 80 cm; sapwood marked against the heartwood, yellowish white, light goldish-yellow, h heartwood changeable even for the same species, turning dark in time, is yellowish red, violaceae pink, dark brown red wood with straight grain, mediur grain structure, high resistance and hardness, decorative aspect due to its colour and grain structure.

- Physice-mechanical properties:

density (d) 800 - 1075 kg/m3

shrinkage and swelling ratio: α_v = 8.7 %

tensile strength Rtp :

compression strength: Rcp = 104

bending resistance Ri = 260

modulus elasticity E :12000-18000 MPa

shearing strength Rfp 12-17.5 MPa

splitting resistance: -

hardness H (J,B) -

-- Other properties

High natural hardness of heartwood which resists to fungi and insects (even thermites).

Sapwood is perishable.

Lent natural drying; it is kiln dried, initial to = 50°C, tu = 47°C, U = 85 %, final to = 75°C, tu = 75°C, U = 40 %.

It is workable with any type of tools, which is rapidly worn out; it is veneered after thermal treatment; assembling (with nails, screws, glue) is resistant; good finishing, sometimes the skin becomes irritated in contact to sawdust.

- Use:

Furniture, art and handicraft articles, carved and turned works, brushes, billiard cues, musical instruments, sport articles, tool handles; ships; indoor panelling.

Crt. no. BIBLIOGRAPHIC SEARCH OF THE PROPERTIES OF THE MOST COMMON SPECIES OCCURING IN THE VIETNAMESE FORESTS

1. a. Botanical name: Carpinus Betulus-2

b. ATIBT name:

c. Standard name: hornbeam

d. Local name: Carpen

2. General description:

Medium size wood (up to 30 m); diameter up to 70 cm.
Channelled stem; light grey white wood; heartwood is differentiated by colour of sapwood, growing rings with wavy contour; wood-homogenous, dense twisted fibre without smell and taste; without decorative aspect.

3. Physico-mechanical properties:

density (d) = 710...844...938 kg/m3

shrinkage and swelling ratio: $\alpha r = 6.9$; $\alpha t = 12.5$; $\alpha v = 18.8\%$

tensile strength Rtp: 160.4 MPa
Rtv: 4.7 MPa

compression strength RCP: 60.5 MPa

bending strength Ri: 143 MPa

modulus elasticity E: 16600 MPa

shearing strength Rfp: 15.6 MPa

splitting resistance: rd=0.80 MPa
tg = 1.38 MPa

hardness H (B,J): HJr= 80 MPa;
HJt = 81.7 MPa

4. Other properties:

It belongs to heavy and hard wood species; large shrinkage to higher values than beech; good mechanical resistance higher to beech; good natural durability; good machining, difficult splitting, peeling in green state, without thermal treatment, attention is to be paid when drying because of cracks and deformations.

5. Use:

Sawn timber, parquetry, veneer, tools, lasts, pieces for metallurgic industry, machine building, accessories for textile industry.

Crt. no. BIBLIOGRAPHIC SEARCH OF THE PROPERTIES OF THE MOST COMMON SPECIES OCCURING IN THE VIETNAMESE FORESTS

1. a Betanical name: Fagus sylvatica

b. ATIET name: beech

d. Local name: Fag

c. Standard name:

2. General description:

Medium wood (h = 37 m) diameter up to 70 cm.

White-yellowish colour except for the heartwood falsly coloured in light-brown to dark-brown; distinctive growing rings.

Homogeneous grain structure wood fine structure with diminished decorative aspect, mat, without large colour contrasts of the limits of growing rings; visible mirror effects on the radial section owned to medulary rays; tasteless and smelless.

3. Physico-mechanical properties: (U = 12 %)

density (d) : 583...693...817 kg/m3

shrinkage and swelling ratio αr = 5.5; αt = 12.4; αv = 17.4 %

tensile strength Rtp 139 MPa
Rtv 3.4

compression strength Rcp 53.2 MPa

modulus elasticity E : 15000 MPa

bending strength Ri : 119.3 MPa

splitting resistance: -

shearing strength Rfp:

hardness HJrd = 52.6
HJtg=54.4
crosswise:68.8 MPa

4. Other properties:

Low hardness wood

Hard natural and artificial drying, liable to cracks and deformations

Appropriate machining especially for green wood; well peeled especially after steaming treatment; easy bending and finishing.

5. Use:

Sawn timber, parquetry, cross members, plywood, pitwood, pulp, buildings, barrels, hollow core boards, camps, furniture, prefab houses, particle board , fiberboard, accessories for textile industry.

ABBREVIATIONS

d = density
R = strength
R12-15= strength at the moisture content of 12 - 15 %
Rv = strength of green wood
Rc = compression strength
Rcp = compression strength, parallel to grain structure
Rtp = tensile strength, parallel to grain structure
Rtv = tensile strength, perpendicular to grain structure
Ri = bending strength
E = elasticity modulus
Rd = splitting resistance
Rfp = shearing strength
H(J,B)= hardness
β = shrinkage
β v = volume shrinkage
β r = radial shrinkage
β t = tangential shrinkage
U = moisture content
h = height
Ø = diameter

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ANNEX 1.3.

LIST OF STANDARDS

1.	STAS 84-87	Wood. Determination of volume weight.
2.	STAS 85-68	Wood. Determination of shrinkage and swelling ratios.
3.	STAS 86/1-87	Wood. Testing for compression strength parallel to grain
4.	STAS 337-67	Wood. Testing for static bending strength.
5.	STAS 336/1-88	Wood. Determination of tensile strength parallel to grain.
6.	STAS 6291-72	Wood. Determination of tensile strength perpendicular to grain.
7.	STAS 1651-83	Wood. Testing for shear strength.
8.	STAS 1038-82	Wood. Testing for splitting strength.
9.	STAS 338-82	Wood. Testing for impact bending resilience.
10.	STAS 2417/1-87	Wood. Testing for Janka hardness.
11.	STAS 83-68	Wood. Determination of humidity.
12.	STAS 9266-73	Timber. Determination of humidity.
13.	STAS 10349/1-87	Timber. Drying under 100°C temperature.
14.	STAS 9302/4-87	Wood. Improving of the surface for solid pieces.