OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

FAIR USE POLICY

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

RESTRICTED

DP/ID/SER.A/1367
29 June 1990
ORIGINAL: ENGLISH

18470

STRENGTHENING OF THE TECHNOLOGICAL CAPABILITY OF THE THAI PACKAGING CENTER
DP/THA/87/019
THAILAND

Technical report: Development of Packaging for distribution of fresh fruits and vegetables*

Prepared for the Government of Thailand
by the United Nations Industrial Development Organization,
acting as executing agency for the United Nations Development Programme

Based on the work of E. Pichler,
expert in transport packaging

Backstopping officer: J. Belo, Engineering Industries Branch

United Nations Industrial Development Organization
Vienna

* This document has not been edited.

V.90-86225

CONTENTS

Abstract

Dimensions and performance specifications of boxes for domestic and regional (neighboring countries) distribution of fruits, vegetables and fisheries products are defined. Procedures for testing are proposed. Boxes and a basket were designed to be made out of wood and bamboo. Yang Para (Hevea brasiliensis) wood is indicated. Criteria for dimensions are based in observed conditions of distribution (handling, transportation, storage) with the improvement of certain conditions (easier handling, nesting, heigher stacking) and foreseen possibilities of palletization (ISO sizes). Criteria for performance testing are based in discussion of traditional test methods, adapted to possibilities of the country, specially considering the capabilities of the Thai Packaging Centre.

1. INTRODUCTION

1.1 Job Description and Program of Activities

Annex I shows the Job Description of the Expert in Transport Packaging with the purpose of "strengthening the capability of Thai Packaging Centre staff to develop packaging for fresh fruits and vegetables, made from indigenous materials, for local distribution and export to nearby countries". This Job Description is actually related to a mission with a duration of three months, according to the Project Document.

Considering the necessity of a certain time period for preparing the proposed prototypes of packages and assembly of test equipment, as specified by the expert in the first part of his mission, the expert's mission was split into two, the first in May and the second in December, January 1991.

Then, the outputs expected to be produced during the first month of the mission were :

- the development of specifications of transport packaging for fresh fruits and vegetables, and marine products;
- the design of prototypes (two or more) of packages for these products, to be made out of indigenous materials with utilization of low cost equipment (low capital technology), for domestic and regional distribution.

"Fresh fruits and vegetables" also include garden plants, flowers, medicinal plants. "Marine products" include fresh fisheries products, in ice or refrigeration, unprocessed. Rather than defining specific products for a specific package it was

preferred to classify groups of products for each class of a group of packages. A specific package should be adequate to a series of products.

In the second part of the mission an analysis of alternative designs, with experimental study using the proposed specifications, shall be performed. A study of implementation of the project, an analysis of manufacturing and distribution of the standardized packages, including the treatment of wood against contamination, the production of a Manual to be published and a Seminar, are proposed for the second part of the mission.

1.2 Survey of Present Situation

Descriptions of the usual packages were presented by the Thai Packaging Centre for fruits and vegetables (references 1, 2, 3, 4) and by the National Materials Handling Bureau of Australia (Food Handling Project, ASEAN-Australia Economic Cooperation) for fisheries products (reference 5). Field observations were also made by the consultant with photographic documentary in Appendix I.

2. RESULTS

2.1 Specifications

2.1.1 Dimensions

The following dimensions of boxes or crates were specified :

Designation	Base ext. dim. (mm)	capacity (l)	approximate ext. height (mm)
A	Pallet box	-	-
B 100	600 x 510	100	450
B 50	600 x 510	50	235
C 40	500 x 370	40	310
D 30	600 x 250	30	230

2.1.2 Performance

The performance of the packages (boxes or crates, sacks were not considered) is defined by a series of tests :

- compression
- lifting
- drop
- vibration
- repetitive shock
- impact
- stability of stack

The methodology of these tests is presented in Annex II.

Another aspect of performance, important for reusable boxes or crates, is the sanitary treatment. This is not covered in the present part of the project.

2.2 Design of alternatives

Three wooden boxes were designed, in sizes B 100, B 50, C 40, and a bamboo basket in size D 30.

Drawings and specifications are in Annex III.

3. CRITERIA

In order to minimize the economic costs of physical distribution, besides minimizing the investment and operational costs of the packages themselves, packaging has to be designed in such a way that it gives good protection to the products and it is efficient in operation.

Efficiency in use of space, in storage and transportation, and in handling, is related to the geometry, capacities and performance of the packages. The protection of the product also depends on performance. These two aspects, then, must be considered : geometry and performance.

3.1 Dimensions

The following criteria are recommended for the establishment of standard dimensions of boxes and crates :

- A limitation and rationalization of internal capacities so that the gross weight (mass) is compatible with handling. Manual handling limits the mass to 40 kg (80 kg with two persons). The rationalization must take into consideration the traditional commercial practices and the necessary corrections of eventual observed problems. In general, the

capacities should be as large as possible, or as convenient in each case, in order to reduce the specific cost of packaging ($ per kg of content, or $/C). The possible, or adequate, has to be defined in each case.

For fresh fruits and vegetables, in particular for flowers, the height of the container must be limited by the sensibility of the products to compression by its own weight, in a dynamic environment. It was observed that the present packages use in Thailand, are mainly large and very deep baskets, which consequently cause damages or losses by internal compression.

When mechanical handling is available, pallet boxes are a possibility (size A in the proposed designation). This is only to be considered in industrial operations (agroindustry or fisheries industry).

Manual handling limits the maximum capacity of packages to 100 l. For products with a higher apparent density, such as fishes, this would mean a gross mass around 80 kg (two persons handling). This large capacity is suitable for low apparent density products, like leafy produce, and large fruits, such as pineaple, papaya, watermelon and melon, bananas and onions.

The B50 size has the same base dimensions as B100 but smaller height, around 220 internal (it is impossible to specify the height of the box, since the internal volume and external base dimensions are defined, but the thickness of the walls depend on each specific design and material). The reduced height is recommended for products sensitive to compression, like

certain fruits, flowers and fishery products (tomatoes, litchis, mangostines, longan, grapes, roses, fishes sensitive to gut burst, are typical examples).

The C40 packages are suitable for products with higher density and resistance, like citrus and green mangos, cucumber, peppers, garlic, etc.

The D30 sizes are adequate to more sensitive products, like grapes, berries, flowers (orchids) with stalks (that require long and shallow boxes).

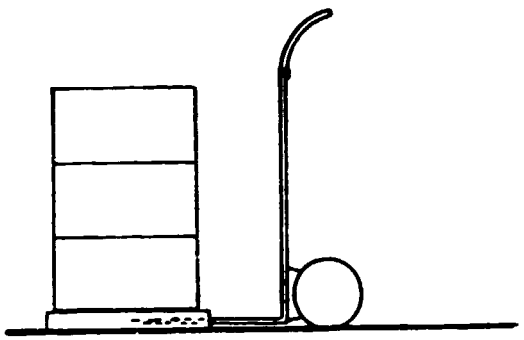
- The dimensions should be convenient for handling. A maximum dimension of 600 mm is proposed for manual handling.

Mechanical handling or transportation poses important restrictions to dimensions. The external basic dimensions of the packages must be adequate for palletization. The ISO pallet sizes are considered : 1100 x 1100 and 1200 x 1000 mm. The square pallet is indicated for transportation in ISO freight containers and trucks, with an internal width between 2250 and 2350 mm. The 1200 x 1000 mm is indicated for rail transportation, mainly in Europe and USA.

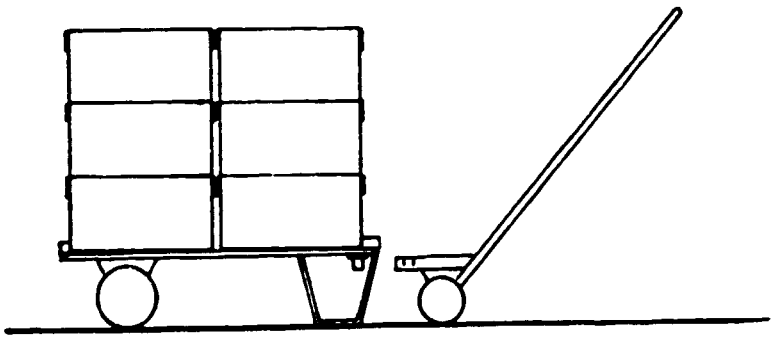
The domestic and regional land transportation in Thailand is basically done by truck, with the dimensions of typical trucks given in Annex IV.

Palletization is important, but more as a trend to the future. Presently more important are the handling (or short haul) equipment to be used, consisting of manual carts.

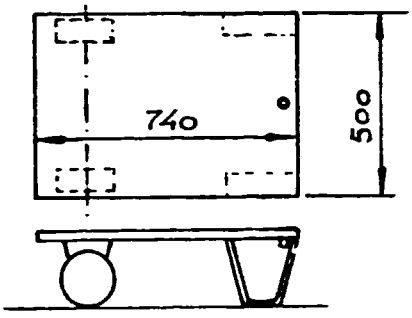
Two wheel carts are normally used in Bangkok, as observed at the Park Klong Talat market. They require that the boxes be placed over two wooden cleats in order to facilitate the entrance or removal of the supporting platform.



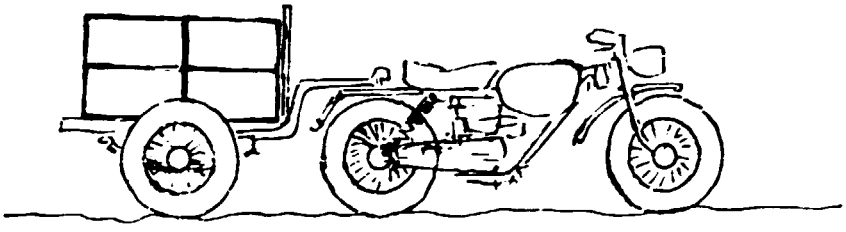
This type of cart is preferentially used when a manual handling of the packages is difficult (like with the large baskets observed). If the boxes can be handled it is better to put them over a 4 wheels cart, or 2 wheels with a "Johnson bar".



The platform of this cart, to be compatible with the sizes of the boxes proposed and with the narrow spaces observed in the markets, should have 500 x 740 mm.



Carts with larger wheels and a suspension system could be developed for motorcycle haul by small producers or retailers.



It was verified that motorcycles are an important mode of transportation in the country, not only for persons.

- Reusable boxes or crates, in order to have better efficiency of transportation when empty, must be able to collapse or nest into each other. The geometry of the packages, then, must be such that one or two can be put inside other two, or they have a trapezoidal shape that allows certain penetration of one another.

The trapezoidal shape is good for plastic boxes. For other materials this shape reduces substancially the stacking strenght, so the faces must be parallel.

- The ratio between length and width of the packages should permit the interlocking stack.

3.2 Performance

In the opinion of the expert, the standard for performance testing given by ISO and ITC (Ref. 6) should be reviewed in some aspects. It is very important that tests be realistic. Avoidable costs could rise from standards with excessive severity, that would lead to high cost of packaging, or with insuficient or inadequate severity, leading to losses in the real distribution environment. The severity level must be defined for typical specific conditions : a reusable package should be stronger than a disposable one, for instance, requiring different safety factors.

3.2.1 Compression

The test must be a static compression test rather than a dynamometric compression, in order to be closer to the real stacking conditions. The dynamometric press doesn't allow racking, which is a common cause of collapse, mainly of wooden structures.

The safety factor, if we consider stacking in a truck, ship or airplane, should be higher than the dynamic factor (or vertical acceleration in G units). A safety factor of 3, then, is a minimum. If test has to simulate a static stack, 1,5

is a minimum, 2 is better. The worst case, with respective stacking heigh, should be considered in testing.

It is very important, in the static compression test, that the load be applied without impact. Then the specification of the velocity of descent of the load plate (not mentioned in ISO 2234) should be determined.

An arrangement of packages in two levels, in a real stacking configuration, under the load plate, is important in the case of interlocking stack.

3.2.2 Lifting

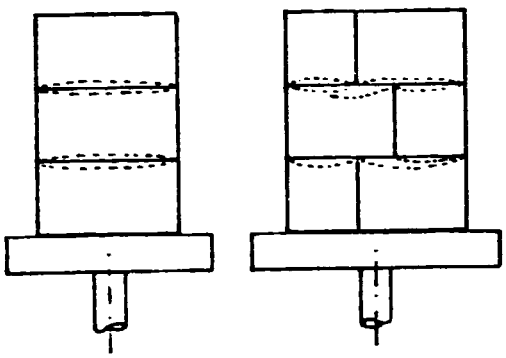
There is no reference literature on lifting testing but it is considered important since one of the weak points of packages may be the bottom or handles, that break in handling.

3.2.3 Vibration

The proposed procedure is based on ASTM D999, with some variations introduced with regard to a relation between test duration and lenght of truck transportation. This correlation was found in studies made at the Technological Research Institute of S. Paulo State, Brazil. Further studies are, nevertheless, recommended.

The expert feels that ISO 2247 is somehow far from reality. Acceleration of 0.75 + 0.25 G is too vague. A stack with the same height as in transportation is necessary, if possible with

interlocking if it is to occur. One of the problems with vibration is a flexural fatigue or weakening of the bottom of a box, in a stack. It is important, then, to reproduce the stack conditions in a test, when possible.



Horizontal vibration is not important in truck but is important in rail transportation. The effect of horizontal accelerations, if an horizontal vibration table is not available, may in some extent be observed in horizontal (or incline) shock tests of the unit load (see ahead : 3.2.7. -Stability).

3.2.4 Repetitive shock

The proposed procedure is based in ASTM D999 C. It is however important, again, to have a real stack configuration. If it is then more severe than ASTM, the duration must be much shorter. One minute is proposed (5 for reusable packages) but an experimental study is still necessary.

This test only reproduces conditions found with unlashed stacks at rear of a truck, so has minor importance.

3.2.5 Drop

The drop test is important but is highly subject to discussion in relation to drop height. Actually there are two conditions in real handling : operational and accidental falls. The usual standards, like ISO, BS, ASTM, AFNOR, refer to accidental falls. The proposed procedure is based in ISO/ITC recommendation (Ref. 6).

A study of a new procedure for operational drops, with a large number of small impacts, as in real handling, is proposed as a new approach.

The shocks against the corners are considered more critical and realistic than against the edges.

In the case of boxes with more than 50 kg, to be handled by two persons, another procedure must be defined. A rotational drop may be indicated (according to US MIL.STD.). This is also valid for pallet-boxes.

It is questionable if a different severity shouldn't be applied to reusable packages. Drop tests of empty boxes may be applied to reusable ones, with higher drop height, to simulate handling risks when empty.

3.2.6 Impact

This test gives an idea of the resistance of a box or crate to an impact localized over a critical point. It is based in an AFNOR standard with a proposed alteration of the

dart. The energy of 15 J is indicated but may be too high. Experimental investigation is recommended.

3.2.7 Stability

Two possible procedures are envisaged to verify the stability of packages in a stack or unit load : the determination of the angle of instability or the verification of stability by an horizontal shock.

The first procedure is better when a quantitative result is searched, like a friction coefficient. The second is better to analyse the behavior of a unit load, where the stacking configuration, like interlocking, may interfere in stability.

4. CRITERIA FOR PROPOSED ALTERNATIVES

4.1 Wooden Boxes

The reusable wooden boxes are, together with bamboo baskets or boxes, a good alternative in terms of costs of production and operation. Low capital labor intensive technology is applicable in decentralized small industries for their production. One-way wooden boxes, like wirebound, would be more expensive in operational cost, since the multiple trips reduce the specific operational cost, and would be more harmful to the forest resources. On the other hand, a serious problem with reusable wooden boxes is the possibility of contamination. An analysis of careful bacteriological treatment of the wood is necessary, possibly by a specialist consultant. Labels or marks in the boxes for control of this treatment may be

necessary. In the case of fishes, a plastic liner must be applied in the boxes (also to reduce heat transfer of ice).

Other problem with reusable boxes is that they have to be returned and this cost of transportation of empty used boxes may be higher than that of new ones. It is difficult anyway to evaluate this cost. It may be even zero when a truck has to go back empty, then it can take back empty the boxes corresponding to three or four truckloads of full boxes, nested, at practically no cost. More critical is the loss of boxes, by pilferage or by going astray. This loss of return makes the use of more expensive boxes impossible, like the plastic ones used in fisheries. In the case of fisheries plastic boxes should be used only on board vessels, where better conditions of control are possible.

The design of wooden boxes was based in the following criteria :

. Use of boards with a standard width of 100 mm, in some parts cut in two 50 mm pieces (actually around 49 mm for the saw thickness), and with a thickness of 20 mm for the larger boxes - B100 and B50 - and 15 mm for C40.

. Use of the tree-way corner in the bottom.

. No lids.

. One box is adjusted to the top of the other by lateral guides to improve stability of stack.

. Gaps between boards smaller than 20 mm.

. Lateral guides also used to keep ventilation spaces between boxes in unit load.

- Wood

The specification of materials rather than determine species should be based in an important mechanical property of wood, like its hardness. The use of reforested timber is nevertheless recommended when possible.

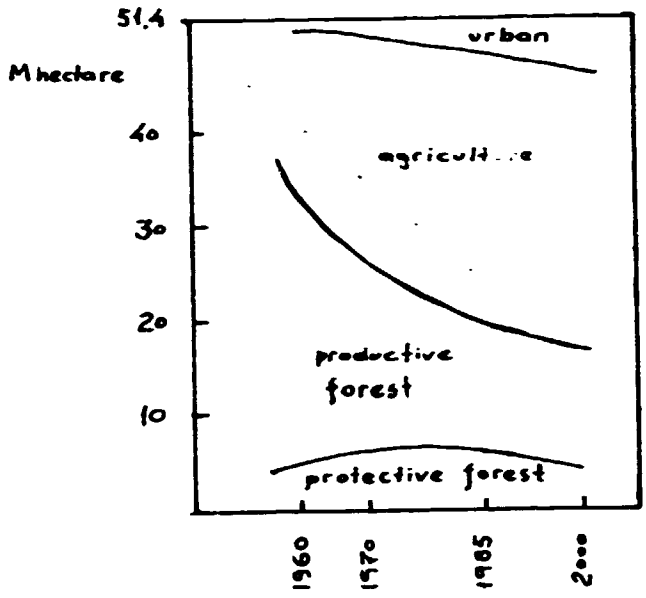
According to P. Sono (Ref. 7), the wood used for manufacture of boxes in Thailand are, mainly, the following :

Karmpoo - Samanea Saman Merr; MIMOSACEAE
Yang - Dipterocarpus spp.; DIPTEROCARPACEAE
Yang Para - Hevea brasiliensis Muel. Arg.; EUPHORBIACEAE
Ngew - Bombax spp.; MALVACEAE
Sompong - Tetrameles nudiflora R.Br.; DATISCACEAE

Sompong and Ngew have a production around 10000 cu.m/year (data of 1973).

Yang Para is by far the most promising species. It is a cultivated tree. "The production of the timber from the replanting sheme is about 2,5 million cu.m/year with the possibility of increasing up to 6 million cu.m, if the sheme is run in full scale". (data of 1973 - Ref. 7).

Reforestation is a very important issue to avoid depletion of forest area, reaching 10%/year (Ref. 8). The graph shows the trend in uses of land in the country (Ref. 7).



The cultivation of Yang Para is, therefore, a valuable resource besides its use for latex.

The design of proposed boxes is based, then, in this wood. Other woods, with similar or higher hardness may however also be used.

The hardness of Yang Para is 530 kgf (Janka hardness). A dynamic measurement of hardness is better, however not usual. A procedure based in ASTM D 2394 section 18 (Falling-Ball Indentation Test) may be developed, presently with research being carried out in Brazil by IPT.

The usual practice of sawmill is to prepare timber or boards for civil construction, thus with large thickness. The normal thickness of 25 mm, reduced to 20 mm by dressing the two faces, is indicated for the larger boxes (B100 and B50) but would

be excessive for the smaller ones (C40 and D30). Specially equiped sawmills are recommended for a better economy of material, in a large scale production, giving thiknesses of 12 or 15 mm.

- Nails

Since softwood is used, the use of special nails may be necessary.

Annularly or helically threaded nails are a good solution but not available, with low cost, in Thailand. Coated nails may be better as they have, besides the retention properties, some protection against corrosion, and are easier to produce. A serious problem of corrosion is foreseen in the boxes for marine products.

- Treatment

The wood boards must by dry, dressed the two faces for cleanliness. A treatment for preservation may be combined with a sanitary one. This subject remain to be studied, possibly with the participation of the Forest Products Research Division.

- Production

The production of the boxes by small industries in a low capital labour intensive system should be combined with a technology that can bring a minimum economic cost. So the use of assembly templates is necessary for wooden boxes as well as for the bamboo ones. Regularity and a certain precision in dimension is very important, what requires templates also for cutting and drilling the wood and to fold the bamboo.

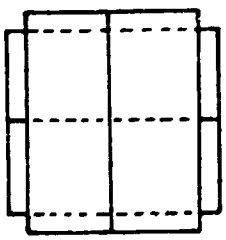
An example of industrial facility able to produce 200 boxes/day, size C40, model proposed, with 10 people working 8 hours/day, is given in Annex V. This is just a first idea to be discussed and improved in the second visit of the consultant, through meetings with industry and governmental agencies for industrial promotion.

4.2 Bamboo Boxes

The bamboo box was designed in the D30 size. A problem with thin intertwined bamboo walls is a low rigidity in bending (due to internal pressure) or buckling (due to compression). This was considered by the proposal of a small wall in the ends and a reinforcement in the large side walls by means of a handle. A reinforcement of the edge, by a double bamboo structure tied by a natural fiber thread, gives better stiffness to the walls.

The material proposed is a Sisuk or Ruak bamboo cut in widths around 20 mm and with thickness around 1 mm. A module of 30 mm is proposed for weaving, in both directions. A template must be used in manufacture.

The stacking pattern is given in the figure, with an interlock system that increases stability and compression strength.



5. RECOMMENDATIONS

The use of boxes, in substitution to the very traditional baskets, is a radical change in the system of distribution of fruits and vegetables. It is not only a question of packaging since it involves also aspects of handling, storage and transportation. The implementation of this project requires, then, an in depth analysis of logistics and economics, with participation of specialists and interested parts. This work is to be understood as a contribution to this broarder analysis. A first recommendation is that a Seminar on Regional and Domestic Distribution of Fruits and Vegetables be programmed, where the problems of packaging, logistics and economics, can be thoroughly discussed. The period of January 1991 is suggested by the consultant.

A Thai Standard on boxes for fruits and vegetables, not to forget fisheries products, may be developed using the present work as a reference. Further work is foreseen is this project regarding selection, quality and treatment of wood, but a close contact with authorities and researchers in technology of forest products in recommended.

Prototypes of the proposed alternatives, made out of Yang Para and bamboo, shall be manufactured in a small quantity for laboratory tests and later in a larger quantity for field tests. Extensive field tests are also important for the involvement of more people and for a demonstration effect.

New alternatives may be developed that result in reduction of economic costs of packaging. The Thai Packaging Centre has already a very good capability in developing these new alternatives or to cooperate with industry on this subject. Some new and very simple equipment is however still necessary, specially the static compression tester. A special structure for this test is recommended, ideally in the climatized laboratory.

The construction of templates for the manufacture of boxes will be important for a study of production rationalization and for demonstration purposes. No equipment is necessary to import for the manufacture of boxes, since the Institute already has a good machine shop for wood work. The budget allocated in the project for tools with this purpose (US$ 20000) may be reallocated.

For the second visit of the consultant it is expected that a series of actions be taken and conditions established before his arrival:

- Proposed laboratory equipment operational:
  - . Static compression tester, masses;
  - . impact tester;
  - . simulative contents for testing;

- Thai Technical Standards, as draf proposals or approved, for Test Methods and Specifications;

- Templates for manufacture of boxes, at least one model, for preparation of prototypes, studies of industrial production and demonstration;

- Prototypes of boxes, according to drawings and materials specifications, in the following quantities for laboratory tests (with dummy load):

B 100 - 5
B 50 - 9
C 40 - 7
D 30 - 9

- Seminar prepared;

- Contacts with Industries and Government Agencies interested in the project (Agriculture, Forest Resources, Transportation, Distribution), including preparation of pilot production and field tests (if possible, to be performed during the mission of the consultant, but not necessarily).

References

1 - Structure and Properties of Containers for Fruits and Vegetables in Thailand - Amornrat Swatditat et al. TISTR, Bangkok 1984.

2 - Existing Containers for Fruits and Vegetables in Thailand - Amornrat Swatditat et al. TISTR, Bangkok 1984.

3 - Study of the Commodity - Container Interaction of Selected Fruits and Vegetables - Mayuree Paklamjeak et al. TISTR, Bangkok 1984.

4 - Development of Bamboo Containers for Agricultural Produce - Niran Sirikan, Amornrat Swatditat - TISTR, Bangkok 1986.

5 - The Use of Standard Returnable Fish Containers in ASEAN Countries - A. Kamari, J.C.A. Sayers - National Materials Handling Bureau, Sydney 1979.

6 - Manual on the Packaging of Fresh Fruit and Vegetables - ITC/UNCTAD/GATT - Geneva 1988.

7 - Merchantable Timbers of Thailand - P. Sono, Forest Products Research Div. 1974 Bangkok.

Annexes

I - Job Description and Background

II - Test Methods and Performance Specifications

III - Proposed Alternatives

IV - Dimensions of Typical Trucks

V - Small Plant for Boxes

Appendices

I - Photographic Documentary

ANNEX I

Job Description and Background

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

PROJECT IN THAILAND

JOB DESCRIPTION
DP/THA/87/019/11-01/J-13320

Title	**Expert in Transport Packaging**
Duration	One month
Date required	November 1989
Duty station	Bangkok (Thailand), with possible travel within the country
Purpose of project	The purpose of the project in connection with the expert mission is to strengthen the capability of TPC staff to develop packaging for fresh fruits and vegetables, made from indigenous materials, for local distribution and export to nearby countries. Two project outputs are expected to be produced during the mission:

(a) two transport package prototypes made from indigenous materials and with the utilization of small hand tools, with particular aptitude of coapsible or nested stacking when empty and stable load stacking up to a well-defined height when filled with the foreseen products contents;

(b) specifications of transport packaging applicable to rural areas and small-scale producing capabilities, for three selected products within the categories of horticultural and marine products.

Applications and communications regarding this Job Description should be sent to:

Project Personnel Recruitment Section, Industrial Operations Division
UNIDO, VIENNA INTERNATIONAL CENTRE, P.O. BOX 300, VIENNA, AUSTRIA

Duties

The expert will be assigned to TPC where he will work in consultation with the National Project Director and in close co-operation with the local technical counterparts designated for the mission. He will be specifically expected to:

1. Get acquainted with the Thai Packaging Centre (TPC) in terms of operational structure and installed testing equipment and human resources for research, development and quality control on transport packages and respective materials;

2. Co-operate with the National Project Director (NPD) in the selection of four to six categories of fruits and vegetables as well as two or three marine products commonly subject to voluminous transportation/distribution within the national market and exportation to nearby countries;

3. Provide information on international or national specifications on transport packaging of similar products in countries at a high level of rationalization and standardization;

4. Co-operate with the NPD in search and gathering of information on the main types and models of traditional transport packages, made of indigenous materials, normally used in Thailand for the selected categories of fruits and vegetables;

5. Collect information and data on the stresses and hazards commonly encountered by these packages along their actual circuits of transportation, storage distribution and empty return in terms of dynamic and static compression, drop, impact, vibration, etc.;

6. Execute a programme of laboratory simulation of the stresses of normal or probable occurence in the actual circuits of transportation and distribution within the national and nearby importing markets, for performance evaluation in the light of the international standards concerned and identification of main weak points;

7. Study and development of improved or alternative transport package models for two of the above-selected categories of fruits and vegetables, also made indigenous materials and of possible manufacture with the utilization of small hand tools. The new models must have improved strength and handling characteristics and also a better economic performance, in terms of balance between packaging plus transportation costs and the value of average product losses and damages in the concerned consignments;

8. Make an analytical study of the afore-mentioned information (section 3) on international or national transport packagaing specifications in the light of their adaptability to the prevailing conditions of rural areas and small-scale producing facilities of Thailand;

9. Elaborate tentative detailed recommendations on national transport package specifications for at least three of the important horticultural and marine products identified on section 2;

10. Discuss the draft specifications at joints meeting with representatives of the concerned producers, packagers, transporters, consignees and package manufacturers, for appraisal, revision and final form elaboration of the specifications above (section 9);

11. Co-operate with the NPD on programming of further works on transport packaging specifications for the remaining selected products, as well as of further works on study and development of transport packages made of indigenous materials for the remaining categories of fruits and vegetables which were selected according to section 2.

Qualifications Packaging technologist with a university degree or equivalent experience and specific specialization in transport packaging applied research and development, in the light of products to be packaged, storage and distribution systems as well as available raw materials and converting tools. Appropriate experience related to intermediate technology and technology adaptation to country's conditions.

Languages English

Background information

The major packaging problems in Thailand are based upon the fact that manufacturers, customers, exporters, and transporters, etc., have not paid attention to the importance of proper packaging. Most of them concentrate their efforts only in low-cost production without paying attention to loss and damage due to improper packaging. There is also a lack of well classified information on packaging which causes serious obstacles in marketing, particularly in the foreign market.

The Government has greatly put its effort to solve these problems by establishing the Thai Packaging Centre covering R & D, testing, consultation and promotion. Some packaging problems remain unsolved up to now, although the activities have been carried out for four years. It is due to the lack of experience of officials in the Center in special packaging, and the lack of appropriate facilities, such as, a computer including data system, photocopying and training equipment for prototype-making. Thus, the enhancement of technical personnel and service capabilities as well as the strengthening of R & D together with availability of equipment are very essential.

R & D activities will help exporters and industrialists in selecting the most profitable packaging design and methods for their products.

Research should result in efficient and cost-effective export packaging which protects the product at a minimum overall cost and at the same time meets all the requirements of the market. Such research activities require financial assistance which should be supported by the Government and international organizations so that the results can be disseminated to all concerned.

In the export of horticultural products, the existing transport packages used are bamboo baskets, wooden crates, fibreboard boxes, plastic crates and boxes. At present, there are no proper export containers for fresh produce which gives adequate protection at minimum cost. Research and development is absolutely necessary to develop suitable export packaging, in terms of strength and standard dimensions.

The packaging problems of these products are not only being experienced for exports but also for locally consumed products. Severe damages are inflicted on fresh fruits and vegetables due to inadequate containers and packing methods.

Marketing of fresh fruits and vegetables always involves transportation from producers in far away places which are scattered all over the country, to a central market place, mainly Bangkok. Transportation is usually made by road 84 per cent of which are transported by trucks.

Traditional bamboo baskets of various shapes are popular and used all over the country because of their low cost and availability. However, these baskets are responsible for the highest amount of product losses, since they have a low compression strength and they are weak in supporting, handling and stacking during transportation. Their round shape also does not make them suitable for achieving greater utilization of space.

Another container presently being used is the wooden crate which is mainly made of para rubber wood, mixed hardwood, recycled wood planks from incoming boxes or pallets which are not adequate enough to withstand distortion and micro-organism contamination. Though it has an excellent stacking strength, it is quite heavy and its surface is hard and rough and may have sharp edges which will damage the product.

Corrugated fibreboard boxes are used for certain high-value commodities like lychees. These boxes are increasingly used as export containers for fresh produce. Plastic crates and boxes are also used for certain commodities and reused. They have good stacking strength and are resistant to water and humidity; however, the price is higher than containers made from other materials. Considering the advantage and disadvantage together with the availability of the containers, it is necessary to improve the containers in strength, shape, dimension and quality of materials. Although the Centre has studied several types of packaging designs for fresh fruits and vegetables containers such as rectangular containers from indigenous material like bamboo which enables better stacking strength and space utilization, there are still some weak points regarding stacking and handling of empty containers. Further work should be carried out to obtain the proper prototype which can be produced from individual material or composite materials, either at the cottage- or small-scale industries level.

For marine products, the demand for foreign markets is increasing. The problems are not only the quality of product itself but also packaging quality which cannot adequately protect products from physical and biological hazards. In addition, the graphic design does not meet the international market requirement; hence, the development of suitable packaging for processed marine products should consider both structural and graphic design emphasizing on the international standards.

As for natural health foods which are produced from medicinal plants, there has been an increasing demand particularly in the developed countries. Though Thailand has abundant raw materials, the export market share is very low due to many causes concerned with production, quality control and packaging. At present, most of the medicinal plants are exported in the form of bulk containers, such as jute sack and woven plastic sack, which result in low-product value.

Most of the packaging industries throughout the country have no laboratory facilities and also do not have access to testing facilities. Therefore, the Centre, which is the only organization of the country that is well-equipped and has a standardized laboratory, will play an important role in this matter. In order to get accurate and reliable results, utilize the existing equipment in a more effective and efficient manner and provide guidance and advice to the industry, the strengthening of official testing capabilities is urgently required to fulfill the country's need.

ANNEX II

Test Methods and Performance Specifications

1. COMPRESSION

1.1 Equipment

- plate with certain mass (500 kg, for instance), with three eyelets to tie it with cables or chains to a hoist (Figure);

- hoist, electric or manual, with velocity of descent adjustable to 10 + 5 mm/min, with capacity higher than 1000 daN, fixed to a roof or structure sufficiently strong and high;

- floor, under the plate and winch, horizontal and resistant, where the point in a vertical under the hook of the winch should be marked with long crossing lines;

- calibrated masses (25 kg, for instance, for easy handling);

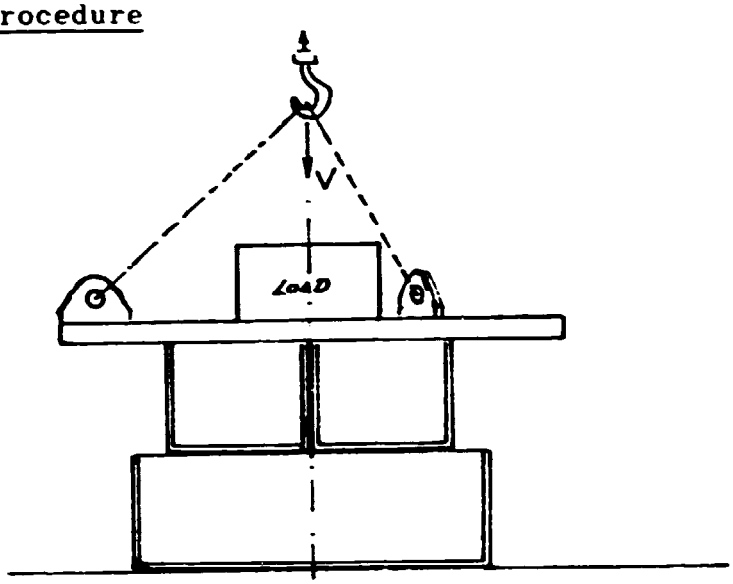
- chronometer and meter;

in the case of packages made with hygroscopic materials:

- ambient conditioner able to keep temperature of 20 + 2 °C and relative humidity of 65 + 5%, or

- thermohygrograph, and ways to determine water content of hygroscopic materials.

1.2 Procedure



- arrange the boxes in two levels of stack, centered under hoist hook, with simulation of real stacking positions; use crossing lines as reference;

- calculate load considering : high of stack in the truck, ship or plane; multiply the gross weight of a box by the number of boxes expected over the two levels; multiply by a safety factor of 3 or 4; 3 for disposable boxes, 4 for returnable, and have the load rounded up to a multiple of 250 N (25 kgf);

- place calibrated masses over the deadweight plate, the total weight beeing the calculated load, positioning so that the plate remains horizontal;

- apply the plate with the load over the packages, with a velocity of 10 ± 5 mm/min; keep the plate attached to the hoist, with loose ties, for safety; keep the load for one hour.

- check the ability of the packaging to withstand compression, observe deformations.

2. LIFTING

2.1 Equipment

Ballast weight with mass twice that of expected usual content of the package, with form and size as similar as possible to those of expected content.

Small textile bags with sand may be a good simulative load for fruits and vegetables.

2.2 Procedure

With the package in an horizontal floor, place in it the ballast simulating the expected content - with twice the mass of the most dense expected content.

Control temperature and humidity in case of hygroscopic materials.

Raise the package manually in the same manner, if possible, of normal operation, without significant accelerations. If necessary, use two people.

Observe if the bottom, walls or handles of the package break or have irreversible deformations.

3. VIBRATION

3.1 Equipment

3.1.1 Vibration table able to vibrate in frequencies sweeping from 3 to 100 Hz, back and forth, at a variation rate of one octave/minute, in vertical sinusoidal motion with constant acceleration amplitude of 0,3 G.

3.1.2 Means to stabilize over the table a stack of packages to be tested, in the same height as stacked in transportation by truck, without restriction to vertical movements.

3.1.3 Expected contents of the packages, or the ones with higher density, or simulative load. Small bags with sand or/and sawdust are good simulative for certain fruits and vegetables.

3.2 Procedure

Stack the packages, with the contents, over the center of the table, applying the means of stabilization.

For disposable packages apply 10 sweeps of vibration, or one for each 100 km of transportation by truck.

For reusable packages apply 100 sweeps of vibration (approx. 17 hours).

Observe for damages.

Control temperature and humidity if materials are hygroscopic.

4. REPETITIVE SHOCK

4.1 Equipment

4.1.1 Vibration table able to vibrate in sinusoidal vertical motion at 5 Hz with displacement amplitude of 12 mm (acceleration amplitude of 1,1 G).

4.1.2 Same as 3.1.2

4.1.3 Same as 3.1.3

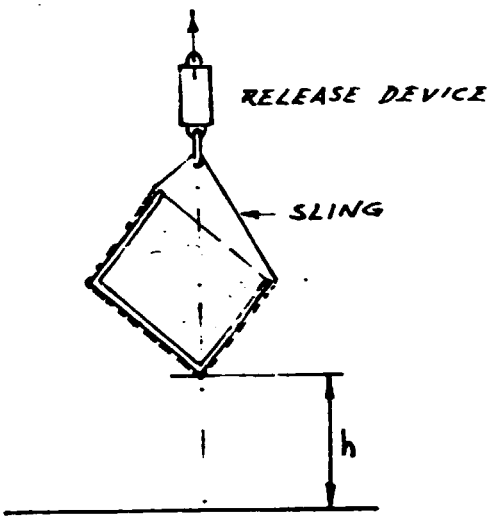
4.2 Procedure

For reusable packages, keep the vibration for 5 minutes. For disposable packages, keep the vibration for one minute. Observe for damages.

5. DROP TEST

5.1 Equipment

5.1.1 Release device attached to a hoist, able to release the load without any horizontal acceleration, and a flexible sling belt with eyelet attached to the release device, as in Figure:

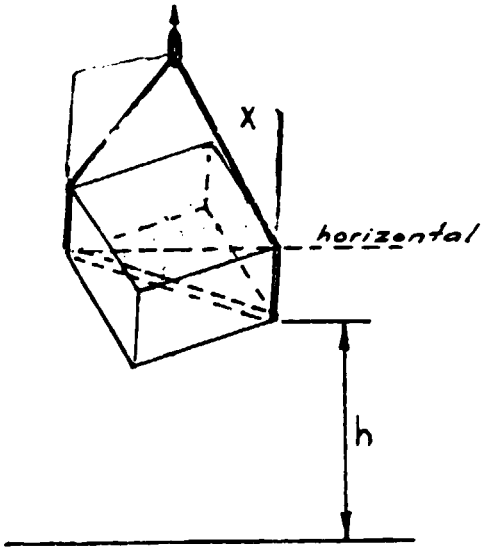


5.1.2 As in 3.1.3

5.1.3 Meter or calibrated length bars

5.2 Procedure

5.2.1 Adjust the package on the sling so that a diagonal is horizontal and the plane which contains this diagonal and the edges in the height of the package is vertical (x in Figure).



5.2.2 Adjust the drop height h

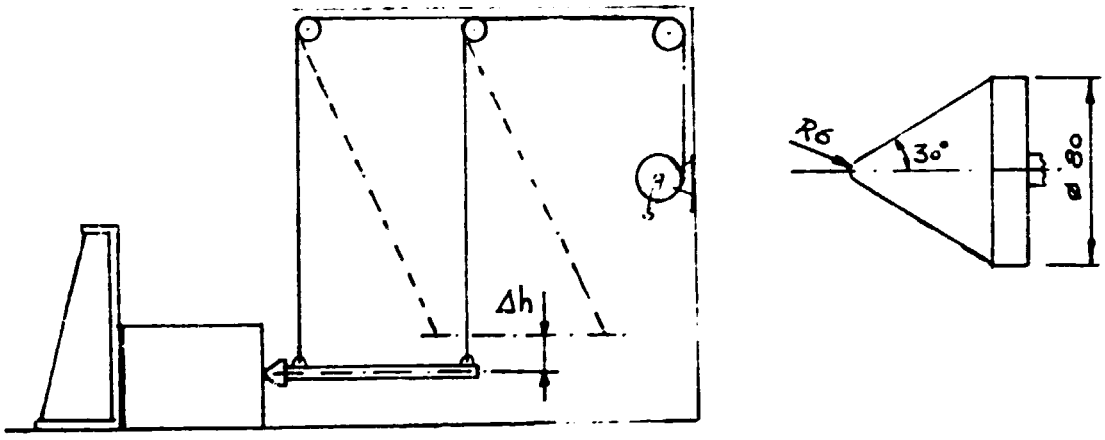
So that : H = 70-P is the gross weight of the package, with the contents specified in 5.1.2

5.2.3 Drop the package and check any damage. Repeat for the four bottom corners, in the same specimen.

6. IMPACT

6.1 Equipment

6.1.1 Pendulum, with a mass of 5 kg, consisting of a steel bar with a dart according to Figure, with adjustable height.



6.1.2 Backstop to hold the package against the impact.

6.2 Procedure

Adjust the package, the backstop and the height of the pendulum so that the dart touches the center of a face of the package, or a specific part of it.

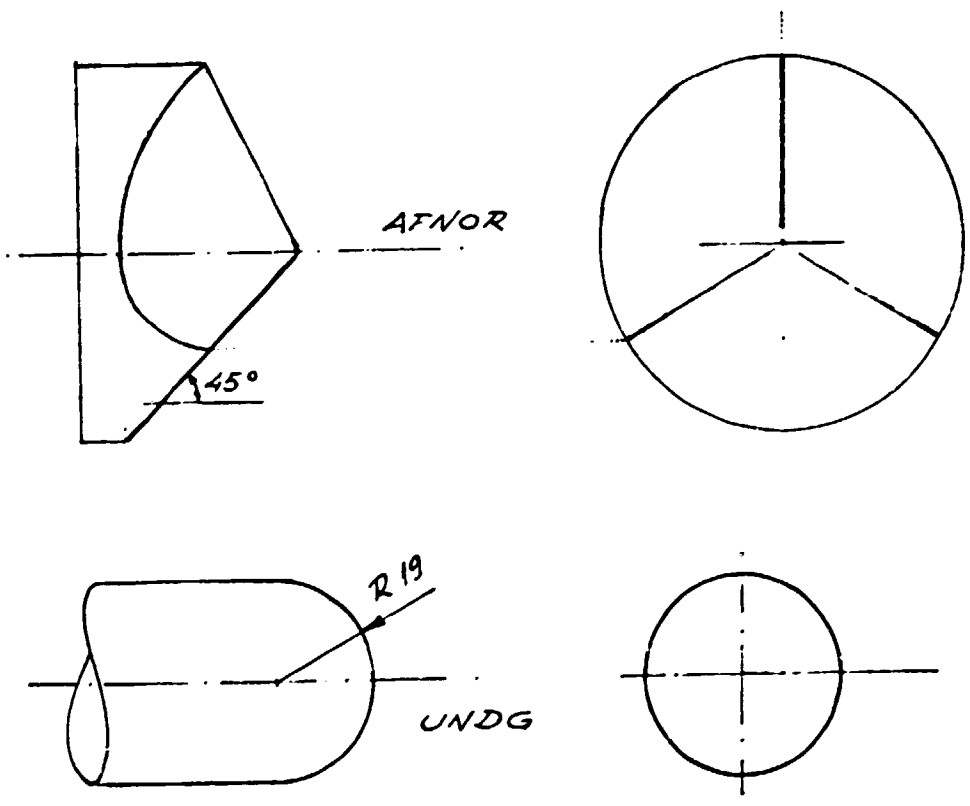
Raise the pendulum to a potential energy of 15 J.

$$E = W . \Delta h$$

$$\Delta h = 15 \text{ J}/50\text{N} = 0,3 \text{ m} = 30 \text{ cm}$$

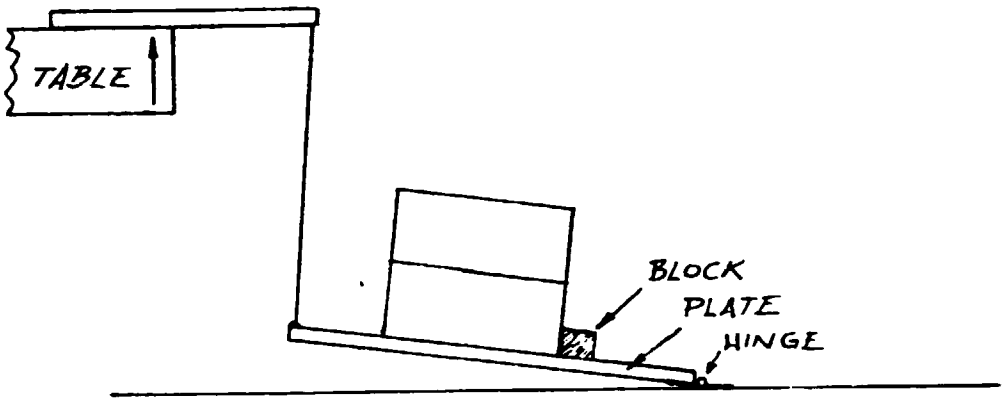
Apply the impact by releasing the pendulum. Check for damages.

Note : Other possible dart forms



7. STABILITY

7.1 Equipment



Flat and strong plate fixed by a hinge in one end and suspended by the other end to a cable fixed to a table with controlable vertical movement (dynamometric compression tester), or to a low speed electric winch, with velocity of 10 ± 5 mm/min, upwards.

7.2 Procedure

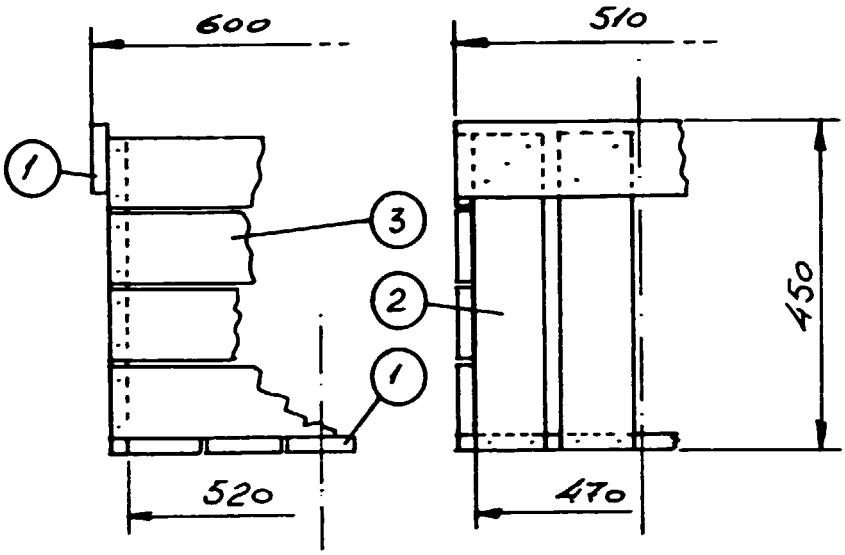
Place the package over the plate in near horizontal position fixing it against slide. Place another package over it, in stacking configuration.

Incline the plate up to 45° and check if the upper package sled or tilted. Register the angle when a slide is observed.

ANNEX III

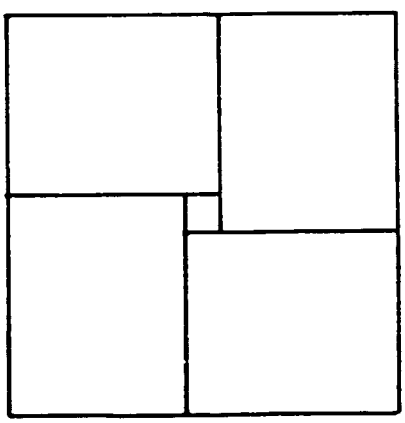
Proposed Alternatives

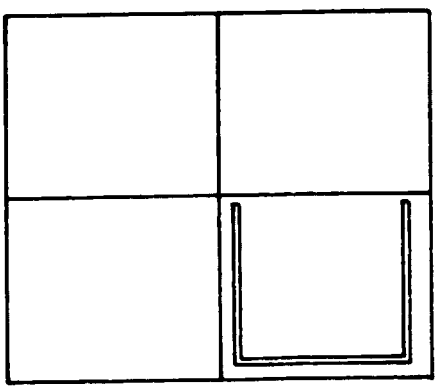
B 100



ITEM	DIMENSIONS mm	QTY.
1	100 x 20 x 510	7
2	100 x 20 x 435	8
3	100 x 20 x 560	8
•	nails ϕ3 x 50	88

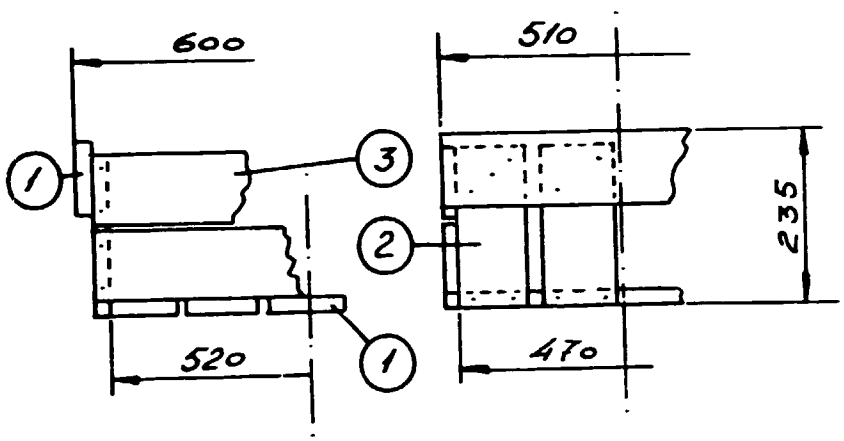
EXT: 600 x 510 x 450
INT: 520 x 470 x 410
CAPACITY: 100 l
wood: 23.000 cm³
tare: ~ 18 kg





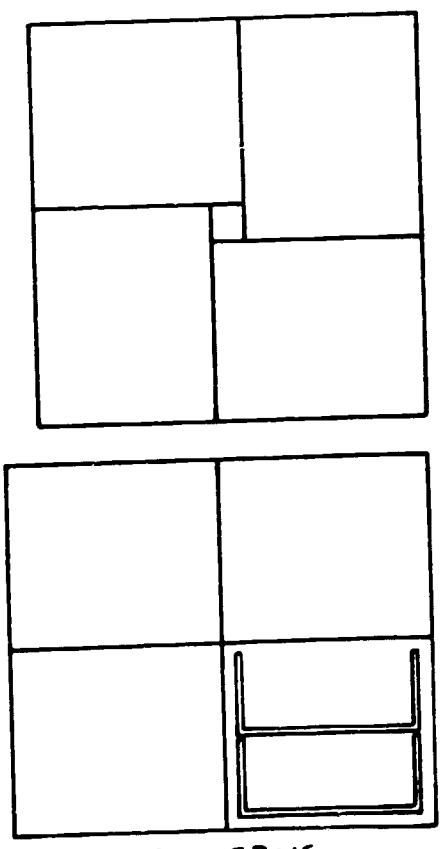
PALLET PATTERNS

B 50



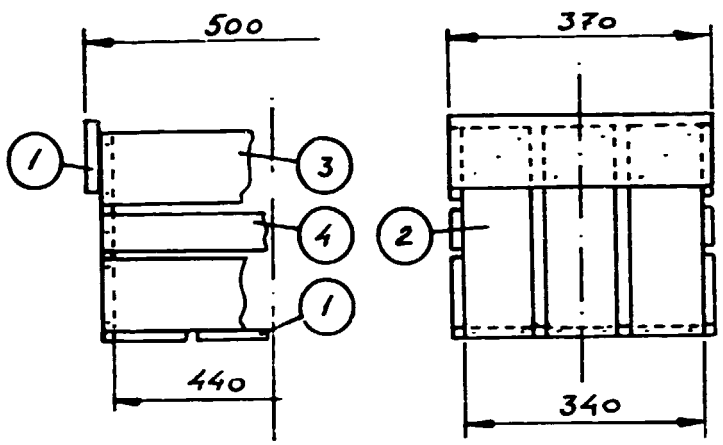
ITEM	DIMENSIONS mm	QTY.
1	100 x 20 x 510	7
2	100 x 20 x 225	8
3	100 x 20 x 560	4
.	nails ϕ3 x 50	72

EXT: 600 x 510 x 235
INT: 520 x 470 x 205
CAPACITY: 50 l
wood: 15200 cm³
tare: ~ 10kg



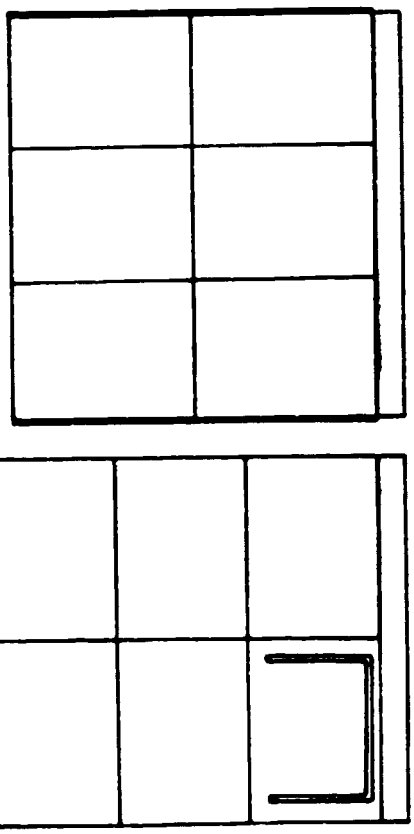
PALLET PATTERNS

C 40



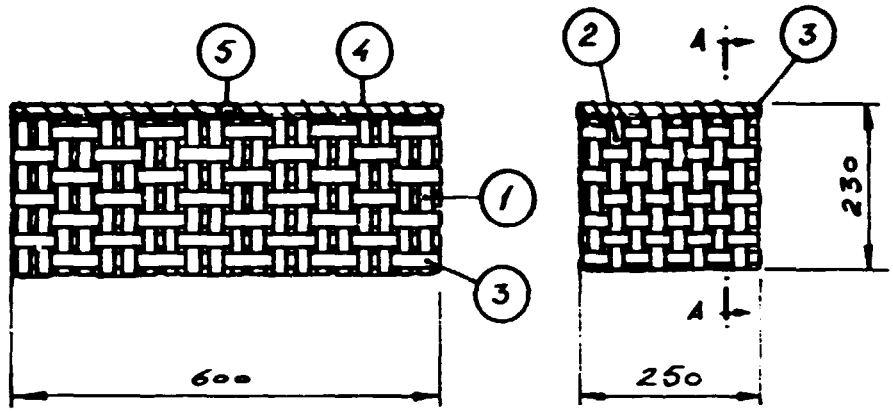
ITEM	DIMENSIONS mm	QTY.
1	100 x 15 x 370	6
2	100 x 15 x 295	6
3	100 x 15 x 470	4
4	50 x 15 x 470	2
.	nails ϕ2.5 x 40	60

EXT: 500 x 370 x 310
INT: 440 x 340 x 280
capacity : 40 l
wood : 9510 cm^3
tare : ~ 8 kg



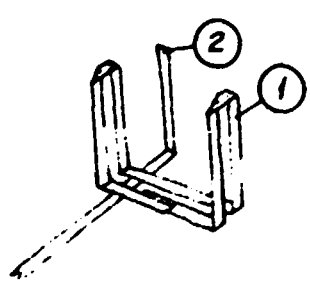
PALLET PATTERNS

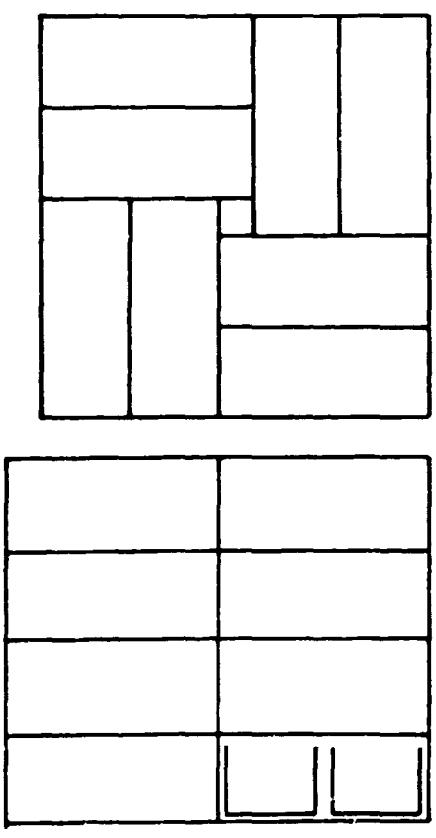
D30



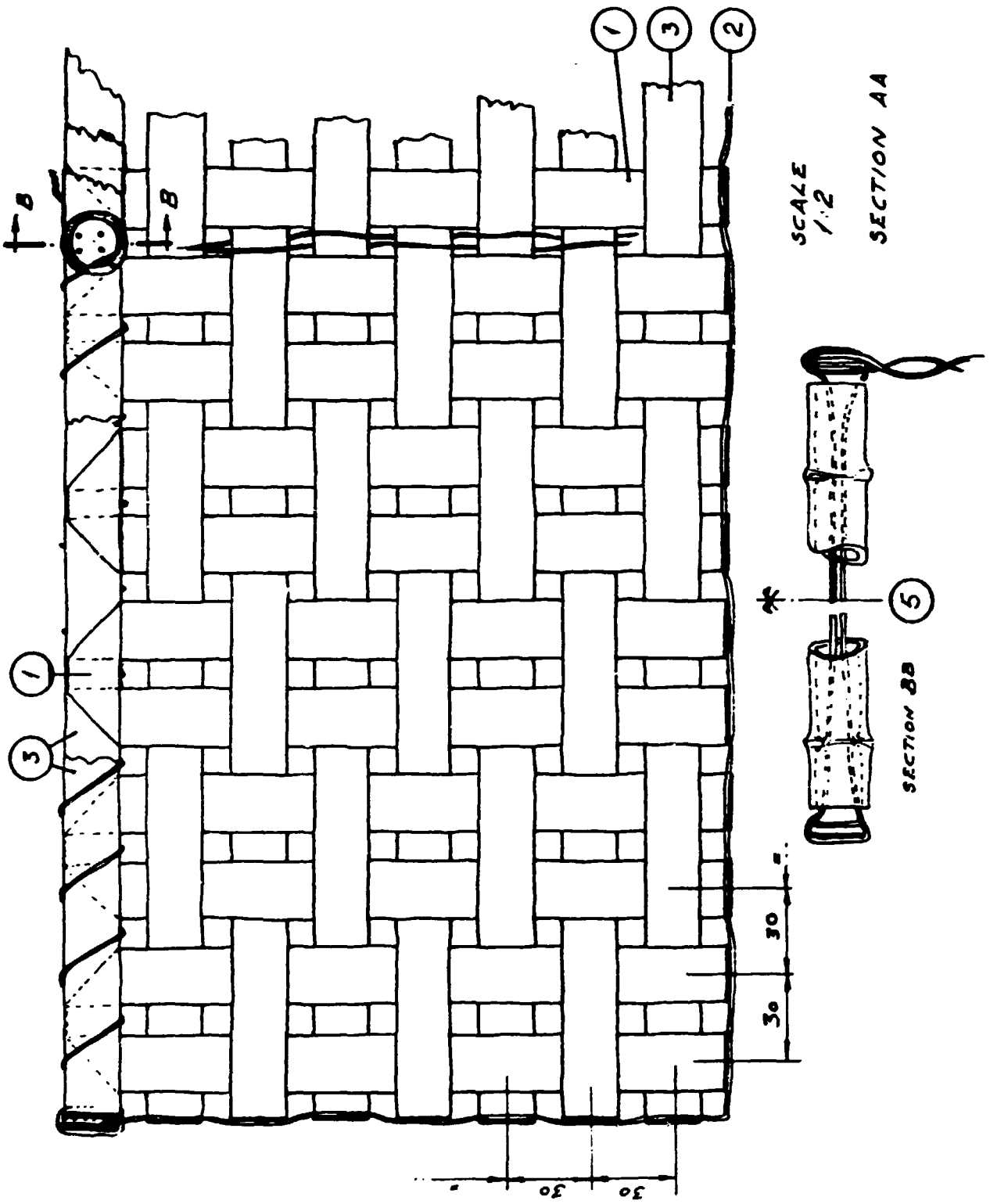
ITEM	DIMENSIONS	QTY
	mm	
1	20 × 1 × 1500	10
2	20 × 1 × 1060	8
3	20 × 1 × 1750	?
4	thread	
5	Φ25 × 240	1

EXT. : 600 × 250 × 230
CAPACITY : 30 ℓ
6 om 600 20 × 1
~ 40 m





PALLET PATTERNS


B
B
1
3
2
1
3
SCALE
1:2
SECTION AA
5
SECTION BB
30
30
30
30

ANNEX IV

Dimensions of typical trucks

and arrangement of boxes

Dimensions and weight of trucks commonly used in Thailand

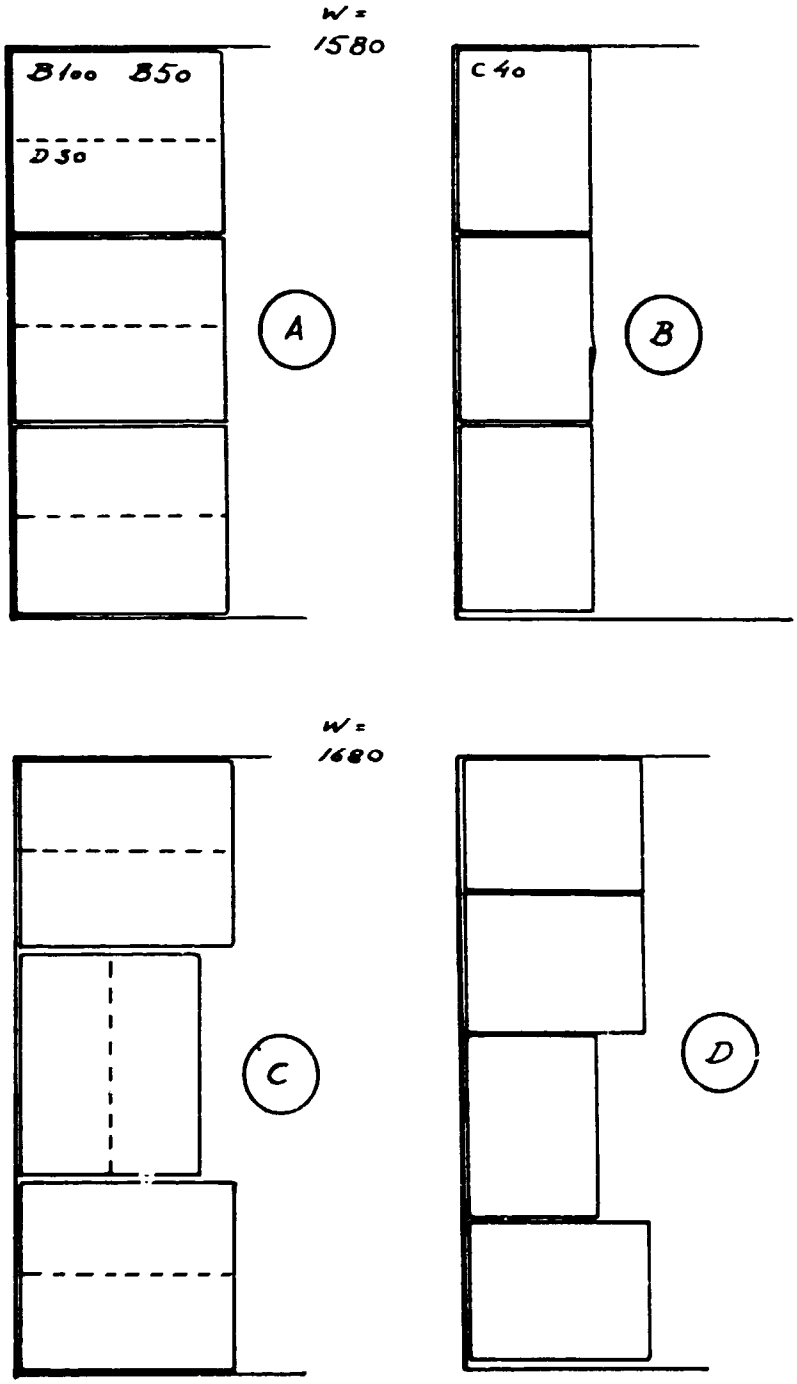
Type	Brand	Width (m)	Length (m)	Height (m)	Gross (kg)	Tare (kg)	Net (kg)	Volume (m^3)
4 tyre	Isuzu	1.58	3.08	1.10	4,200	1,900	2,300	
6 tyre	Isuzu	1.68	4.17	(1) truckbed open 0.58 (2) truckbed covered 0.38	4,800	2,340	2,460	
6 wheel	Isuzu	2.33	4.50	0.60	12,000	4,900	7,100	6,210
6 wheel	Steyr 480	2.33	4.55	(1) truckbed covered 0.60 (2) truckbed extension 0.35	10,000	4,500	5,500	(1) 5,300 (2) 9,011
6 wheel	Steyr 590	2.25	4.70	(1) truckbed covered 0.50 (2) truckbed extension 0.40	8,500	4,300	4,200	(1) 5,288 (2) 9,518
6 wheel	Hino	2.35	4.75	0.60	12,000	5,000	7,000	6,698

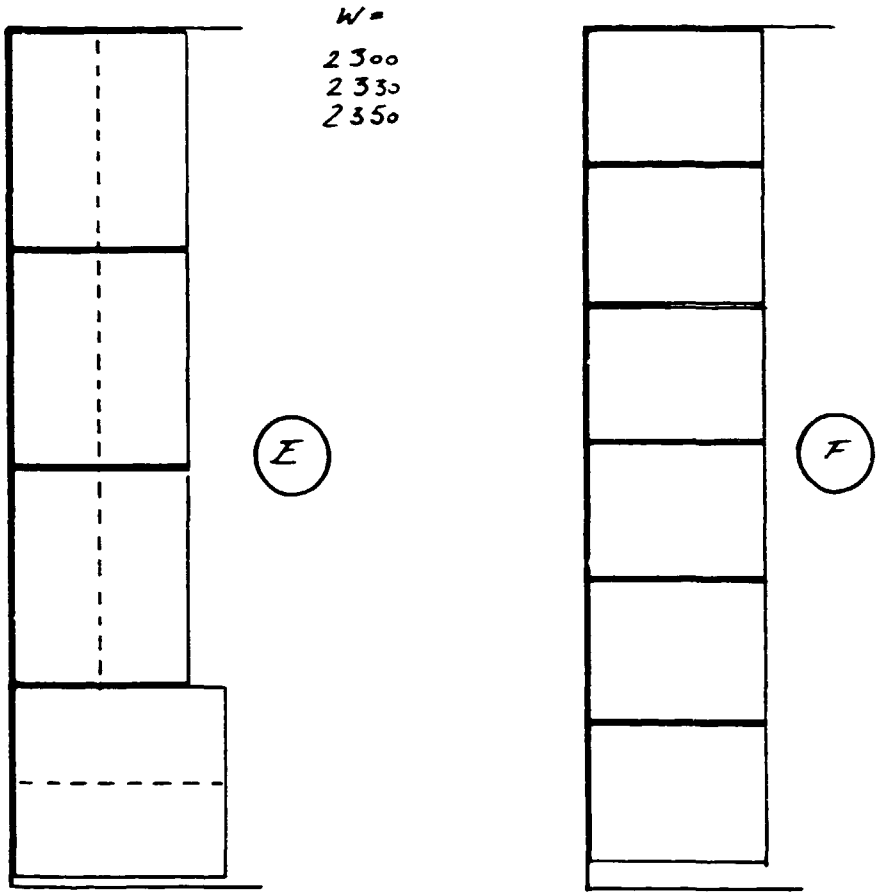
Truck

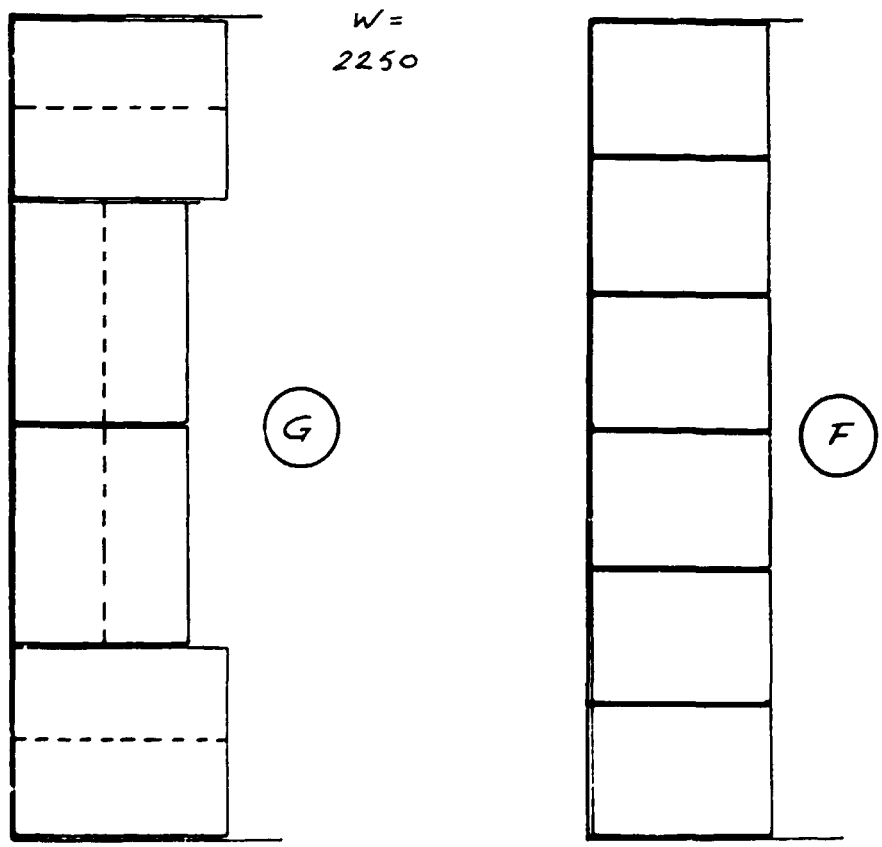
Type	Brand	Width (m)	Length (m)	Height (m)	Gross (kg)	Tare (kg)	Net (kg)	Volume (m^3)
10 wheel	Steyr 680	2.35	5.80	(1) truckbed covered 0.50 (2) truckbed extension 0.45	18,000	6,500	11,500	(1) 6,815 (2) 12,949
10 wheel	Hino	2.40	5.75	(1) truckbed covered 0.60 (2) truckbed extension 1.00	21,000	7,500	13,500	(1) 8,280 (2) 22,080
10 wheel	Isuzu	2.30	5.60	(1) truckbed covered 0.60 (2) truckbed extension 1.45	21,000	7,300	13,700	(1) 7,728 (2) 18,678
8 wheel (Trailer)		2.25	5.70	-	-	-	12,000	
8 wheel (flatbed)		2.45	6.75	-	-	-	11,300	
8 wheel (semi-trailer)		2.30	9.00	-	-	-	13,600	
8 wheel (lowboy)		2.75	8.00	-	-	-	25,000	

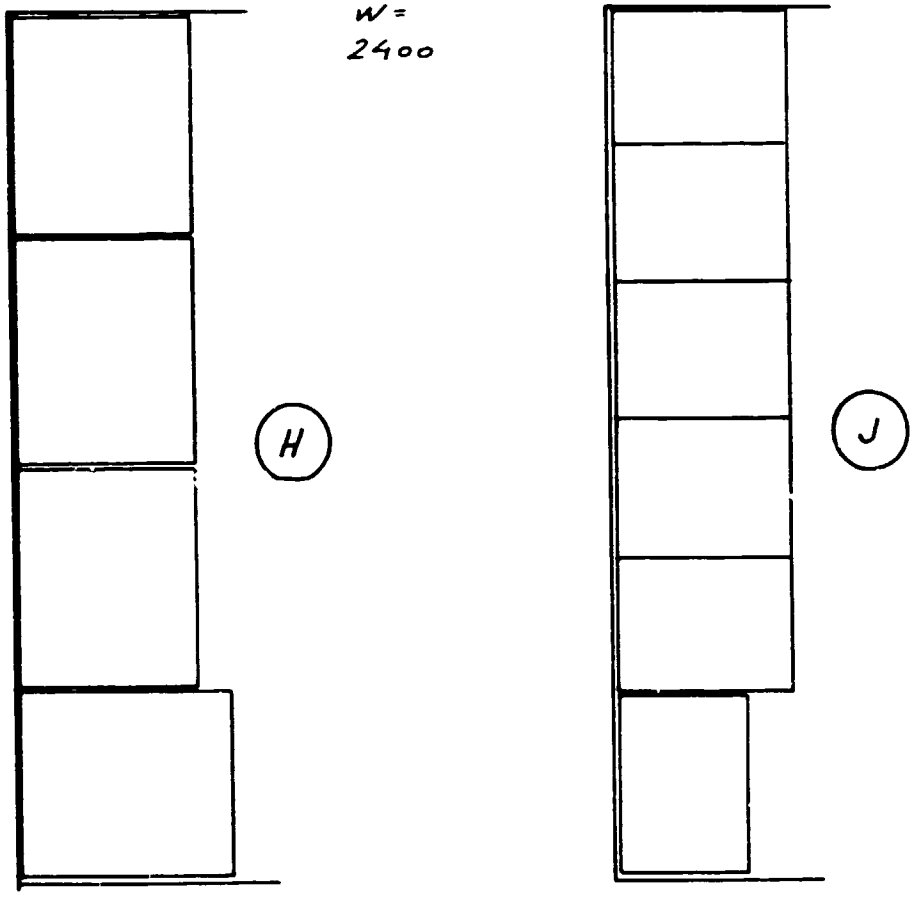
TRUCK				BOX Arrangement Number per truck Number per layer x layers + additional			
Tyres	W/L (mm)	NET (kg)	kg/m^2	B100/50kg	B50/40kg	C40/30 kg	D30/20 kg
4	1580 3080	2300	470	A 46 15x3+1	A 57 15x3+12	B 76 24x3+4	2A 115 30x3+25
6	1680 4170	2460	350	C 49 20x2+9	C 61 20x3+1	D 82 35x2+12	2C 123 40x3+3
6	2330 4500	7100	670	E 142 31x4+18	E 177 31x5+22	F 236 54x4+20	2E 355 62x5+45
6	2330 4550	5500	520	E 110 31x3+17	E 137 31x4+13	F 183 54x3+21	2E 275 62x4+27
6	2250 4700	4200	397	G 84 32x2+20	G 105 32x3+9	F 140 54x2+32	2G 210 64x3+18
6	2350 4750	7000	620	E 140 34x4+4	E170 34x5	F 233 57x4+5	2E 350 68x5+10
10	2350 5800	11500	860	E 230 *42x5+20	E 282 42x6+30	F 383 66x5+53	2E 575 84x6+71
10	2400 5750	13500	990	H 270 *42x6+18	H 337 42x8+1	J 450 70x6+30	2H 675 84x8+3
10	2300 5800	13700	1060	E 274 *39x7+1	E 342 39x8+30	F 456 66x6+60	2E 685 78x8+61
8	2250 5700	12000	800	G 240 40x6	G 300 40x7+20	F 400 66x6+4	2G 600 80x7+40
8	2450 6750	11300	680	I 226 52x4+18	I 282 52x5+22	J 376 83x4+44	2I 565 104x5+45
8	2300 9000	13600	650	E 276 66x4+12	E 340 66x5+10	F 435 108x4+3	2E 680 132x5+20

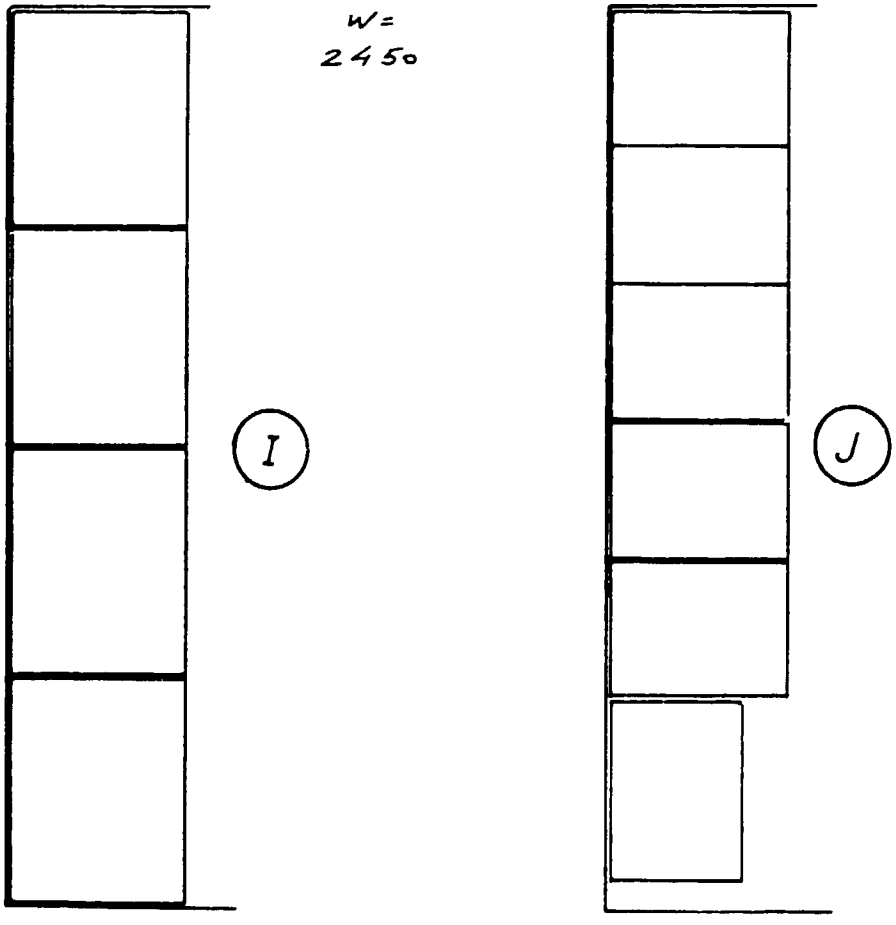
* maximum stack is 5
for limitation of trucks dimensions, stability


W = 1580
B100 B50
D30
A
C40
B
W = 1680
C
D


W =
2300
2330
2350
E
F


W =
2250
G
F


W=
2400
H
J


W=
2450
I
J

ANNEX V

Manufacture of boxes

Production estimates

Fruits : 5 M ton/year

Vegetables : 2 M ton/year

Total with some increase in future

conservative : 8 M ton/year

optimistic : 12 M ton/year

assuming : 10 M ton/year

- 6 in boxes = 120 M kg/week
- 3 in baskets
- 1 in sacs

assuming boxes reused each week

				kg/box	1000 boxes
assuming	B 100	30%	36 M kg	50	720
	B 50	30%	36	40	900
	C 40	30%	36	30	1200
	D 30	10%	12	20	600

assuming life of box 1 year, production will be:

Type	1000 boxes/year	
B 100	720	
B 50	900	
C 40	1200	
D 30	600	
total	3420	= 20000 boxes/day

assuming 100 small industries, production must be 200 boxes/day, each industry.

Manufacture of boxes

Plant to produce up to 200 boxes/day, size C40, model proposed.

- Necessary machinery and installations

1 - disc saw

one

model :

approx. cost : 20000 Bt

2 - pillar drill with special 4 drill device

one

model :

approx. cost : 15000 Bt

3 - Template for corners

two

model : see drawing

approx. cost : 2 x 1000 Bt

4 - Template for ends

one

approx. cost : 1000 Bt

5 - Template for sides and bottom

one

approx. cost : 1000 Bt

6 - Hammer

six

approx. cost : 6 x 300 Bt

7 - Carts for handling/storage, treatment

six

model :

approx. cost : 6 x 3500 Bt

8 - Treatment tank

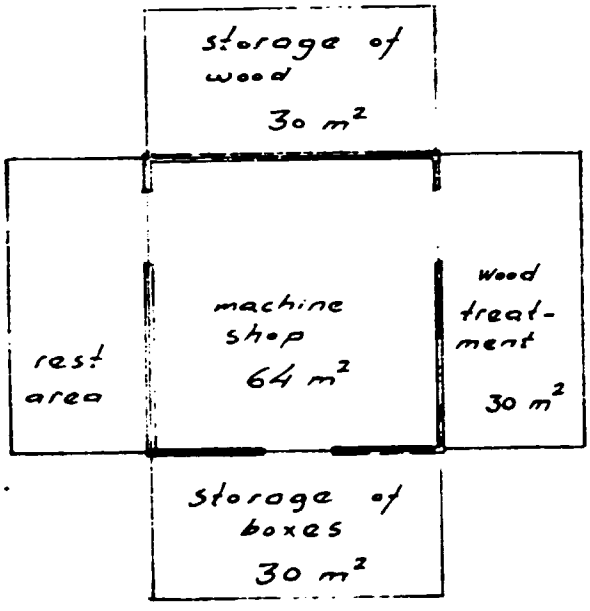
one

approx. cost : 10000 Bt

total cost of equipment : 40000 Bt

- Areas, arrangement

The following covered areas are necessary, according to scheme :



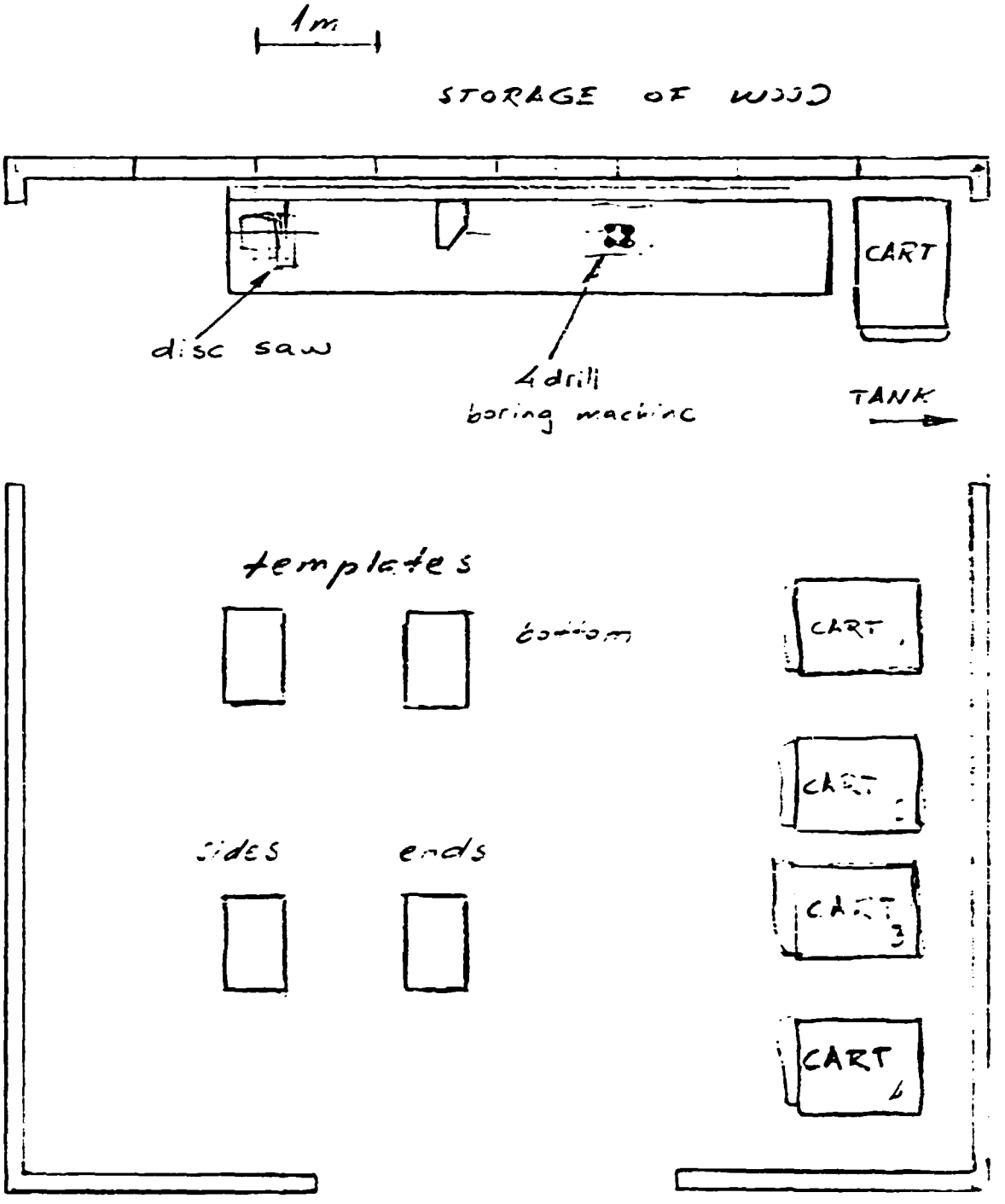
An arrangement of the machine shop is proposed in sketch.

- Operation

The boards are received from the sawmill already in the width and thickness specified (100 and 20 mm, 15 mm). If the wood is expected to dry the storage area must be much larger.

Two boards at a time are taken from the storage and placed over roller racks on line with the disc saw. Two parts are sawn at once, with lenghts given by templates. The parts go for boring in a 4 drill machine, and are placed in a cart, one cart for each item. The cart with the parts is dipped in the wood treatment tank. After some time, and some time for drying, the cart is taken to the machine shop. Parts are distributed to the templates and nailed. Assembled boxes are taken to the storage area, dispatched. For a production of 200 boxes/day, ten workers are necessary :

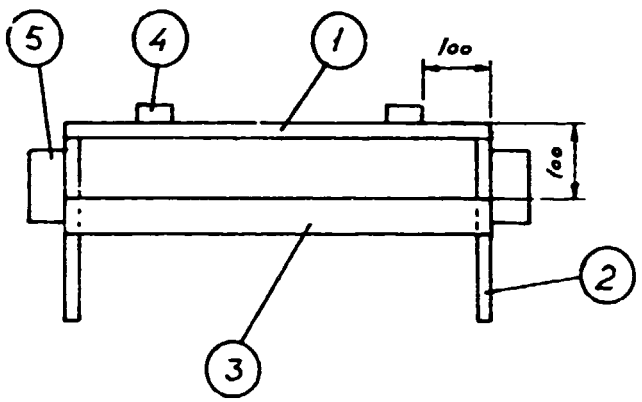
workers	operation
1	saw
1	drill
4	handling (one supervisor)
4	nailing

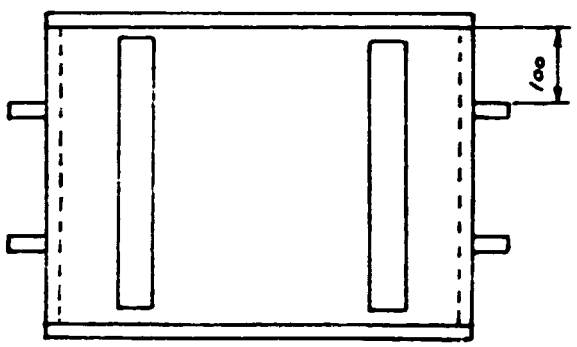


STORAGE OF BOXES

TEMPLATE FOR C40 BOX

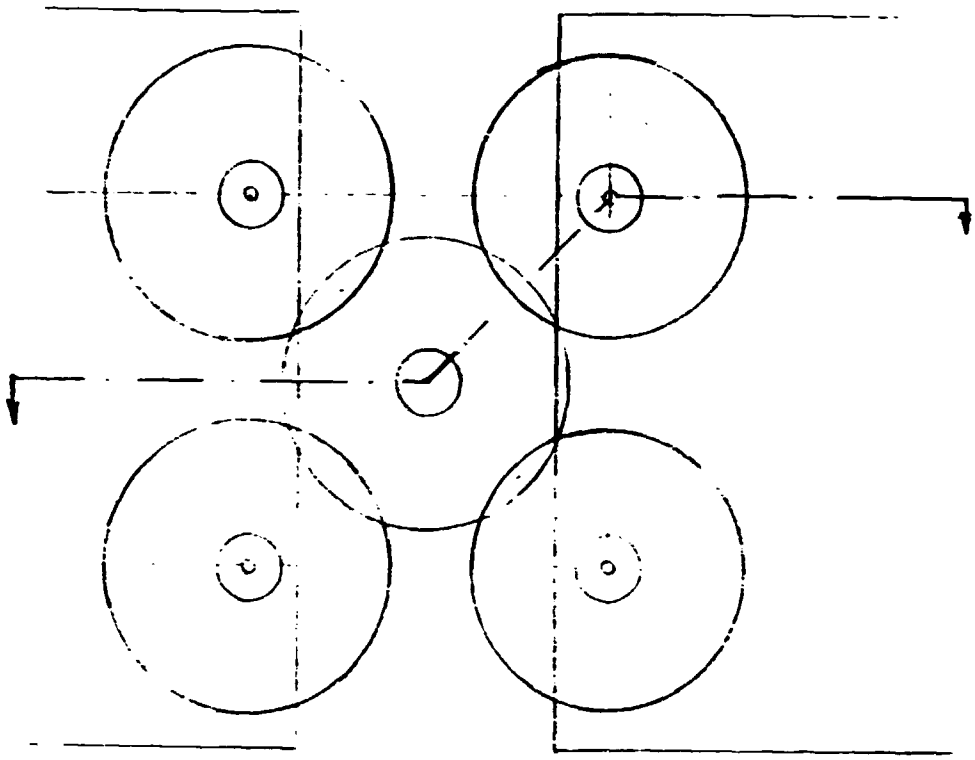
ITEM	DIM	QTY.
1	440 x 340 x 20	1
2	340 x 260 x 20	2
3	50 x 20 x 440	2
4	50 x 20 x 340	2
5	50 x 20 x 120	4

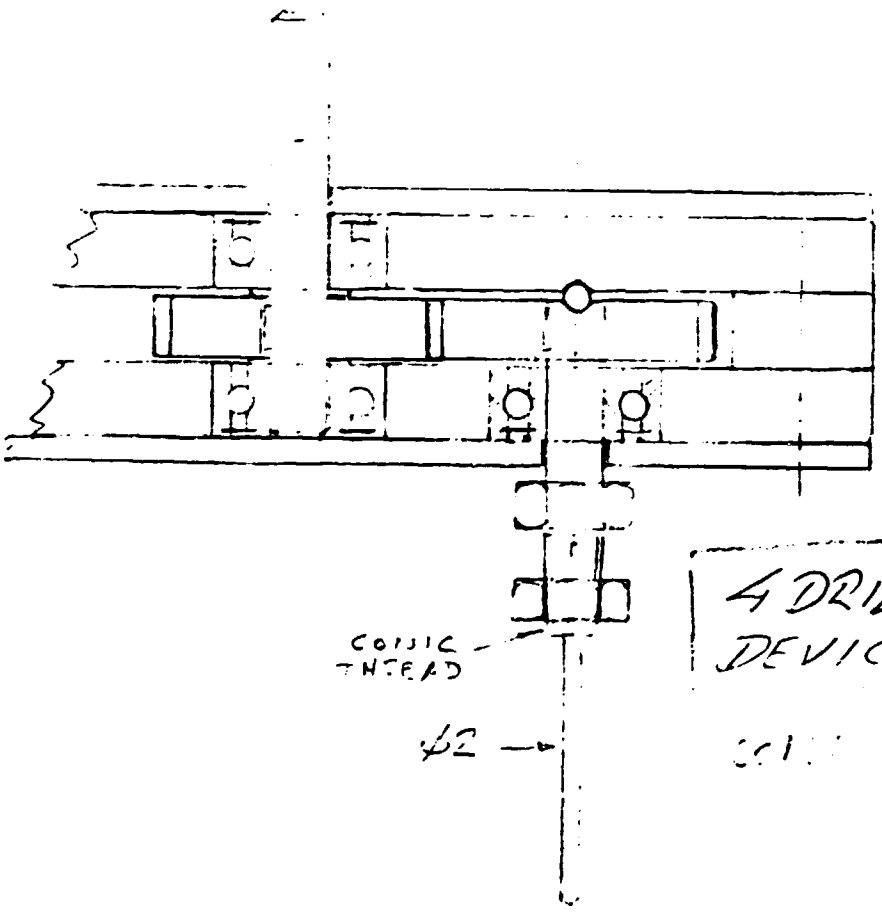




MATERIAL : WELDED STEEL PLATE

66 kg




4 DRILL
DEVICE
CONIC
THREAD
Ø2

Appendix I

Photographic Documentary

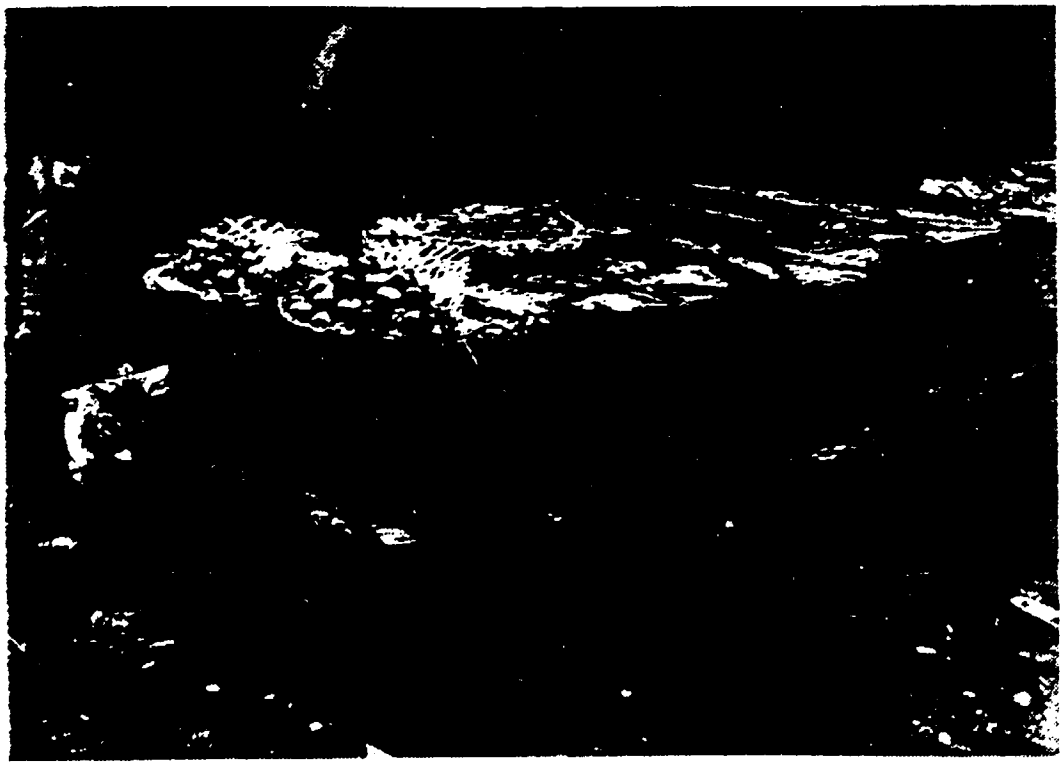
A - Pictures taken at the Park Klong Talat market, in Bangkok, in Dammernsaaduak (Floating Market) and in Naaklornpathom, showing some of the usual packages and handling operations.

B - Pictures of proposed boxes, prototypes made at the Thai Packaging Centre. The wood used is not the specified Yang Pa-a, but a harder and darker one (Yang).

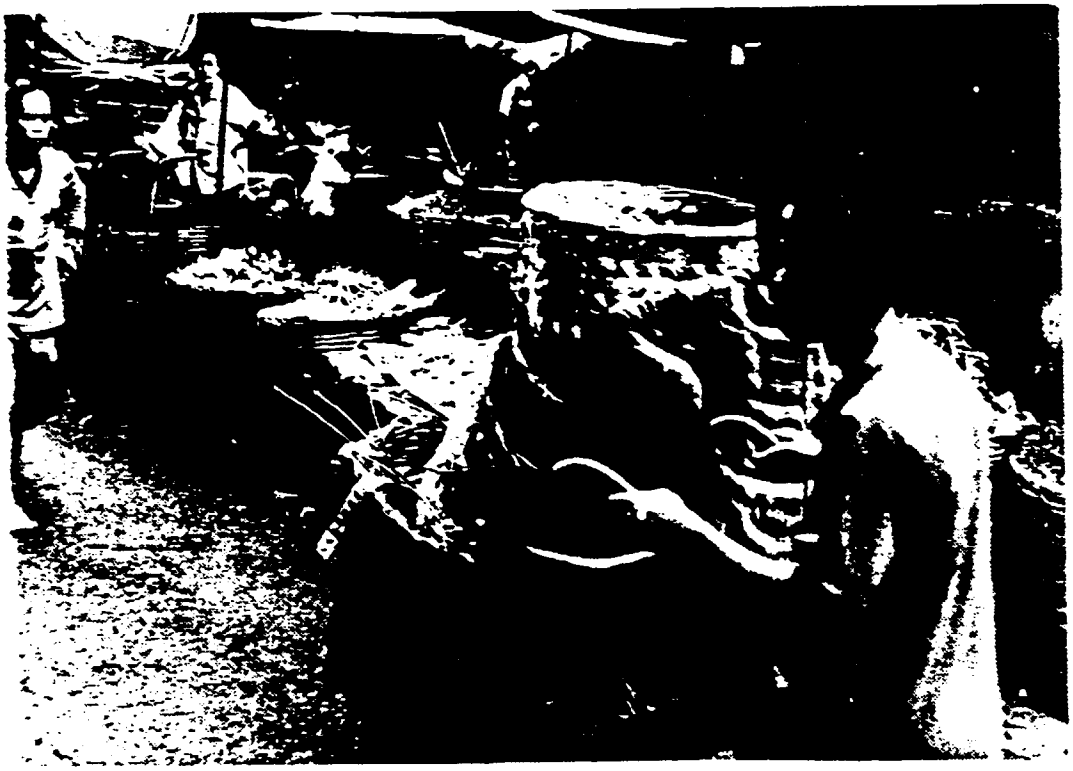
Present practice based on bamboo baskets. Difficult to stack, heavy baskets, some with paper or synthetic liners from used sacks. Note different forms of construction.

Large area for storage, due to impossibility of stacking higher. Baskets burst in the bottom because of handling conditions.

Baskets with reinforced lid to improve stacking strength and protection.



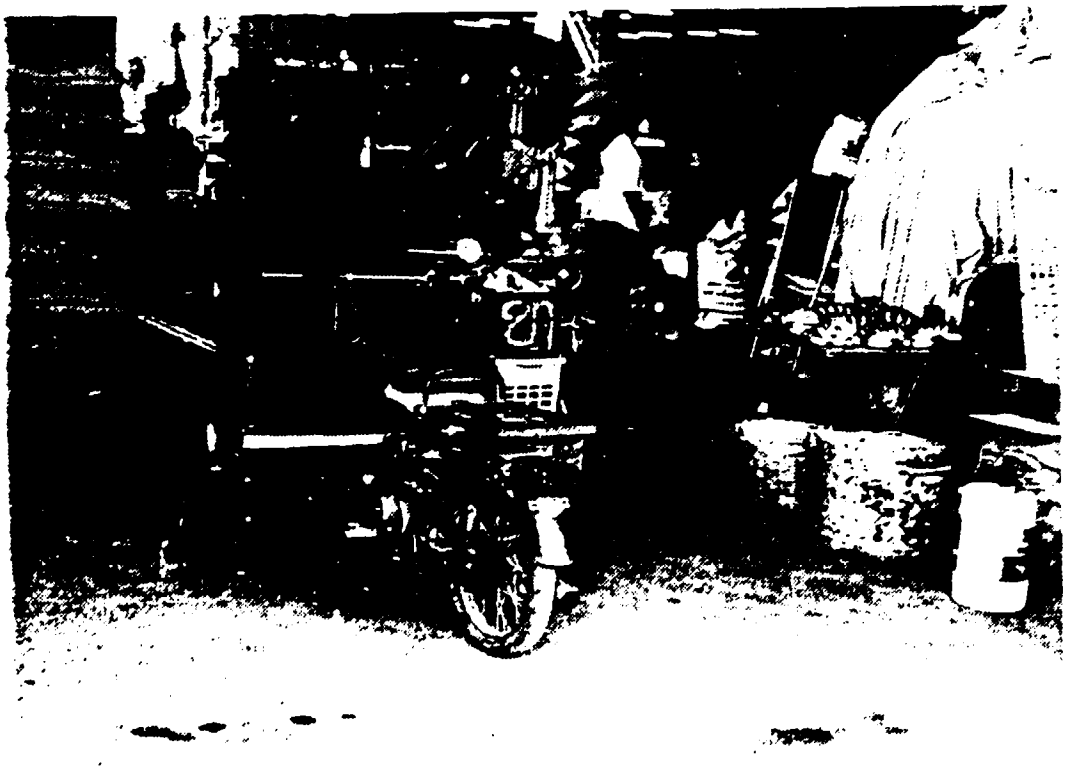
Baskets with commonly observe difficulty in stacking and large dent which causes damage by crushing the produce.



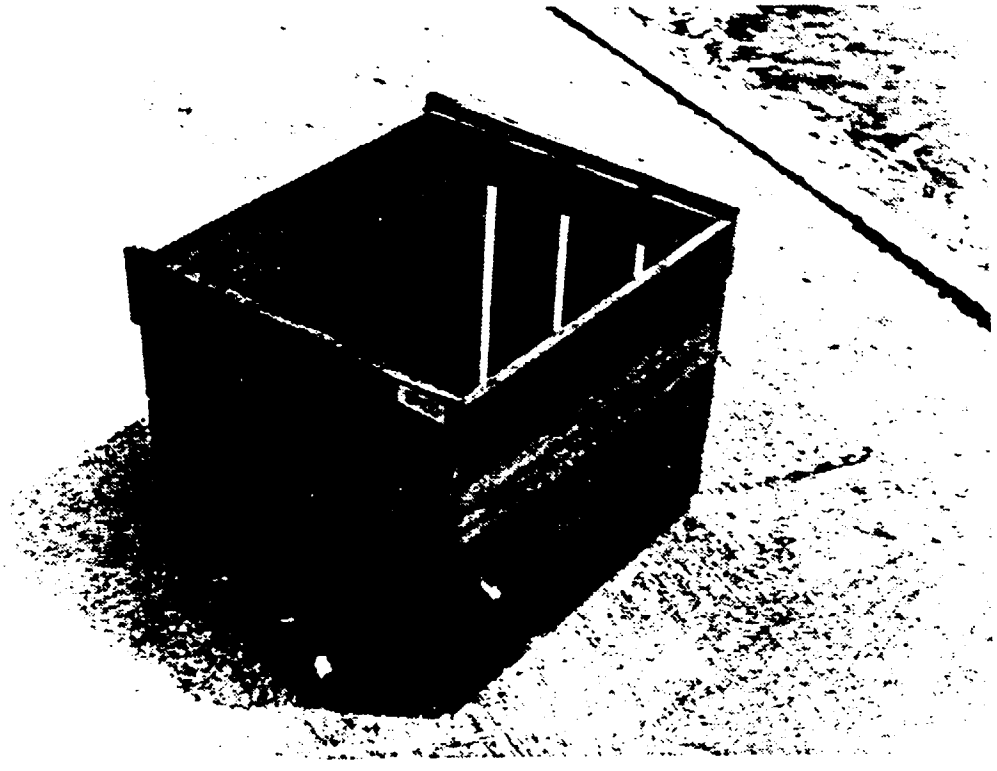
Carts used for handling (short haul) of baskets. Nesting of empty baskets is usually possible.

Handling of ice block with the cart. Note the use of plastic boxes, with important identification.

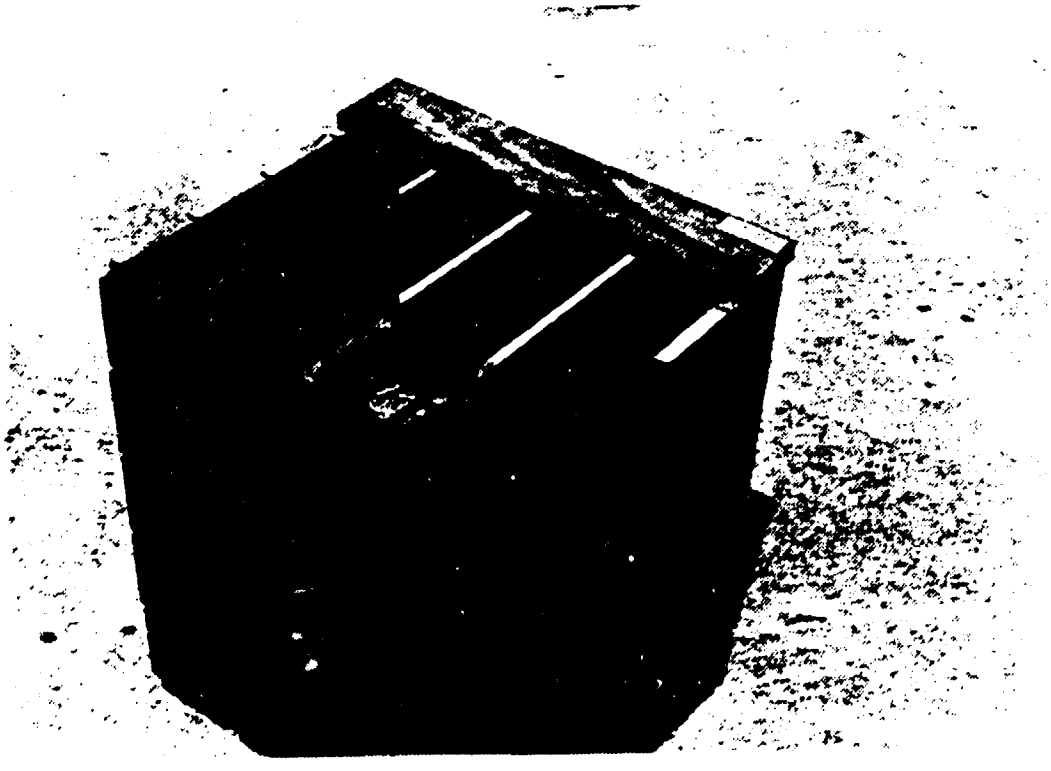
Plastic boxes and baskets, at the Floating Market.



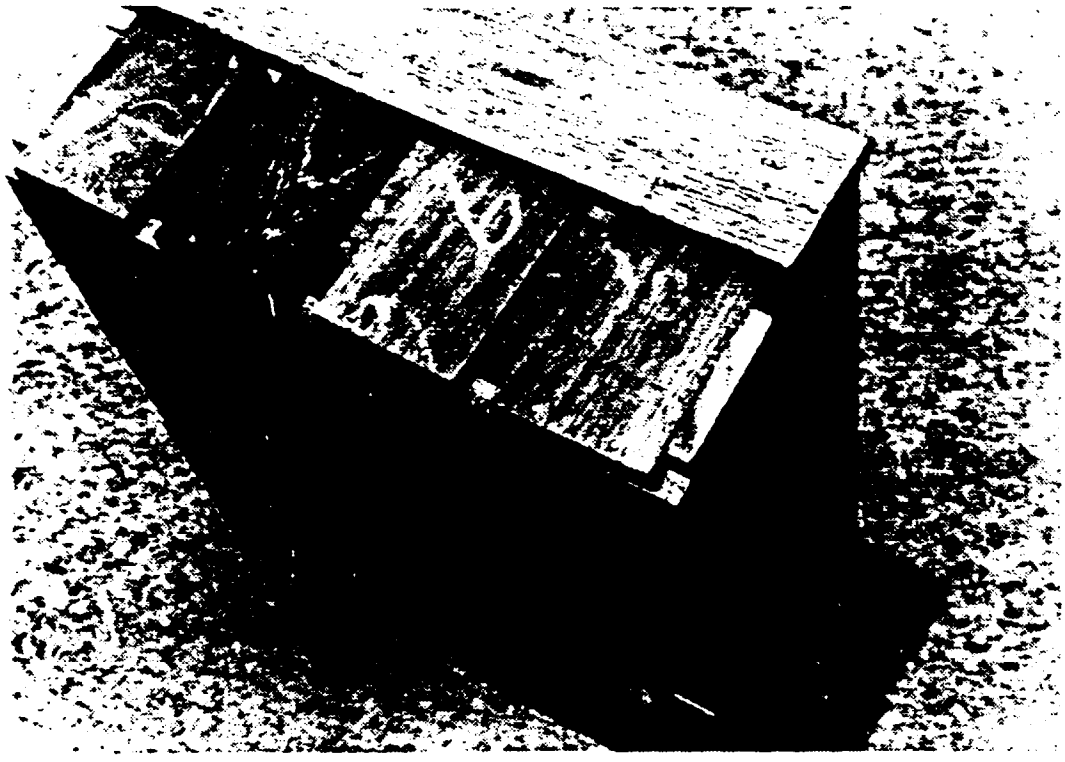
Motorcycle used for local transportation, at the Floating Market. Sacks, baskets and plastic boxes, no wooden boxes are seen.



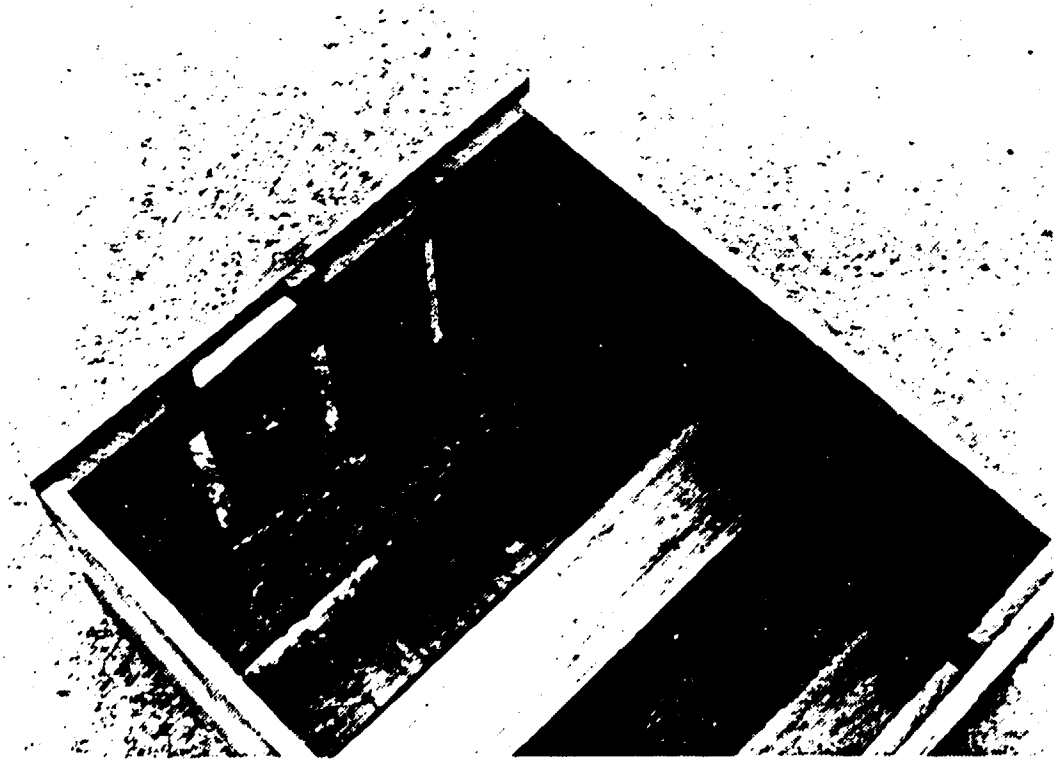
Proposed Box in size B100, made of tung wood.



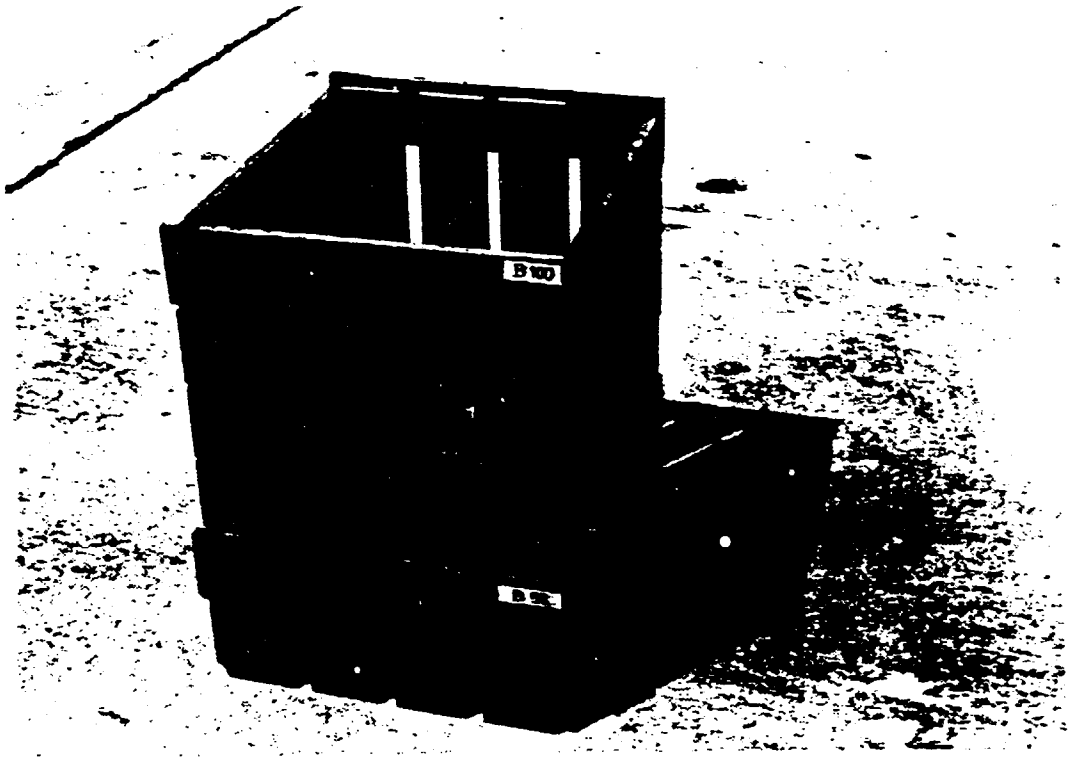
Box B100, showing corner and bottom construction.



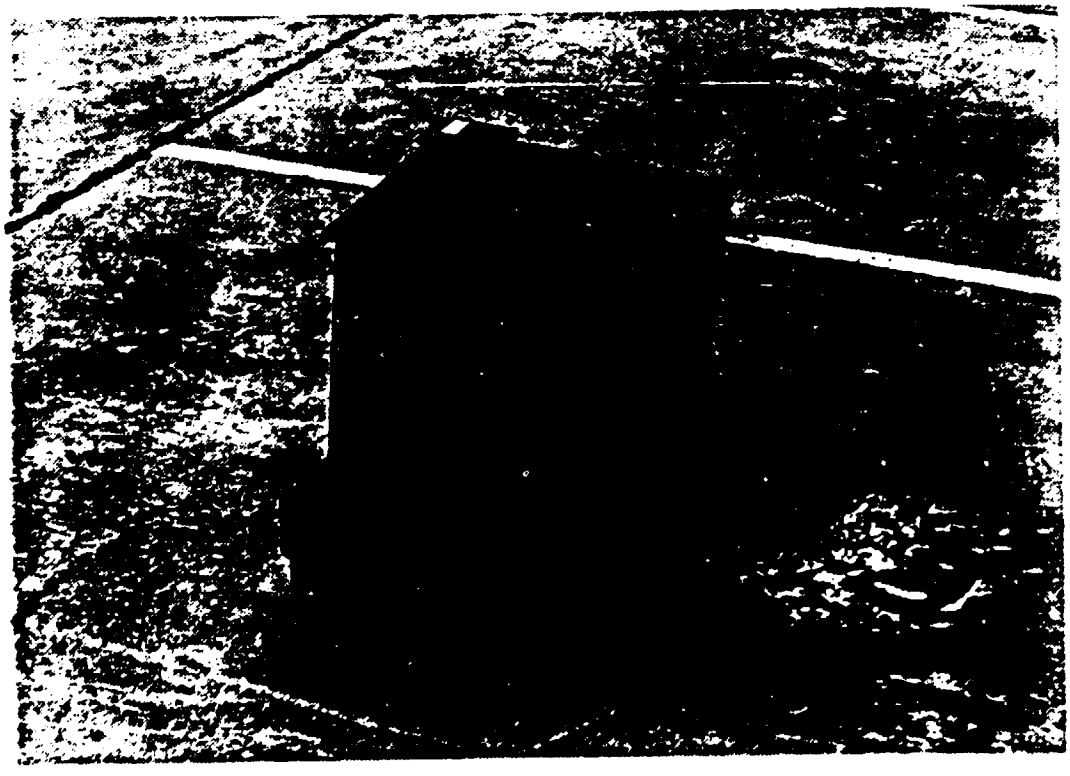
Box in line 350.



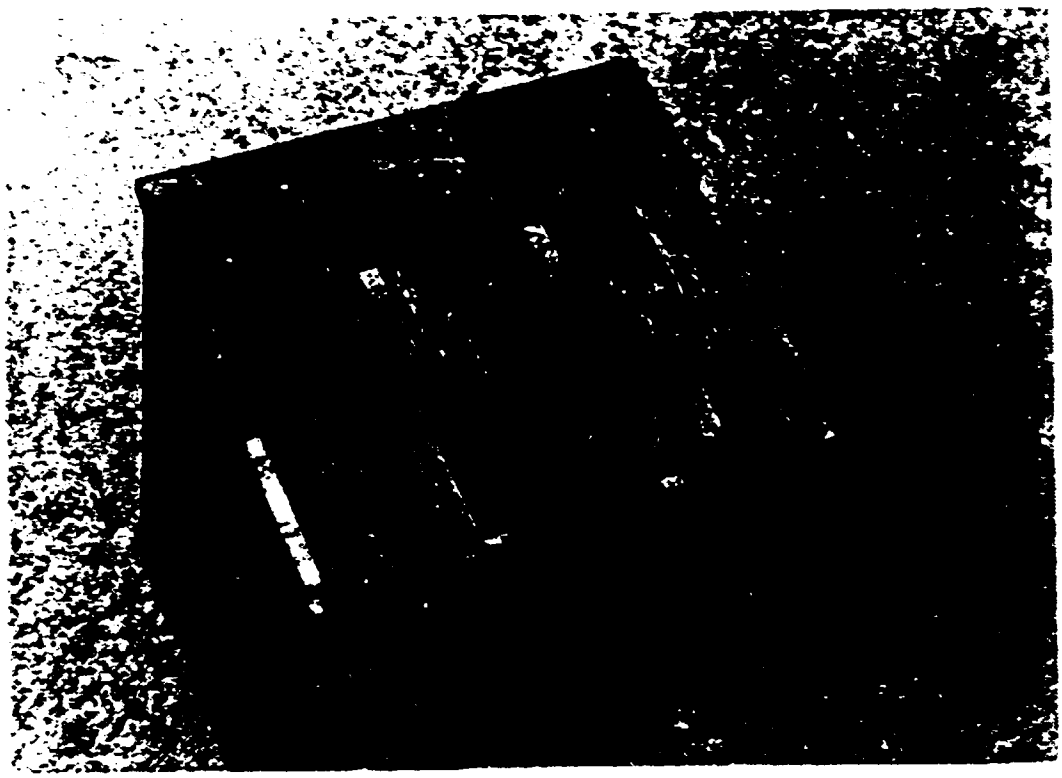
Box in line 350, showing ends with blocking parts.



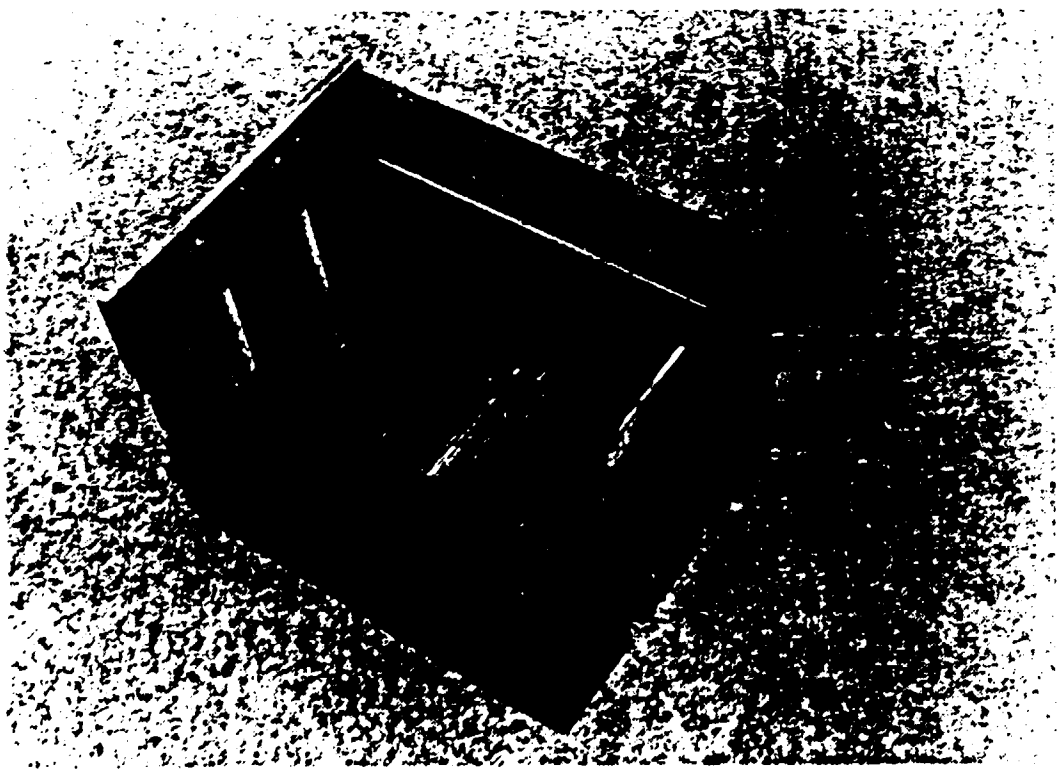
Box B100 stacked over a B50.



Box B100 inside a B50.



Proposed box size D40, showing corner construction.



Proposed Box D40, internal view.