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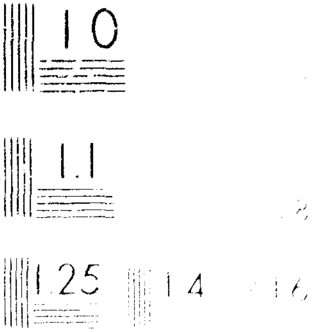

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19 January 1982
English

KOREA DESIGN AND PACKAGING CENTER, PHASE II

DP/ROK/78/008

REPUBLIC OF KOREA

Technical report: Heavy weight packaging *

Prepared for the Government of the Republic of Korea
by the United Nations Industrial Development Organization,
executing agency for the United Nations Development Programme

Based on the work of Ernst Schmidt, consultant in heavy weight packaging

United Nations Industrial Development Organization
Vienna

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V.82-20332

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SUMMARY

DOCUMENT: DP ID SER.A 325 V.82-20706 19.1.82

NATURE: Survey and advisory technical report

TITLE: Heavy weight packaging

AUTHOR: Ernst Schmidt

LENGTH: 96 pages

TYPE OF DOCUMENT: Restricted circulation, original English

SCOPE: Survey, advice and training in packaging of heavy equipment for the Korea Design and Packaging Centre (KDPC).

CONTENTS: Summary, introduction, findings and recommendations. The annexes include reports on visits, abstracts of lectures and seminar and an explanation of the package modulus system. Both the body of the report and the annexes are illustrated with pertinent technical notes and figures.

RECOMMENDATIONS: KDPC should organize and carry out a programme of visits, testing and research in co-operation with the industry in order to promote and assist the improvement of heavy packaging techniques in the country.

C O N T E N T S

SUMMARY

Based on visits to some big factories producing heavy goods and some producers of auxiliary packaging means for heavy goods packaging, it may be said that the availibility of packaging materials of sufficient quality and the existance of rather good know-how and working capacity in the production and packaging companies may guarantee a normal level of the protection of heavy goods against distribution hazards.

There were discussions, lectures, seminars in the factories with people responsible for packaging and shipment and in the KDPC about the basic functions of packaging espacially referring to heavy goods and about the possibilities to fulfil them.

They have shown that it is necessary to come to a still deeper understanding of the decision processes, of determining design details of the packages and of the methods to solve the problems arising out of observations and failures.

Therefore it is recommended that some research work should be done apt to make more comprehensive the importance of various design details of heavy goods packaging and to solve the problems that have been found during the visits and discussions.

INTRODUCTION

Under the Fourth Five-Year Economic Development Plan, the Government is continuing to place strong emphasis on the promotion of both light and heavy industry and on the export of industrial products. The total value of exports, which increased from US$1,624 million in 1972 to 12,500 million in 1978, is projected to rise to approximately US$20,200 million in 1981, while an estimated 92 per cent of this total will be composed of manufactured goods. In order to reach this target the country will have to continue to improve the quality of its exports and diversify its markets.

An important requirement for increasing the marketability of local products, both at home and abroad, is the continuous improvement of packaging for both presentation and handling purposes. The Korean Design and Packaging Centre(KDPC) is expected to play an important role in this respect by continuing to assist industry in improving the design and quality of domestic packaging through the transfer and adaptation of advanced packaging technologies and the establishment of quality standards and testing procedures.

FINDINGS

(Main activities and their results)

1. Producers and users of packages, packaging materials, and auxiliary packaging means were visited and some tests made to be able to evaluate the aptitudes of these materials, etc. and of the techniques of their use for heavy goods packaging (see job description appendix 1.1.)

Packaging companies and big producing companies seem to be rather well informed on packaging and eager to avoid defects.

The packaging materials, etc. also seem to be well made.

Nevertheless during the visits a great number of questions had to be answered especially referring to the following topics;

Details of methods apt to protect iron and steel parts against corrosion. (See appendix 6)

Bundling steel parts,

Packaging steel structures (see appendix 5)

Organization of packaging,

Marking products and packages (see appendix 5)

The visits also were a good source of information about research tasks.

2. Lectures were conducted about packaging technology especially with reference to heavy goods packaging. (see job description, appendix 1, items 1,2,3, and 4)

The method used to deal with these topics was characterized as follows;

a) An abstract of each topic was given on paper charts, visible to all participants.

b) Drawings, slides, and models were used to demonstrate essential facts and details.

c) Each participant got reproductions of the charts.

d) Translations to Korean partially already were given, but complete translations of the abstract are planned.

e) The topics of the lectures were the following ones;

Title: Current techniques and knowledge concerning Distribution packaging

- Physical Distribution, Definition
- Distribution packaging, Functions
- Suppositions for finding out the Optional Means and Methods of Protection
- Distribution Hazards
- Behaviour of the Product with Reference to the Distribution hazards
- Behavior of Packaging Materials and Means, auxiliary packaging means, auxiliary transport means, with reference to Distribution Hazards
- Rationalization of the Distribution Process
- Information as to all Participatns in the distribution process
- Process of the Development of an Optimum Package especially for Heavy Goods

3. A seminar was performed at the KDPC with reference to items 1 to 4 of the Job description under the following titles;

Title : experiences made during my stay in Korea

a) Experiences as to the lectures

b) Experiences made during visits to various companies

c) Experiences as to the research work of the KDPC

c.1) Research concerning the essential properties of packaging and auxiliary packaging materials and means.

c.2) Research on goods with reference to their behaviour under the influence of distribution hazards.

c.3) Research on the distribution hazards.

c.4) Research as to packaging problems having occurred and occurring constantly in the exporting industry.

c.5) Research as to the use of ISO containers in the country.

d) Experiences made on the occasion of discussions with staff members of the KDPC.

d.1) Standardization of the sizes of packages.

d.2) Development of fruit packages (reusable)

d.3) Finding out the range of application for different means and methods to prevent corrosion during a distribution process.

e) Experiences and observations concerning the combination of Design, Development, Research, Production, and Teaching in the KDPC.

4. Discussions with different staff members of the KDPC were performed under following topics (see items 2,4,5 of the job description);

Packaging of argricultural goods in reusable packages,
Standardization of packaging,
Anti-corrosion packaging

The results of these discussions were treated during the seminar (see appendix 9) and are part of the basis for the recommendations (see its chapter 4).

The following is an abstract of the discussions concerning the above mentioned three topics.

The cost of reusable packages can be diminished by increasing the number of uses in eliminating weak points and/or generally reinforcing the packages or by reducing the material where it is not needed.

The standardization of packaging should be organized as described in appendix 10. Its characteristics are;

The use of the modulus 600mm x 400mm for the determination of packages and pallet sizes.

These dimensions are the so called "nominal dimensions".

Sizes to be ordered for the production of packages are the "outer sizes" that are smaller than the norminal sizes because they take into a account deformations by compression and production tolerances so that the nominal sizes are not exceeded during the distribution process.

RECOMMENDATIONS

1. The visits to the companies exporting heavy goods should be continued with the following aims;

1.1 To find out if their means and methods correspond to the requirements described in the lectures and the reports on the first visits.

1.2 To discuss with those who are responsible for shipment and/or packaging if the deviations from the given rules are admittable or not.

1.3 To recognize problems to be treated with in the KDPC (see chapter 3).

1.4 To draw the attention of the companies to the possibilities, e.g. to develop and use test programms to check the quality of the packages fabricated by the production and packaging companies.

2. To collect or find out by testing according to the corresponding standards reliable data as to the following items of the technology of heavy goods packaging in the country. Uncertain, non-appropriate, and missing data should be treated with by performing appropriate research work (see chapter 3.4.4.)

2.1 The properties of goods with reference to distribution hazards, e.g. their shape, size, structure, weight, susceptibility to corrosion, impact, compressive forces.

2.3 The methods used for handling and stacking during loading and unloading, transport and storage in this country and in countries that are customers of Korea.

2.4 The methods and means to pack heavy goods in containers used by the production and packaging companies.

3. To solve the following problems recognized during the visits to Doo San, Sam Sung, and Hwa Chun companies.

3.1 How to avoid splitting of wood by nails used in the country?

The influences of nails (their dimensions, shape and surface the points) of the distances between one another, and to the brims of the board, of the kinds of applying the nails, of the kinds and moisture contents of the wood should be investigated.

3.2 Find out the influences of splitting of wooden boards and beams on the performance of their function.

Nailed and more or less splitted asemblies of boards and beams with other boards or beams should be tested appropriately.

3.3 To find out if it is necessary to protect the surfaces of galvanized steel parts contacting each other (see appendix 4) in an open crate aginst being worn at the points of contact.

A model must be found representing the essential situation in the open crate filled with galvanized steel parts. This model should be submitted to vibrations of different directions, frequencies, intensities, and durations in order to find out under what conditions abrasion is observed and how it could be avoided effectively with a minimum of cost.

3.4 To find out the optimum method of testing the water and air proofness of a heat sealed foil.
Some of the methods are the following ones:
Blowing up with air of different pressure,
Sucking out air with different pressure,
Immersing in water.

Covers for parallel-epipedical contents should fabricated out of the same foil. The foil or the seams should be provided without and with different artificial holes.
The rates of presure change should be measured using the above mentioned methods.

3.5 To find out the effeciency of several methods to counteract the occurrence of small holes in a foil. The following methods should be tested using their influence on the transmission rates for water, air and watervapor:

Optimizing seam and heat sealing parameters,
Two parallel seams,
Seam without crossing two concentric foils.

3.6 To determine the probability that small holes may occur in plastic foils and in heat sealed foil by finding out at least.

The influences of the following variables;

Foil quality,
Foil thickness,
Bad treatment of foil (e.g. simulated by definite bending and/or twisting),
Heat sealing pressure, time, and temperature,
The seam surfaces with and without definite deficiencies.

3.7 To find out the influences of watervapor, water, and corrosion products on the properties of coatings of oil and wax.

The cup method for measuring the water vapor transmission rate of foils may be used to determine the water and watervapor transmission and absorbence rate using permeable foils with known WVPR and respectively impermiable foil.

Equally corroded surfaces may be coated with oils and waxes and investigated the influences on color and other properties of the coating.

4. To treat the following problems based on observations and discussions by performing the appropriate research work:

4.1 The assessment of the behavior of packaging material, packages, and auxiliary packaging means during different distribution processes must be based on reliable data.

These are the following possibilities to get data usable for the prediction of the behavior of packages, etc. to be expected during the distribution processes.

4.1.1 The ISO standards concerning the testing of packages allow variations as to the normal use of the standards.
The deviations from the normal use only must be mentioned in the test report. They can be conceived so that the test corresponds more accurately to the reality of the distribution process. The deviations should be standardized internally and their influence on the test results should be investigated.

4.1.2 Other standards e.g. test for VCI and dessicant material have no direct reference to the reality of the distribution process.

To find out their behavior during a distribution process it is necessary to perform adequate field tests and laboratory tests that simulate as well as possible one or more types of distribution processes. The tests should also be conceived so that they make it possible to compare with one another different materials and means serving for the same purposes, e.g. VCI, dessicant and coating materials.

4.2 How to improve reusable wooden packages for fruit?

4.2.1 Find out the duration of use of packages actually used.

4.2.2 Find out the weak points that is the parts of assemblies failing first and most often.

4.2.3 Eliminate the weak points and test once more the duration of use before getting damaged.

4.2.4 Diminish the cost for packages by diminishing the quantity of material where it is not or not so much needed, even if the duration of use is decreased by this measure.

4.2.5 Find out the optimum solution for cost/number of uses going to the minimum.

4.3 Standardization of sizes of packages and unit loads.

The following research tasks should be dealt with:

4.3.1 Investigation of the actual state of determining and producing packages with different sizes by questionnaires.

4.3.2 Investigation of the differences between the actual system and the modulus system (see appendix 10) and of the possibilities to eliminate them.

4.3.3. Formulation of the standardization of package sizes for Korea.

Appendix 1

JOB DESCRIPTION

The consultant will be assigned to the Korea Design and Packaging Center in Seoul (KDPC) and will advise the technical staff of the Centre on packaging technologies for various types of heavy equipment and prevailing methods of transportation and handling. The expert will specifically be expected to:

1. Evaluate packaging techniques and packaging materials presently used by local manufacturers for heavy machinery and equipment.

2. Advise on efficient methods for protection of the package contents under various environmental conditions and commonly used transportation and handling techniques.

3. Provide information on present trends regarding materials and methods for heavy equipment packaging, crating, handling and transportation.

4. Advise on international standards for packaging and package testing.

5. Co-operate with the KDPC staff in the planning of research and development activities in this field, based on the needs of domestic industry and the facilities, equipment and personnel resources available at the Centre.

The expert will also be expected to prepare a final report, setting out the findings of his mission and his recommendations to the Government on further action which might be taken.

APPENDIX 2

List of Counterparts

Byung-Hwa Nam

Researcher in Packaging Research and Development Department of KDPC.

Jong-Koo Han

Researcher in Packaging Research and Development Department of KDPC.

APPENDIX 3

List of Fellowships

Mr. Myoung-Hoon Lee

6 months (from August 1981 to February 1982) to
England (PIRA)
for anti-corrosion packaging
guaranteed by UNDP

Mr. Hyun-Jin Kim

5 months (from September 1981 to February 1982)
to Japan
for heavy weight packaging
guaranteed by UNDP

APPENDIX 4

Report on a visit Doo San Co.

Report about a visit to Shin-Han Export Packaging Co. which was packing the products of Doo-San Co. on 23th June, 1981.

1. The product to be packed was the following one;

   1.1 Tubes welded in different shapes and sizes,
   Material: stainless steel
   with flanges and bolts partly made of
   normal steel

   Diameter: about 50 mm
   Wall thick: about 10 mm

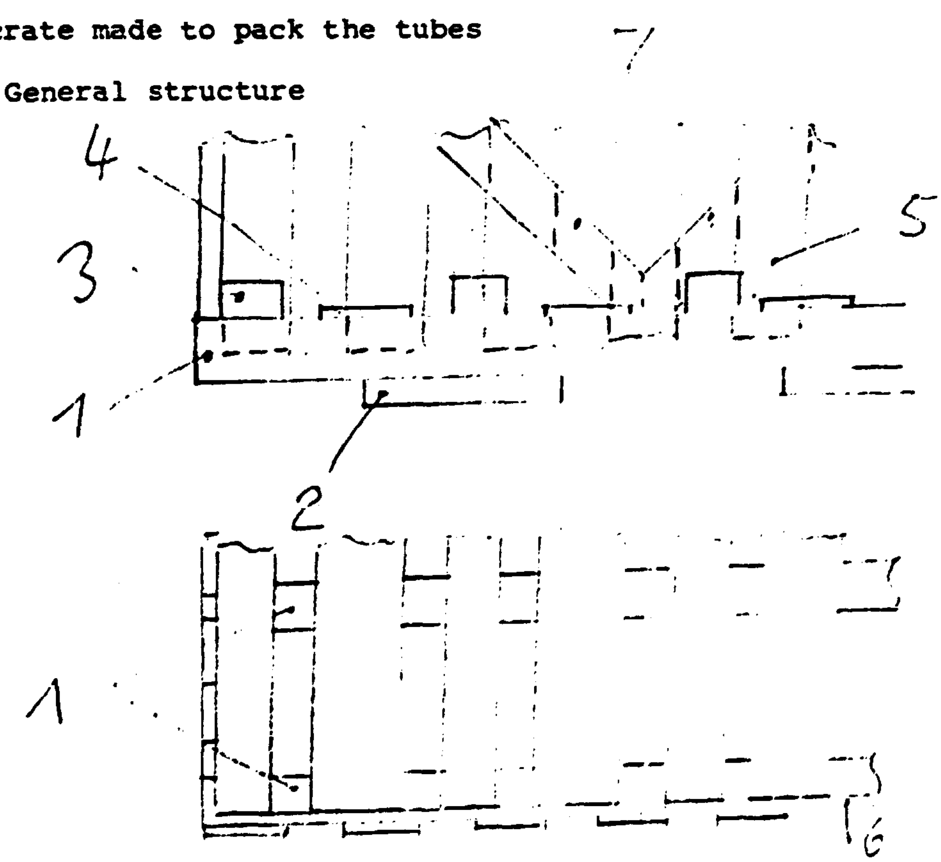
   1.2 Tubes welded in different shapes and sizes,

   Material : galvanized steel
   special treatment after galvanizing unknown

   Diameter : about 30 mm
   Wall thick : about 4 mm

2. The crate made to pack the tubes

   2.1 General structure



The general design corespondsto the rules normally used for building crates, especially the use of element No. 2, the vertical arrangement of element No. 5, the use of diagonals No. 7, the arrangement of elementsNo. 1,3,5,6 at the corners and the reinforcements of the vertical edges and of the upper corners by metal parts.

2.2 Details that should be improved

2.2.1 The ends of element No. 2 should be chamferred in order to allow cratesto be shifted on the ground.

2.2.2 Nailing :
Distance between nails is to small,
The head of nails are too small,
The wooden ends cleave at each nail,
The direction of nails referring to the wood surface should be vertical or oblique in different senses,

2.2.3 Bolts should have larger support surface on both ends.

2.2.4 Marking should additionally include at least the gross weight.

2.2.5 Marking should be done on two adjoining sides.

2.2.6 Abrasion of the zinc layer by vibration is possible and should be avoided by appropriate wrapping.

2.2.7 The used plastic films of 0.07mm thickness have no function.

2.2.8 It is not known if the steel flanges may corrode or not.

2.2.9 The elementsNo. 4 have practically no function.

APPENDIX 5

Report on a visit to Sam Sung Heavy Ind. Co.

Report concerning the visit to
Sam Sung Heavy Industries at Masan

July 29 and 30 1981

Visitor	:	Mr. E.R. Schmidt	UNIDO
		Mr. J.K. Han	KDPC
People visited	:	Mr. S.J. Kang	SAM SUNG
		Mr. P.D. Kim	SHIN HAN

The company produces cranes, conveyers, boilers, tanks, and steel structures for a variety of plants.

Various products being prepared for shipment could be viewed at and the method to pack them discussed. Together with employees of the packaging department and of the packaging company the packaging methods relevant to Sam Sung were dicussed according to a list of questions prepared by Sam Sung.

Following day a set of slides concerning packaging of heavy goods was presented and discussed.

In the following the main problems and their proposed solutions are described.

1. Problem : Packaging of steel parts in bundles (see picture 1)

Solution: a) Determination of the contents of a bundle and preparation of the packing list.

It must be decided what weight a unit load should have according to the demands of handling and transportation. Parts with a weight smaller than that of the optimum unit load must be filtered out and subdivided into groups of similar structure especially of similar length.

Parts of similar length are provided for unit loads of approximately the optimum weight. The packing lists for these unit loads are prepared and the parts marked accordingly (see also 2nd problem).

b) Packing of steel parts by bundling (see picture 1)

A bundle has to acomplish the following functions.

1) To hold the parts of the bundle together during all the operations of the distribution processes so that the bundle can not fall to pieces especially by acceleration in the direction of the length of the parts. Such acceleration could make one or the other part to slide out of the bundle if the forces of the friction holding the parts in the bundle are not sufficient.

2) To facilitate the handling and stacking.

To fulfill the function 1), strapping is the normal procedure. It may be completed by caps of steel plates fastened at the ends of a bundle by separate strapping to make sure that no part could slide out of the bundle.

To accomplish the function 2), it is normally sufficient to fasten the bundle on two crosswise skids by strapping directly around the bundle or over a yoke. If a yoke is used what should be preferred it may be pressed down also by bolts or twisted wire. Bolts are the better solution, because the compressing forces can be adjusted sufficiently well without destroying the yoke and spring washers could and should be added between the nuts and the yoke to keep sufficient compressing forces also after some constant deformation of the yoke.

The material used for the skids and yokes will be mostly wood. But if steel profiles are cheaply available or are required for the assembly at the destination place as auxiliary materials they should be used already for packaging purposes.

The skids should be arranged so that the deformation of the bundle by bending will be a minimum. Normally this is at 0.2L from the ends, if L is the total length of the bundle.

c) Marking

The bundle should be marked according to the general rules of marking, that means at least with the bundle number, port of destination, and weight. Plates made of appropriate material should be used for marking the bundle.

The plates can be fastened by means of wire.

The marking of "sling here" symbols should be arranged at the outside of the skids, if the skids had been arranged according to paragraph b).

2. Problem : Marking of parts that have to undergo sand-blasting and painting.

Solutions: One should provide for each part a plate with the marking and to fix it to the part in an appropriate manner, for instance, by tying it at a hole that mostly exists at the steel part.

3. Problem : Packing method for a cylindrical tank with a protruding part. (see picture 2)

Solution : If the protruding part is not sufficiently strong to withstand the distribution hazards and the tank generally needs only supports to keep it from rolling and to facilitate handling, the protruding part should be protected by a partial packing strong enough to keep the forces occurring during the distribution process from the protruding parts.

A special problem is mostly how to fasten the partial packing on the products. One should use existing supports, strapping, or provide temporary supports by welding steel parts to the product.

The support for the tank should be combined with it by strong steel bands stressed by stretching nuts.

4. Problem : Packing of steel structure of the type according to picture 3.

Solution : The plates (1) are endangered by other parts during handling and transport because they are not protected by members (2) of the same structure. They are likely to be bent or even broken because they are small and thin and have only short welding seams.

The most natural and simple method to protect the plates might be to get them in the protecting space of a bigger structure by tying together two or more structures of the same kind so that the plates of one structure dip into the space of another one.

But there will remain plates at the outside that must be additionally protected or reinforced.

Reinforcement means to weld temporary steel angles to the plates. But it would remain necessary to bring the unit into the horizontal position to facilitate stacking. This would require to add additional steel angles or wooden supports on the opposite side of the structure at the lower side of it.

In this case it would be advantageous also to protect the lower plates by wood.

5. Problem : Organization of packing work to be done.

Solution : The packing and/or shipment department should get as soon as possible lists of the parts, the sequence of the use at the place of assembly and the date concerning the finishing and shipment.

Packing list, packing methods, and packing means are to be prepared on time. If the capacity of the own packaging department will not be sufficient, a packaging company must be found who would be able and prepared to fill the gap at the definite time.

6. Problem : Packing of conveyors and other yielding structures (see picture 4).

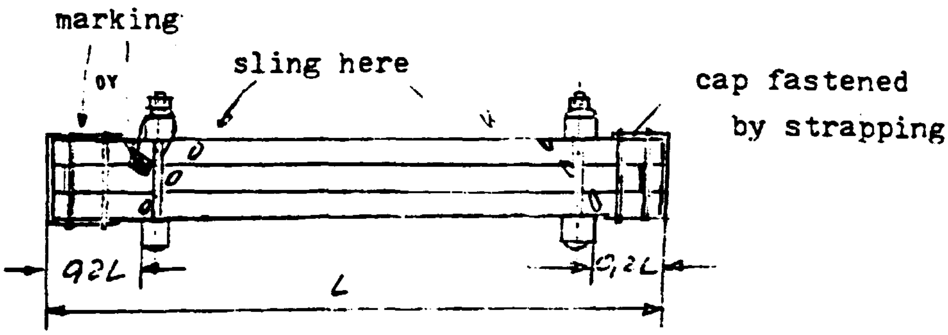
Solutions: Fundamental rule should be the following one: Tie several similar yielding structures appropriately together so that the new unit becomes stiffer. Then it is not necessary to add packing means to the unit in order to reach the necessary stiffness.

Nevertheless the difficulty remains that yielding structures often tend to hook to one another.

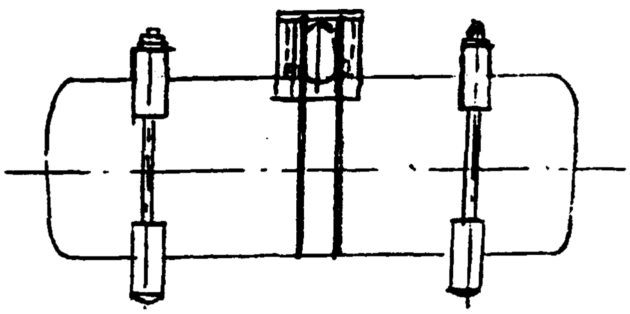
It is important to avoid that, because otherwise after shifting in the ship's hold during transport, it would be difficult and damaging to unload them.

To avoid hooking with a minimum of cost plates of steel or plywood should be arranged in the ships hold between such units during handling and stacking.

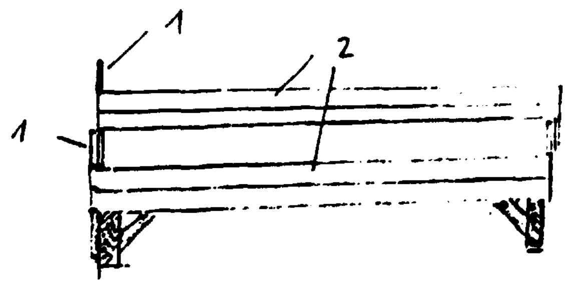
Picture 1.



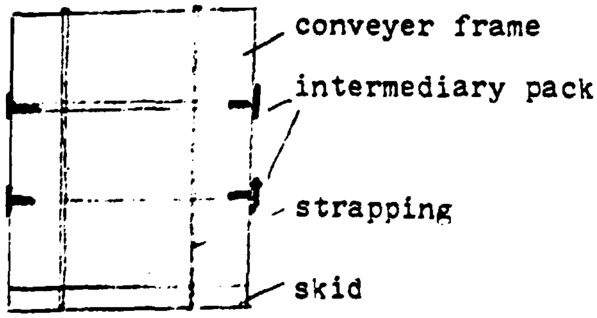
Picture 2.



Picture 3.



Picture 4.



APPENDIX 6

Report concerning the visit to
Hwa Chun Co., Masan.

July 31, 1981

Visitors	:	Mr. E.R. Schmidt	UNIDO
		Mr. J.K. Han	KDPC
People visited	:	Mr. D.S. Park	HWA CHUN
		Mr. P.D. Kim	SHIN HAN

The factory produces different machine tools (lathes, milling and grinding machine). They are packed by Shin Han Co.

The problems of packing especially of the protection against corrosion were discussed with group of employees working in the material department and Mr. Kim from Shin Han Co.

1. Problems : What must be done to guarantee the arrival of machine tools at their destination without corrosion at any part ?

   Solution : The most appropriate method for machine tools is the drying method in combination with an appropriate coating.

   If one wants to use the drying method, the following rules should be taken into consideration;

   a) All parts to be assembled should be cleaned, dried, coated with corresponding oil, and then handled and assembled only in using gloves.

   b) After the assembly outer surfaces should be protected by a preservative that does not drip down being in 70°C, but that should also be apt to be easily removed.

   c) Closed spaces of the machine tools (e.g. the gear box) should be protected separately by coating with normal machine oil and desiccant material filled in bags or plugs. Plugs should be inserted from the outside at corresponding holes and be equipped with humidity indicators.

d) The absorbence capacity of the desiccant material must be known (e.g. 30g desiccant material are in equilibrium with 40% relative humidity and 23°C of the surrounding air when they are loaded by 4g water).

e) The desiccant material should be completely dried when it is used. This can be tested by indicator or drying in 120°C and weighing.

f) The watervapor transmission rate of the foil to be used must be known for the temperatures that may occur during the distribution process.

g) The quantity of desiccant material that must be put into the package must be calculated according to WVTR, area of the foil, endurance of needed protection and mass and moisture contents of the packaging material inside the package.

h) The shape and size of the foil needed for a machine tool must be prepared. Hwa Chun Co. uses the double foil of 0.15mm thickness in tubular shape.

i) The fastening points of the machine tools on its base must be manufactured with appropriate rubber or soft plastic plates bored so that they fit tightly on the unthreaded part of the bolts.

j) Arrangement of the bags with desiccant material so that they do not contact unprotected surfaces, are equally distributed and fastened mainly above the upper part of the machine tools.

k) Sharp edges and corners must be covered by soft materials to prevent the foil from being damaged.

l) The foil is closed by heat sealing under conditions of heat, pressure, and time that have been proved previously.

m) The waterproofness of the package should be tested by sucking air out of the foil or by pressing air into it. The state reached by one of these procedures must remain unchanged during 24 hours if one wants to say that the foil is waterproof and airproof.

2. Problem : Applicability of VCI

Solution : The behavior of VCI is not yet sufficiently known under all possible conditions. For the protection of the different materials different VCI materials are offered. VCI should not be used at products made of or combined with Cd., Pb., and contact materials.

The protection of steel by VCI is proved and advantageous, but a closed foil should be provided around steel + VCI if polluted air may exist in the environment and if the protection should last a longer time e.g. some months.

3. Problem : Can preservative oil decay by watervapor ?
It had been observed that the color of a preservative oil had turned lighter when the coated surface had corroded.

Solution : It can't be assumed that water can be added to mineral oil only by diffusion through the layer of this oil. Probably the corrosive products have caused the color change, but this problem should be investigated.

APPENDIX 7

List of visits, lectures, and seminars, performed during the assignment

List of visits, Lecture, Seminars performed during the assignment

1. Lecutres about

   "Current techniques and knowledge concerning distribution packaging"

   June 29 to July 24 at the KDPC

2. Seminar about

   "Experiences as to heavy goods packaging made in the port of Hamburg"
   at Sam-Sung Heavy Ind. Masan, 29 of July

3. Seminar about

   "Experiences as to packaging during my stay in Korea"
   21 and 26 of August at the KDPC

4. Visits to the following companyes:

Lotte Aluminium	23 of June	Seoul
Lotte Confectionary	23 of June	Seoul
Dusan	17 of July	Seoul
Sam-sung	28 and 29 of July	Masan
Hwachon	30 of July	Masan
Port of Pusan	11 of August	

APPENDIX 8

Abstracts of the Lectures

Current Techniques and Knowledge Concerning Distribution Packaging.

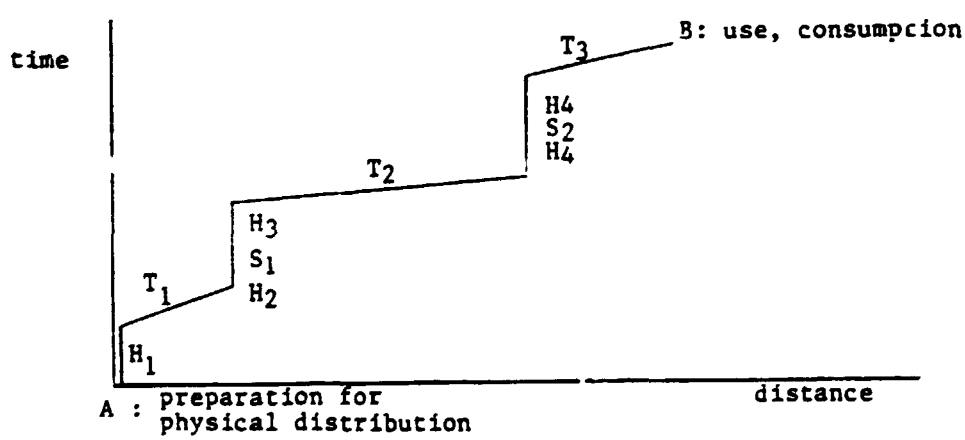
1. Physical Distribution, Definition

According to ISO 4081, I; "Physical distribution is the process to bring a good G from the producer A to the user or consumer B"

Packaging is the process determined to prepare a good for the process of (physical) distribution.

A process of physical distribution consists of various processes of transport, T
handling, H
storage, S

as shows the following scheme;



"Transit" may be called that part of the distribution process, that begins with the first loading on a vehicle to leave A and ends with being put on a shelf for being sold.

The packaging needed for this transit process could be called "transit packaging" to differ it from the "consumer packaging".

Normally the term "transport packaging" is used instead of "transit packaging", but "transport" is only a part of the whole distribution (transit) process.

2. Distribution Packaging, Function

2.1 Protection against distribution hazards

Distribution hazards are events occurring during a distribution process, that may influence the good and/or the package and that are originated by the environments of the goods, the complete filled package or the package alone.

Normally the scope of the term "distribution (transport) hazard" is restricted to external (seen from the package) influences. But because of the interdependency of external and internal influences it seems to be better to include the internal influences directly in the distribution hazards.

2.2 Rationalization of the distribution system or process.

i.e. the organization of the distribution process so that the total cost of the process reach a minimum.

2.3 Information of all those who are involved in the distribution process about that what they need to fulfil their function.

3. Suppositions to be fulfilled for finding out the optional means and methods of protection.

3.1 Availability of knowledge

- as complete as possible -

of the kinds, intensities, frequencies
of the possible distribution hazards
of the methods to take them into account
of the possibilities to diminish them

3.2 Availability of knowledge

- as complete as possible -

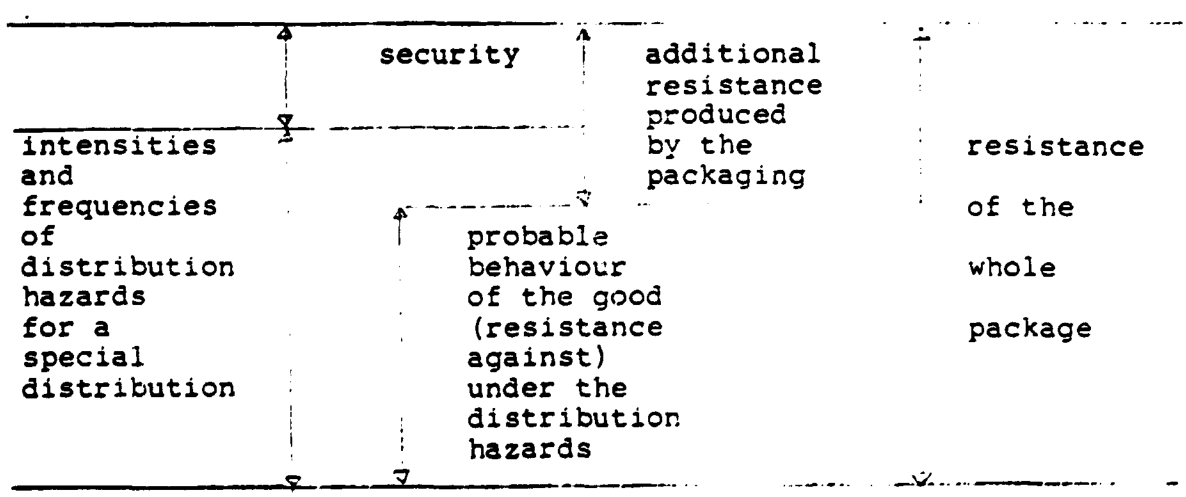
of the behaviour of the good
to be expected when it is exposed
to the distribution hazards
of the methods to determine it
of the possibilities to improve it

3.3 Availability of knowledge

- as complete as possible -

of those features of packaging materials and means, auxiliary packaging and transport means that are relevant for their function,

of the methods to determine them,
to use and improve them



4. Distribution Hazards

the methods to find them out
the methods to take them into account
the possibilities to diminish them

4.1 General Information

4.1.1 Sources of information referring to distribution hazards

a. Literature (e.g. Standard ISO 4081)
b. Experiences derived from losses and damages
c. Observations in ports and similar points of concentration, of handling and storage of packages
d. Experimental voyages

4.1.2 General information as to hazards

a. Kind and quality of the environment as source of hazards
b. Dispersion, distribution of intensities
c. Coincidence of hazards

4.1.3 General information as to testing

a. Simulation and standardization of distribution hazards
b. Reproduceability of testing results
c. Possibility to compare different materials and means with one another
d. Functions of the testing of materials, elements, products

4.1.4 General information as to calculation and assessment

a. Simplification still more than for testing
b. Use of previously made experiences

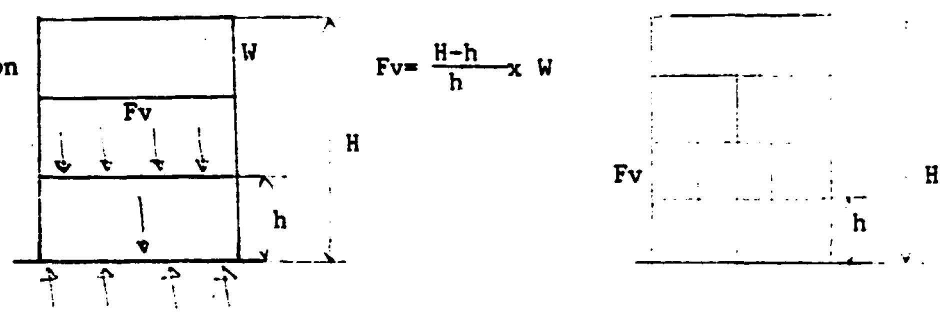
4.2 Mechanical Hazards

4.2.1 Kinds of forces

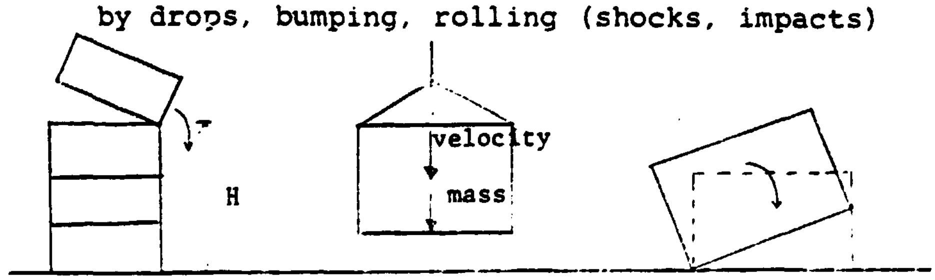
a. Vertical static forces produced by internal masses, masses, stacked upon, people marching on top of them (Compressive, bending, shearing, torsional forces producing the corresponding strains and stresses)

bending

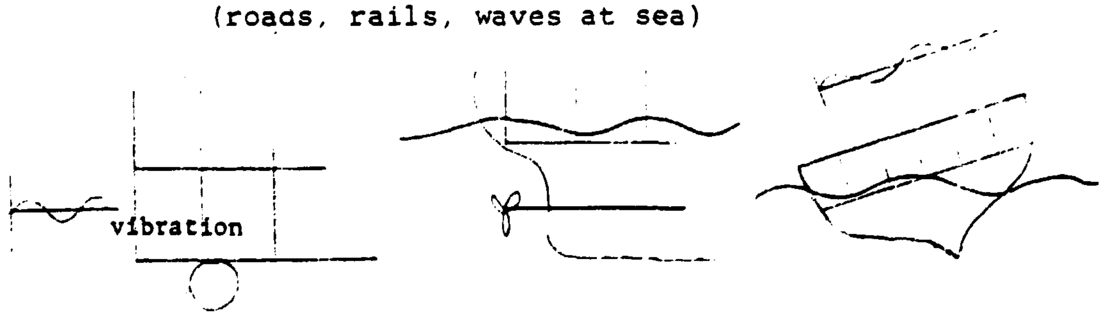
compression



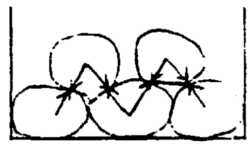
b. Vertical, sporadical, dynamic forces produced by drops, bumping, rolling (shocks, impacts)



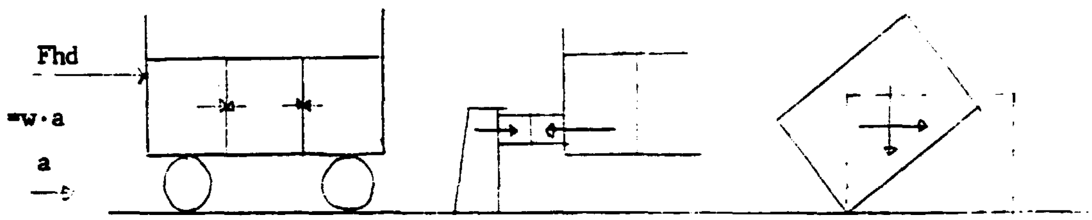
c. Vertical, repeated, dynamic forces produced by internal (motors) and/or external sources (roads, rails, waves at sea)



d. Horizontal static forces
e.g. packages acting like wedges



e. Horizontal, sporadical, dynamic forces(Fhd) produced by braking, driving in curves, bumping, and rolling



f. Horizontal, repeated, dynamic forces

(nearly all occurring vibrations and oscillations have also horizontal components)

4.2.2 Intensities and frequencies of forces during the different possible phases of the distribution process.

a. During the different possible kinds of transport
b. During the different possible kinds of handling
c. During the different possible kinds of storage

4.3 Climatic Hazards

4.3.1 General information

a. Climatic zone
b. Weather, season
c. Neighbouring load, local sources of air pollution

4.3.2 Kinds of climatic hazards

a. Air temperature
b. Radiation
c. Humidity of the air, rain, water on the ground
d. Content of salt, SO_2, etc. in the air
e. Content of dust in the air
f. Air pressure
g. Fungus, bacteria
h. Insects, rodents

4.3.3 Intensities and frequencies of the climatic hazards during the different phases of the distribution process

a. During the different possible kinds of transport
b. During the different possible kinds of handling
c. During the different possible kinds of storage

4.4 Possibilities to diminish the Distribution hazards

4.4.1 With reference to the logistic companies;

Education of their people concerning careful treatment of the packages especially according to the handling symbols and general storage rules.

4.4.2 With reference to the forwarder;

1) To choose such itineraries of distribution and such logistic companies that are characterized by low intensities of hazards.
2) To replace distribution in bulk by distribution in unit loads i.e. palletized loads or ISO freight containers.

5. Behaviour of the product - especially its susceptibilities - with reference to the distribution hazards.

5.1 Behaviour under the influence of forces

5.1.1 Compressive stresses and strains (elastic and plastic), breakage.

5.1.2 Bending strains and stresses, breakage.

5.1.3 Torsional strains and stresses, breakage.

5.1.4 Shearing strains and stresses, breakage.

5.1.5 Diminishing of the friction
for example; in threads (by vibrations) or particle like products (pourable products)

5.1.6 Mechanical deterioration of the surface by vibrations.

5.2 Behaviour under the influence of high temperatures (over 30°C) and radiation.

5.2.1 (temporary) Diminishing of the static-machanical resistance of (thermo-) plastic material.

5.2.2 Lasting deterioration of a product by radiation.

5.2.3 Diminishing of the shelf-life of fresh fruit and vegetable.

5.2.4 Diminishing of the water-content of hygroscopic material

5.3 Behaviour under the influence of low temperatures (up to 5°C).

5.3.1 Diminishing of the dynamic-mechanical resistance (brittleness) especially of thermoplastic material.

5.3.2 Increasing the shelf-life of fresh fruit and vegetable.

5.4 Behaviour under the influence of high relative humidity or water.

5.4.1 Formation of fungus

5.4.2 Formation of corrosion

5.4.3 Increase of water content of hygroscopic material and deformation as a consequence of the unequality of the increase of the water content of different points.

5.5 Brhaviour under the influence of dust particles.

5.5.1 The surface of the product gets soiled

5.5.2 Diminishing of the resistance against corrosion

5.5.3 Producing abrasion.

5.6 Behaviour under the influence of SO_2, CO_2

5.6.1 Formation of deteriorating processes at organic materials (together with H_2O).

5.6.2 Increase of the intensity and velocity of corrosion.

5.7 Behaviour under the influence of rodents and insects.

5.7.1 Organic material may be deteriorated.

5.8 Means and methods to improve the behaviour referring to the distribution hazards.

5.8.1 During the development of the product the design decisions should be influenced also by the above mentioned events.

5.9 The behaviour under the influence of the different events may be assessed, calculated, or tested (See paragraphs 6 and 9.4)

6. Behaviour of packaging materials, packages, auxiliary packaging and transport means with reference to the distribution hazards (including the influences of the product to be packed).

6.1 Behaviour under the influence of forces.

6.1.1 Compressive strains and stresses or breakage produced by external forces, especially at packages and pallets, to be found out by appropriate compression testing.

6.1.2 Bending, tensile, perforation, or bulging strains, stresses, breakage; produced by external or internal forces, to be found out by appropriate testing.

6.1.3 Torsional strains, stresses, breakage; produced by bad handling, storage on uneven place to be found out by appropriate handling and storage tests.

6.1.4 Shearing strains, stresses, breakage; produced mostly by horizontal dynamic forces (see 4.2.1. e) to be found out by appropriate shearing tests on the inclined plane.

6.1.5 Diminishing of friction in threads by vibration; followed by loosening of caps and loss of contents to be found out by vibration tests.

6.1.6 Deterioration of the surface by abrasion; produced by vibrations (for example of a plastic film hanging over sharp edges in a corrosion protective package) to be found out by corresponding vibration tests.

6.1.7 Deteriorstion by differences between the internal and external air pressure.

6.2 Behaviour under the influence of high temperatures (over 30°C) and radiation.

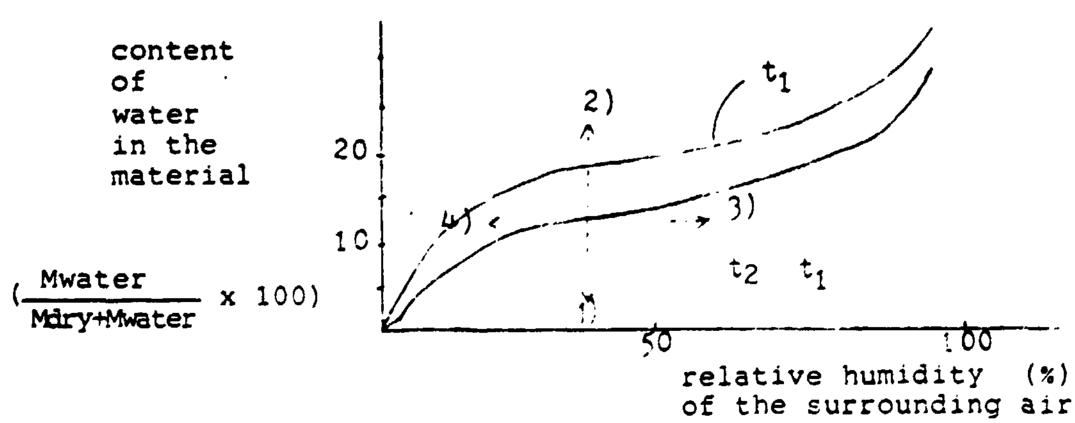
6.2.1 Diminishing of the static-mechanical resistance of thermoplastic material.
(for example of P.E. - drums and plastic strapping continuous flow of the material under stress = relaxation)
to be found out by long time compression, tensile, and bending tests in the corresponding temperature.

6.2.2 Deterioration of a material (especially plastic) by UV-radiation
to be found out by tests in appropriate chambers.

6.2.3 Increase of the water vapor transmission rate of plastic films (see 6.4.4.),
to be determined by corresponding tests.

6.2.4 Diminishing of the water contents (i.e. drying or desorption),
for example of wood, corrugated board, desiccant, shrinkage of wooden boards, formation of cracks, loosening of nails.
The corresponding sorption-desorption curves (isothermic curves) should be known.

* Isothermic curve for sorption and desorption of water by hygroscopic materials.

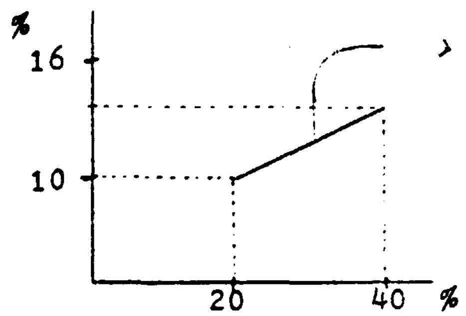


a. Process of desorption (evaporation) of water by increasing the temperature (drying).

b. Process of (ad) sorption = increasing of water content by decreasing of temperature of the material

c. Putting the material in an environment of higher relative humidity than the relative humidity of equilibrium = initiating a process of sorption.

d. Putting the material in an environment of <u>lower</u> relative humidity than the relative humidity of equilibrium = initiating a process of desorption.



part of the sorption-desorption curve of desiccant material (according to DIN 5547; definition of 1unit of desiccant = 30g)

6.3 Behaviour under the influence of low temperatures (up to 5°C)

6.3.1 Diminishing of the dynamic-mechanical resistance, for example of P.E.-drums for dangerous goods (-20°C).

6.4 Behaviour under the influence of high relative humidity or water

6.4.1 Formation of fungus

6.4.2 Formation of corrosion
for example on steel strapping, nails, steel drums, cans, normally combined with a decrease of their mechanical properties.

6.4.3 Increase of the water content of hygroscopic material, normally combined with a decrease of mechanical resistance, for example of wood and corrugated board. (see 6.2.4)

6.5 Behaviour under the influence of dust;

Soiling and increase of corrosion

6.6 Behaviour under the influence of SO_2, CO_2;
Increase of the intensity of corrosion.
(special corrosion-tests with these gases)

6.7 Behaviour under the influence of rodents and insects;
organic material may be deterioated.

6.8 Means and methods to improve the behaviour of packaging materials etc., referring to distribution hazards.

The development work of the producers of the materials should pay attention to this important task.

7. Rationalization of the distribution process.

7.1 Finding out the optimal itinerary,
i.e. the itinerary that demands the minimum of cost for packaging, insurance, damages, freight, and capital cost.

7.2 Finding out the optimal weight or dimensions of a package combined with unitization (palletization, containersation) and standardization of package dimensions.

7.3 Finding out the optimum design of the product to diminish the costs of the distribution process.

7.4 Finding out the optimum design of the package or unit load by diminishing the intensities of the distribution hazards in facilitating the different procedures and predetermining the optimal procedures.

8. Information referring to all participants in the distribution process aims at avoiding errors as to handling, transport and storage processes.
It comprises at least the following activities.

8.1 To determine the contents of the marking.

8.1.1 Symbol for all packages that belong to one order.

8.1.2 Number of packages belonging together.

8.1.3 Successive number of the package.

8.1.4 Town and port of destination.

8.1.5 Country of origin

8.1.6 Weight

8.1.7 Size

8.1.8 Specific markings

8.1.9 Center of gravity

8.1.10 Where to seize
8.1.11 How to protect

8.2 To supply the means for marking

8.3 To perform the marking

9. Procedure of the development of an optimum package, in a definite case, especially for heavy goods.

9.1 Finding out the probable behaviour of the good to be expected under the influence of distribution hazards by analyzing its structure and on the basis of that by assessing, testing, calculation. (see chapter 5.), (see table 8)

9.2 Finding out the hazards (kinds, intensities, and frequencies) to be expected during the possible or used distribution process. (see chapter 4. and table 9)

9.3 Finding our the requirements of the good with reference to the kind and degree of protection that it needs against the distribution hazards. (see 9.1. and 9.2)

9.4 Finding out the properties that the package should have to match the requirements of 9.3.

9.5 Choosing the appropriate kinds and dimensions of materials and means, and the appropriate methods to convert and combine them so that the results will be the optimal package.

That means; Finding out the optimal realizations of the different functions of a package. (see chapter 2.).

9.5.1 The function of the package to realize a definite resistance (see chapter 9.4) against compressive forces.

9.5.2 The function of the package to realize a definite resistance against bending forces.

9.5.3 The function of the package to realize a definite resistance against shearing forces

9.5.4 The function of the package to diminish the possible impacts on the good to definite values.

9.5.5 The function of the package to diminish the amplitude of the possible vibrations to definite values

9.5.6 The function of the package to diminish the unfavourable influences of high temperatures on the package.

9.5.7 The function of the package to diminish the unfavourable influence of high relative humidity, rain, and water on the ground on the package.

9.5.8 The function of package to avoid the possible attack of fungus and bacteria.

9.5.9 The function of package to avoid the possible attack of rodents and insects.

9. Procedure of the development of an optimal package, in a definite ease, especially for heavy goods.

9.1 Finding out the probable behaviour of the good to be expected under the influence of distribution hazards by analyzing its structure and on the basis of that by assessing, testing, calculation. (see chapter 5) (see table 8)

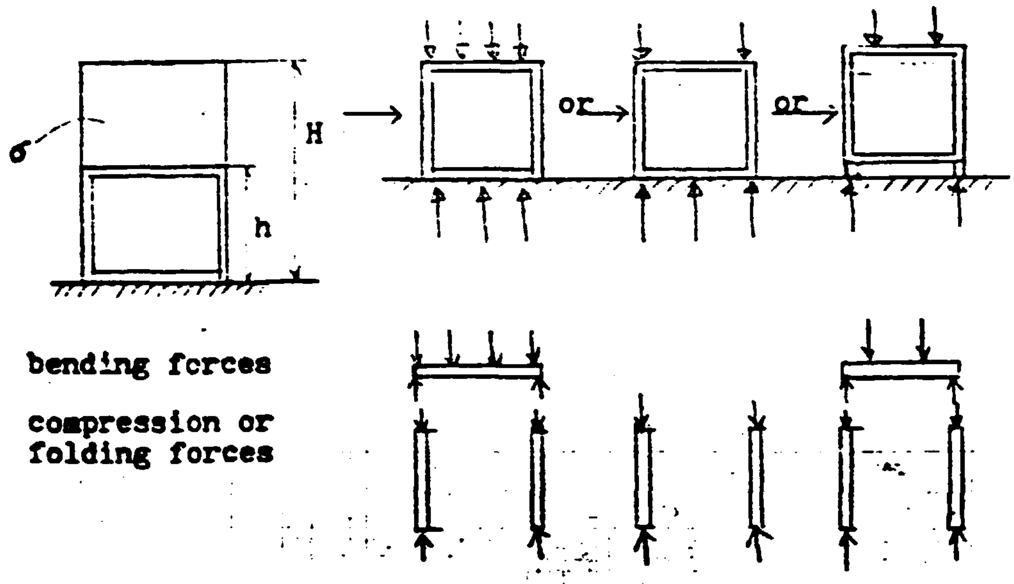
9.2 Finding out the hazards (kinds, intensities, and frequencies) to be expected during the possible or used distribution process. (see chapter 4. and table 9)

9.3 Finding our the requirements of the good with reference to the kind and degree of protection that it needs against the distribution hazards. (see 9.1. and 9.2)

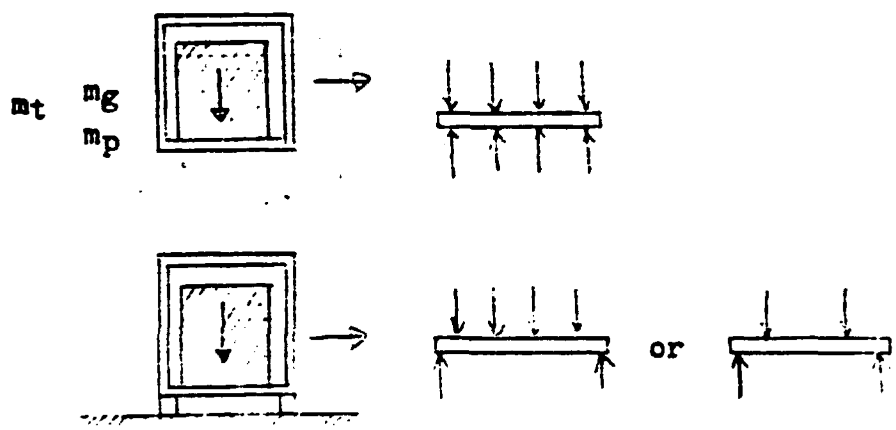
9.4 Finding out the properties that the package should have to match the requirements of 9.3

9.4.1 Find out the forces that the package should be apt to withstand as self-supporting package;

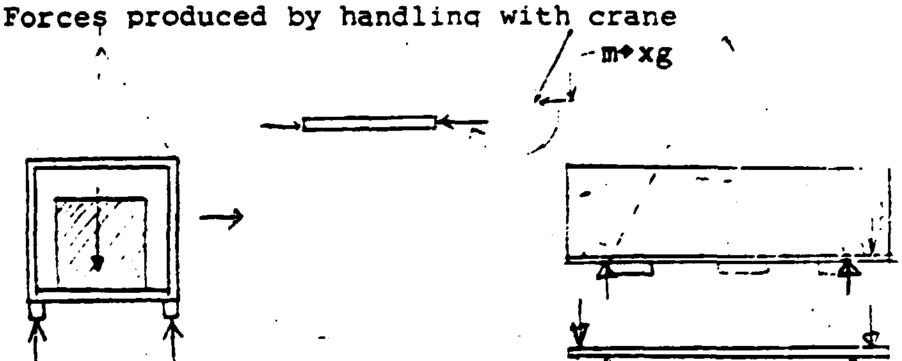
a. Forces (stresses) produced by stowing other packages above it.



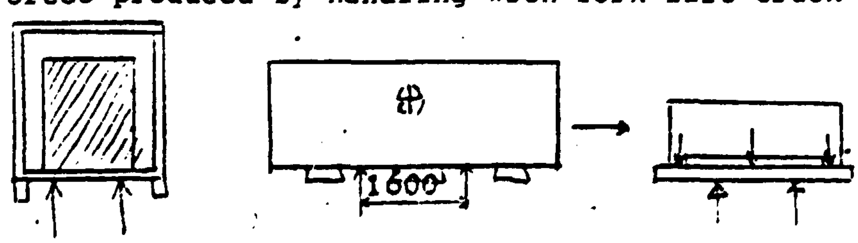
b. Forces (stresses) produced by the good.
(the contents of the package)



c. Forces produced by handling with crane



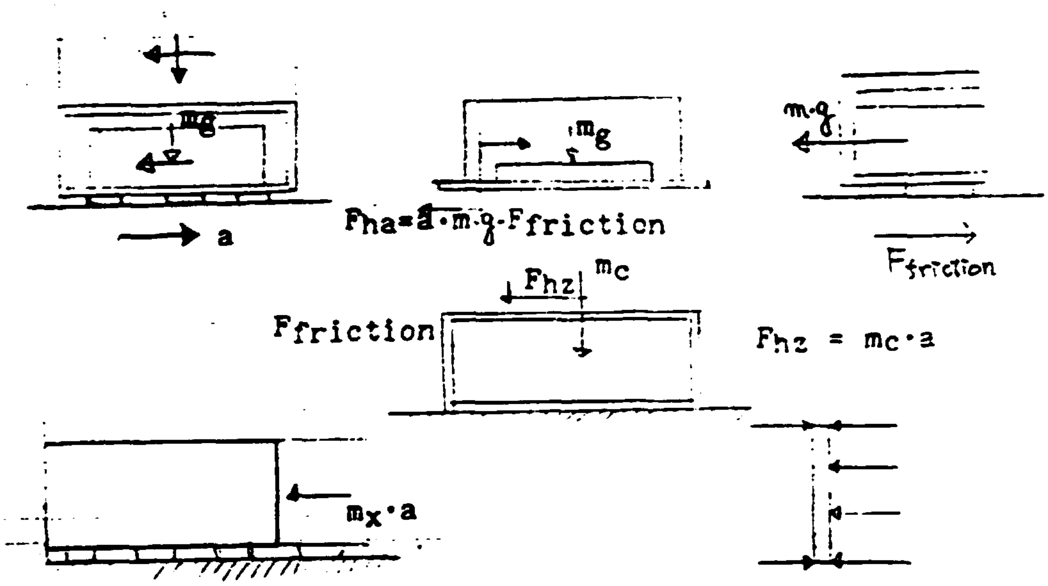
d. Forces produced by handling with fork lift truck



e. Forces produced by accelerations during the transport.

1) vertical acceleration;
to be taken into account by factors for forces according to 1. and 2.

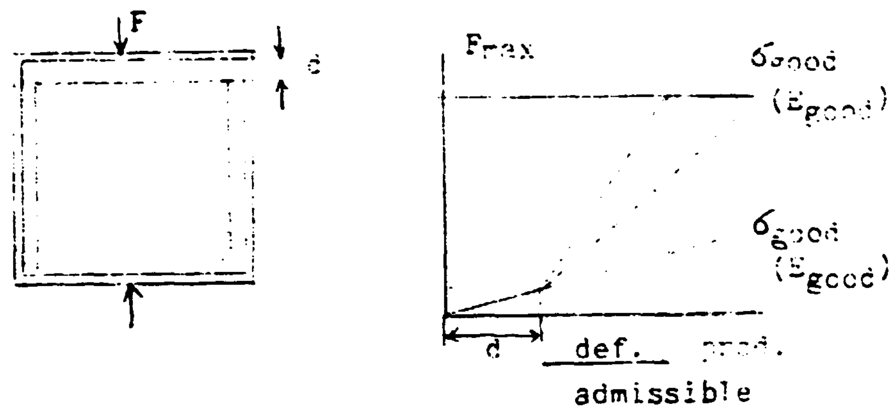
b) horizontal accelerations.



9.4.2 The forces that the package should be apt to withstand as non-supporting package.

a. Compressive forces must be supported by the product (see 9.4.1. a)
b. Forces produced by the good (see 9.4.1. b)
c. Forces produced by handling with crane (see 9.4.1. c)
d. Forces produced by handling with fork-lift truck (see 9.4.1 d)
e. Forces produced by horizontal acceleration. (see 9.4.1. e)

9.4.3 The forces that the package should be apt to withstand as partly supporting package. The distribution of the load on package and contents depends on their elasticity modulus and the initial free space.



9.4.4 The protection against shocks must be designed so that the product is reached by not more than (x) G dropping out of (h)m height
weight of the product: X , dimension: Y (see 9.1)

9.4.5 The protection against humidity and water must be effective during (g) months in a climate of (z)°C and (u)% R.H.
Materials to be protected: see 9.1

9.5 Choosing the appropriate kinds and dimensions of materials and means, and the appropriate methods to convert and combine them so that the results will be the optimal package.

The means: Finding out the optimal realizations of the different functions of a package.
(see chapter 2.)

9.5.1 Optimal realization of the function of the package to have a definite resistance against compressive forces (stresses).

a. (The walls of) packages made of compact board or corrugated board may be calculated on the basis of their edge-crush-resistance.

b. The walls of all packages may be determined on the basis of appropriate tests (=tests simulating sufficiently the real flow of forces).

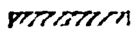
c. Cases made of wood (cut timber, plywood and some plateus on the basis of wood)may be calculated using the W-method (see table 11) or the formula of Euler.

$$F_{adm.} = \frac{\pi^2 \cdot E \cdot I_{min}}{S \cdot l^2}$$

s: coefficient of security against folding

The formula shows that it is important for a high admissible load Fadm. to have

E -------► great

Imin ----► great →  or  instead of 

I -------► small, for example by additional supports

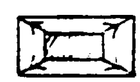
d. The basic elements for the calculation of those parts of a package that have to support compressive (folding)forces are given by 9.4.1.a, 9.4.1.c, 9.4.1.e, 9.4.2., and 9.4.3. the tables 1,3,10, and 12.
An example is described in table 9

e. The possible maximum of compressive stresses should be limited by a corresponding design (for example predetermination of stowage by unitization, fixing the product in the case to avoid events as described in 9.4.1.e and)

9.5.2 Optimum realization of the function of the package to realize a definite resistance against bending forces (stresses).

a. The behaviour of cases made of compact board or corrugated paper board under the influence of bending forces must be determined by appropriate tests.

b. If possible, bending stresses in paperboard should be avoided by stowing wall above wall or by special design. (for example guiding the flow of forces into the walls or edges or using reinforcements by wood or plastic.)



c. Bending stresses ~~on~~ in wooden cases and crates may be calculated according to the table 11 and 12, see also the example table 9.

c. Bending stresses occur incases according to 9.4.1.

d. Bending stresses should be diminished as much as possible by diminishing bending moments, e.g. the radius of the forces. One should predetermine or limit the maximum radius by the design of the package.

9.5.3 Optimum realization of the function of the package to realize a sufficient resistance against shearing forces (stresses).

a. Fix the good in the package so that the resistance against shifting of the good will be

$F_{sh} \geq a \cdot M_{good}$ M_{good}: mass of the good (t)
a: acceleration according to tables 1,9,10

* Possibilities to avoid shifting (or to diminish the probability of shifting) are:

1. bolting the good on the bottom of the case
2. put cushioning material between good and package
3. arrange stopper
4. use strapping and/or shrink wrapping and adhesive between the different layers of the good.

b. The resistance of a package against shearing forces depends largely upon the admissible shearing stresses in the walls of the package:
walls made of one piece (plywood, corrugated paper board)
walls made of boards combined by diagonals

c. Try to get the packages stowed during transport so that they find support in the horizontal directions of shearing forces.

d. Try to get the package stowed during transport so that it can not move (shift) and bump against other packages.

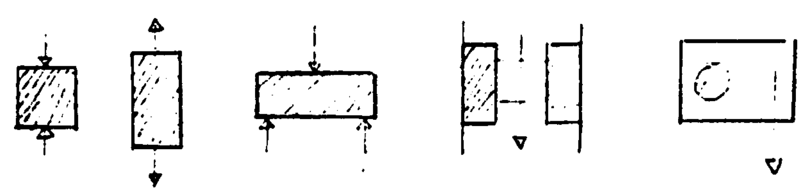
9.5.4 Optimum realization of the function of the package to diminish the possible impacts on the good to definite values.

a. General Principle :

to allow the product to make a longer way for decreasing its bumping velocity than the container itself and to dissipate its kinetic energy as quickly as possible by a combination of a spring element with a damping element or the use of a spring with high damping capacity.

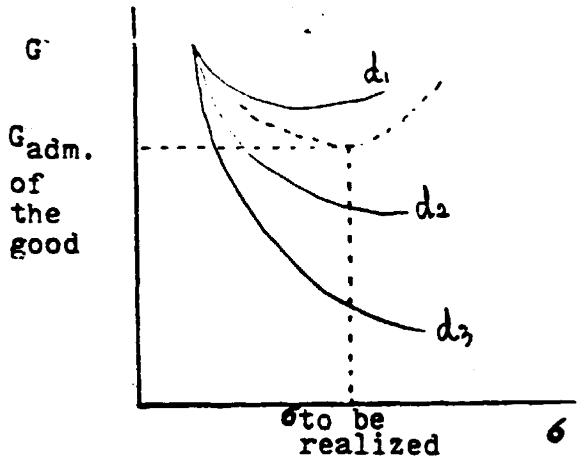
b. Before calculating it is necessary to know the following data:

a) possible bumping velocities or the corresponding drop heights(h) and their frequency
b) duration and climate of transport and storages
c) the admissible impact for the good (G), its weight and shape and size
d) the behaviour under these conditions of the existing cushioning materials (PE- foam, PS -foam, PV -foam, corrugated board, wood-wool, particles (chips), air-cushion)
e) the possibilities to use these materials as spring:



f) the possibilities to damp the oscillatious (by inner friction, surrounding air, additional damper)

c. Use of curves G=f (6,d.h)



$6 = \frac{\text{Fc static}}{\text{Acushion}}$

d = thickness of cushion

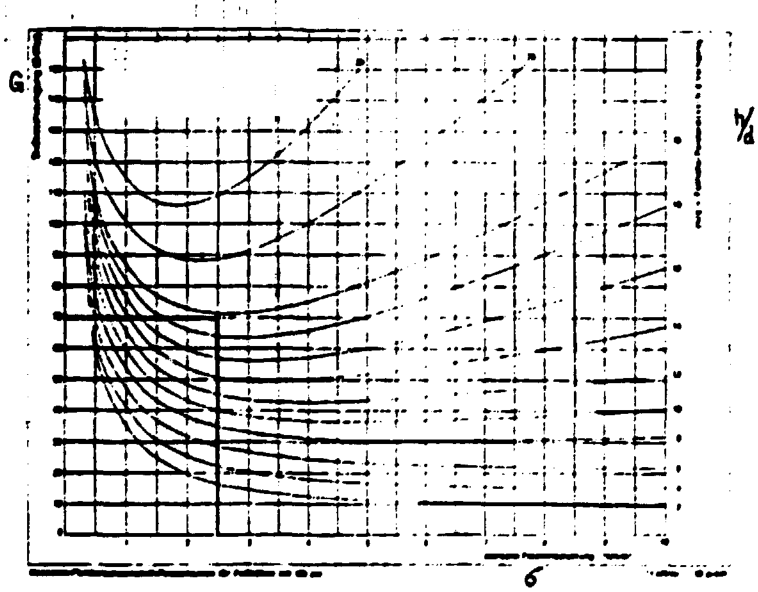
h = drop height

G = (admissible) $\frac{a}{g}$

material ; x
h = y (Cm)
} Parameters of the curve

occurring normally (or rarely) during the distribution process.

*** Example ***



G: factor a/g

o: static load produced by product on the cushion. KN/m^2

h/d: drop height divided by thickness of the cushion

Susceptibility of the product as to shocks:

G: 70

o: 2.5

maximum drop height occuring during the distribution is 100 Cm.

$$d = \frac{h}{h/d} = \frac{100\ Cm}{20} = 5\ Cm$$

9.5.5. Optimum realization of the function of the package to diminish the amplitude for the possible vibrations to definite values.

9.5.6 Optimum realization of the function of the package to diminish the unfavourable influences of high temperatures on the package.

9.5.7 Optimum realization of the function of the package to diminish the possible influence of high relative humidity and/or water on the product.

a. General principle

* Origin of corrosion:

corrosion susceptible material (special metals; iron, etc.) + moisture on its unprotected surface + salt, etc. + potential difference between two points of the surface.

* Origin (sources) of moisture on the surface:

water in pores of the surface
water out of the water vapor in the air
water out of hygroscopic materials
water out of rain or water on the ground

* Sources for the promotion of corrosion:
finger prints,
dust particles,
SO_2 out of the surrounding air.

* Protection against water on the surface:

  drying before packing
  drying the interior of a package before closing
  drying the interior of a package after closing
  avoiding the entrance of water and watervapor after closing
  drying the interior always when water and water vapor enters.

* Avoiding potential differences on the surface:

  avoiding contact of unprotected different metals.
  avoiding traps for moisture. (design)
  avoiding dust particles, finger prints, etc. on the surface. (pack)

b. Using a completely waterproof and watervapor-proof package and drying the interior of the package (the air, the good, packaging auxiliary means) before closing or after closing e.g. by desiccant materials. The quantity of the desiccant material may be determined according to the formula:

$$m'_{des} = 5 \cdot Volume_{air} \cdot 0.17 \cdot \text{(g)} + m''$$

$Volume_{air}$: volume of the air inside the package in Cm^3

0.17 : absolute humidity of the air at 20°C. (0.17 g/cm^3)

5 : transformation of mass water in mass desiccant

m'': $5 \cdot c' \cdot x$

x : number of kg of hygroscopic material inside.

c': water content of hygroscopic material inside. (g/kg)

Usable packages:

steel-(aluminium-tin plate, etc.) container,
containers made of glass and thick plastic,
Al-P.E. foil

c. Using a package that is completely waterproof but not completely water-vaper proof i.e. it is made of walls (e.g. P.E. foil) with a definite and not too high water vapor transmission rate measured in $g_{H2O}/24$ hours$\cdot m^2$ foil surface, but has not holes or pores (does not allow water to pass the walls), combined with a quantity of desiccant according to

$$m''des = 5 \cdot WVTR \cdot A \cdot n \cdot \tfrac{1}{2} (g) + m'des + m''des$$

A: surface of the walls (m^2)
n: number of the days of protection

d. Using VCI-products especially for steel-parts in combination with a closed cover (package).
e. Using protective layers of oils, lanolin, wax in solvents or melted, or of other materials e.g. acetobutyrate.

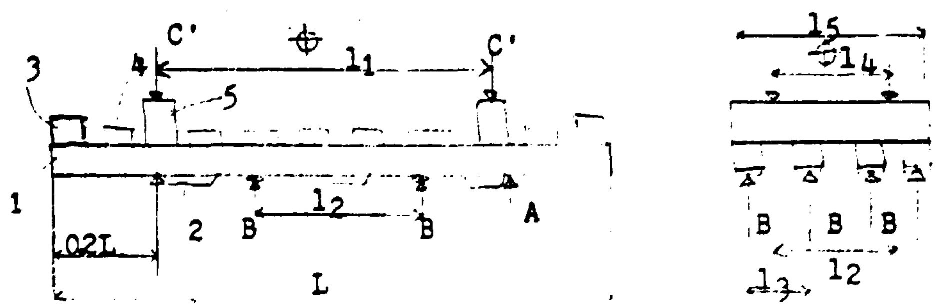
9.6 Details of the design of boxes and crates for heavy goods.

9.6.1 Design of the base (bottom),

a. With crosswise basic beams:
Small resistance against bending

b. With board frame :
Especially for plywood cases

c. With lengthwise beams = skids;



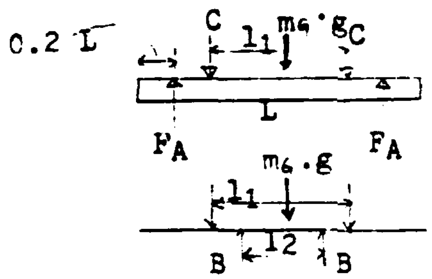
The functions of the base are the sum of the functions of its parts.

Functions of the parts:

Part 1 : Skid

a) to produce the necessary resistance against bending - if it is not allowed to include the bending resistance of the walls - originated by the weight of the good during handling operations by crane (supports A) and/or fork-lift truck (supports B).

section of the skid and their number according to table .... and/or according to the calculation on the base of the following schemes:



$$\sigma = \frac{M_b}{W}$$

$$M_{bA} = \frac{m_G \cdot g}{2 \cdot 2}(L - 0.4L - l_1)$$

$$M_{bB} = \frac{m_G \cdot g}{2}\left(\frac{l_1 - l_2}{2}\right)$$

$$l_2 = 1400 \cdots 1600 \text{ cm}$$

b) to allow to fasten the walls (sides and ends) and to support them and the loads that they must support.

Calculation of the number of nails, see table ..

c) to allow the arrangement of the goods in connection with the boards (4) and the load bearing elements (5) or

d) to allow the direct fastening of the goods on outside or inner skids.

e) to diminish - by means of inner skieds- the bending stresses in the parts (4) and (5) by diminishing the distance 13 (this function of the inner skids is doubtful during handling by crane)

Part 2

a) to provide appropriate points of support for the crane ropes (A)(chamferring of (2) and its reinforcement by parts 6)

b) to allow (and to determine) the entrance of the fork of a fork lift truck (B)on the side.

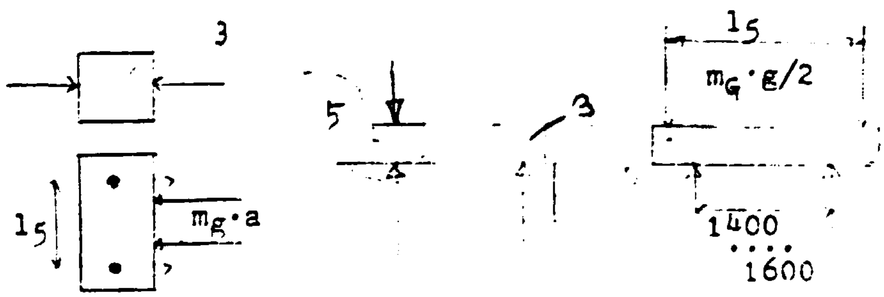
c) to facilitate a sliding motion on the ground

Part 3 : end cross member

a) to offer an appropriate area for fastening the "ends" (smaller walls)of the box.

b) to be a strong (additional) support for horizontal forces produced by the contents (see 9.4.5.), e.g. by using members (7).

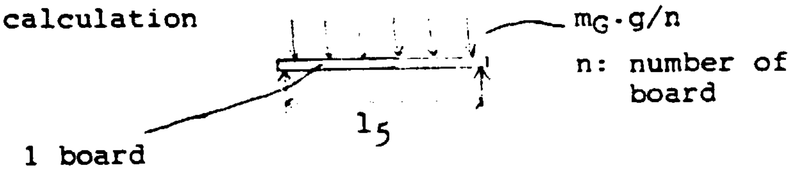
c) to be (in connection with members 5) an appropriate support for the fork of a fork lift truck entering from the ends. Dimensions according to table 14 and/or according to calculation based on following scheme.



Part 4 : base boards

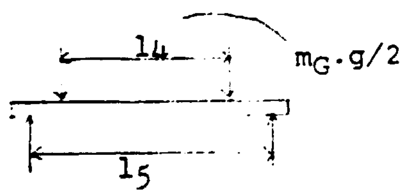
a) To support the contents if it consists of several parts
b) To close the box from below if this seems to be necessary to protect the contents against dirt, dust, and minor forces.
c) To give to the box sufficient resistance against shearing (torsional) deformations.

Dimensions according to table 13 or according to calculation

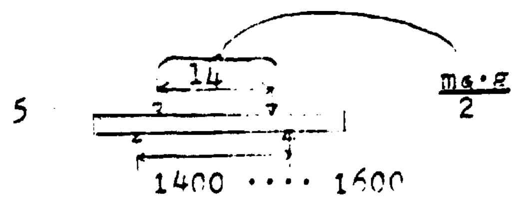


Part 5 : load bearing members

a) To allow fastening the good
b) To support the bending stresses produced by the good.
Dimensions according to table13 and/or calculation according to the following scheme.

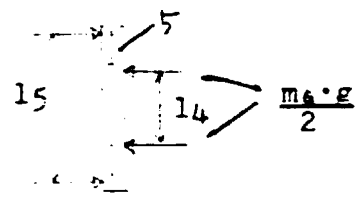


c) to direct the forces produced by the mass m_G of the good into the skids.
d) to serve (together with part 3) as support for the fork of a fork lift truck entering from an end. Calculation according to this scheme



e) to support (and direct into the skids) the forces (stresses) produced by horizontal acceleration of the goods.

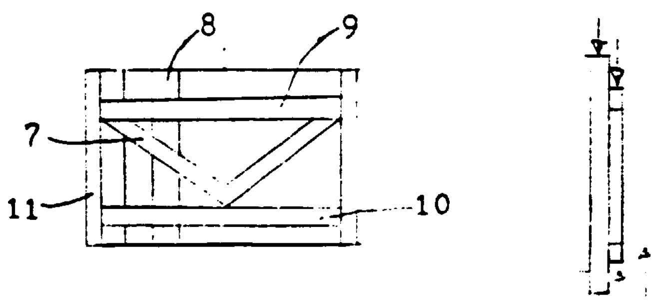
Calculation according to:



9.6.2 Design of the walls (sides and ends)

a. All parts of the walls are bearing parts for forces: vertical boards (8) combined with diagonals (7) and horizontal parts (9), (10).

The functions of these parts and the determination of their shape and size are as follows:



Part 7 : diagonal

a) to produce the necessary resistance against shearing forces produced by accelerations of the load.
Dimensions: see table 13

Part 8 : vertical boards

a) to provide the height necessary for the protection of the good against vertical forces.
b) to protect the good and the packaging measures taken inside the package (e.g. foil) against influences (forces, rain) coming from the sides.

c) to support vertical forces produced by stacking.

Calculation according to W-Method (table 11) and to direct these forces from the top into the skids (see 9.5.1.). Supposed forces see tables 1 and 3. Admitted stresses see table 13. Required number of nails to direct the forces into the skids see table ....

Part 9 : upper horizontal boards

a) to form out of parts (8) in combination with parts (7) and (10) a coherent wall with sufficient resistance against shearing forces.

b) to be vertical supports for parts (23) in the top if there are no other supports.

c) to be vertical support for the top if it does not find a support on parts (8).

Part 10 : lower horizontal board

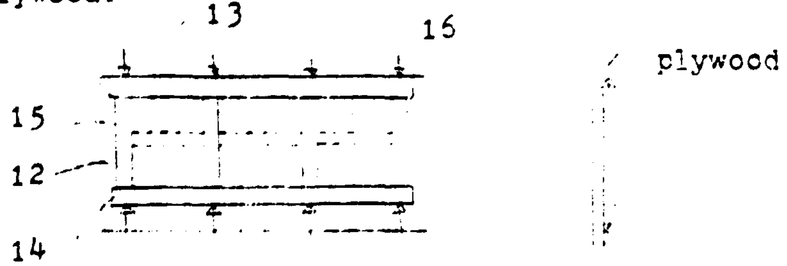
a) to form out of parts (8) together with parts(7) and (9) coherent walls.

b) to direct part of the forces from parts (8) into the skids.

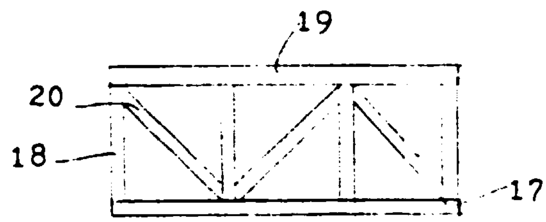
Part 11 : additional vertical boards

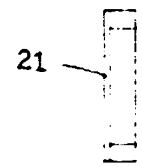
a) to increase the resistance of the vertical edges of the box in improving the nailing possibilities

b. Bearing (supporting) parts for vertical forces are specially designed and arranged struts.
Other functions are realized by plates e.g. of plywood.



c. Vertical and horizontal forces (inside the plane of the wall)are supported by a frame-work of beams, that may be sheathed to close the interior of the box.





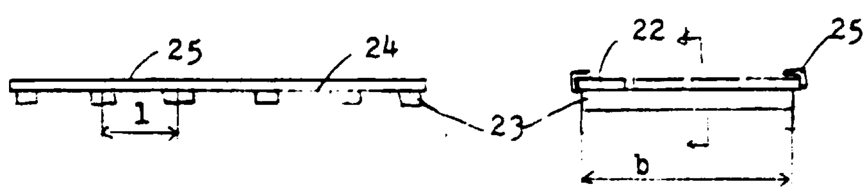
9.6.3 Design of the Top (Lid)

a. The functions

a) To support the bending forces produced by the stacking load and walking on it.
b) To resist to horizontal forces produced by the ropes.
c) To protect the inside against rain.

Depending upon the type of design (see 9.6.3.b) these functions are realized by different parts.

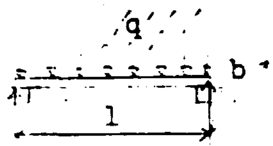
b. Top with lengthwise arrangement of boards.



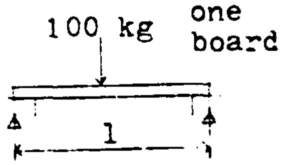
Functions of the parts:

<u>Part 22</u> : To support load stacked upon the box. Calculation according to the following scheme:

equally distributed load



a person standing on the top



$$p = \frac{Fc}{l\cdot b} = 20\ KN/m^2 \text{ (see, table 9)}$$

$$q = \frac{Fc}{l} = b\cdot 20\ KN/m$$

$$Mb = \frac{q\cdot l^2}{8}\ (KN\cdot m)$$

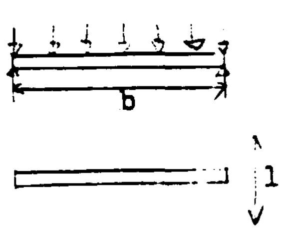
$$= \frac{20\cdot b\cdot l^2}{8}$$

$$Mb = \frac{1000\cdot l}{4}\ (N\cdot m)$$

Part 23

a) To support the load stacked upon the box.

Calculation according to following scheme:



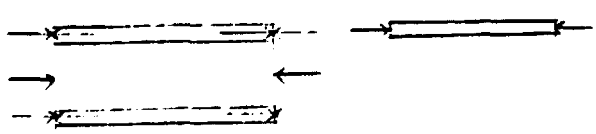
$$p = \frac{Fc}{l\cdot b} = 20\ KN/m^2$$

$$q = \frac{Fc}{b} = 1\cdot 20\ KN/m$$

$$Mb = \frac{1\cdot 20\cdot b^2}{8}$$

b) To support the horizontal force produced by the rope during handling by crane for those parts (23) disposed near the points where the rope passes around the edge. Parts (25) should be used to distribute this force on two parts (23).

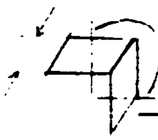
Calculation according to following scheme:



Part 24: Barrier element for rain consisting of foil (P.E. film 0.2mm) + hard board or plywood.

Part 25

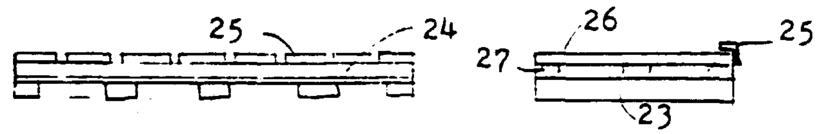
Angle iron to protect the edge of the box against the pressure of the rope and to distribute its horizontal forces on two parts (23).



screws

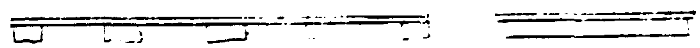
chamferred to avoid
getting hooked by
other packages
Dimension
profile:
length :

c. Top with crosswise arrangement of boards.

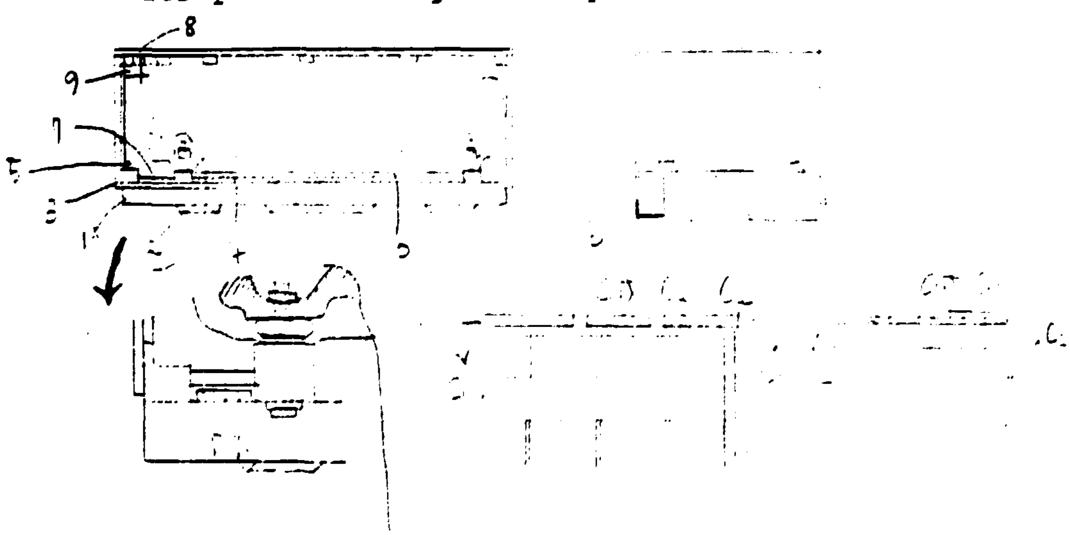


Section of parts 23 may be smaller than according to 9.6.3.b. because the length is subdivided by part 27 and the boards behind 25 partly support horizontal forces together with parts 23.

d. Top with plate of plywood



9.6.4 Assembly of base, walls, top, and product and means for protection against impact and corrosion.



Decision Process concerning Protection against Climatic Hazards

You want the protection of your product against corrosion ?

Then you have to make a decision among the following methods and means:

a) Drying method

Desiccant material in covers that are water proof and water vapor proof or more or less water vapor transmittant.

Usable to protect all kinds of passive products against water, humidity of the air, many contaminations of the air, and solar radiation during long times.

Performance of protection is calculable on the basis of exact data concerning desiccant and cover and checkable every time without opening the cover.

It can be used together with VCI or coatings to increase still the probability of good arrival of the product of its destination.

Concerning further decisions ---- see page 63

b) VCI method

Volatile corrosion inhibitor in a waterproof covering.

Usable for different metals in different types, but not for zinc, cadmium, lead, contacts.

Without at least a waterproof covering protective efficiency strongly limited by air pollution.

Combination with coating not advisable.

For further decision ---- see page

c) Coating method

Oil, wax, lanolin, acetobutyrate + additives (inhibitors) applied directly on a clean and dry surface.

Usable for all kinds of metals with different degree of protection for different environmental conditions and duration, that must be found out by experiments.

Concerning futher decisions, see page

You want to use the "Drying Method" to protect your good against corrosion (or fungus or di-solution) ?

Then you will have to make a decision between the following possibilities:

a) To close completely against humidity a separate space in a product
Concerning further decisions --- see page

b) To put the product to be protected (clean and dry) in a container or other appropriate cover that is completely waterproof (=air proof) and water vapor proof and remains so during a sufficiently long time also under severe environmental conditions, if needed.

If you will use this possibility,
for further decisions --- see page

c) To put the product (clean and dry) in a container or other appropriate cover that is completely water-proof but watervapor-transmittent to a very small degree (up to 0.1 $g/m^2 \cdot day$).
If you will use this possibility,
see page 64

d) To put the product (clean and dry) in a cover that is waterproof but watervapor-transmittent to a considerable degree (about 1 $g/m^2 \cdot day$)
If you will use this possibility,
see page 64

You want to realize the protection against corrosion (fungus) using the "Drying Method" in connection with a water-proof and watervapor-transmittent (w.v.t.r. is about 1 g per $m^2 \cdot$day) cover?

Then you will have to decide about the following details:

a) Kind and thickness of the cover material, that may be as follows:

P.E. film (0.1 or 0.2 mm) or P.V.C. film (0.2mm)

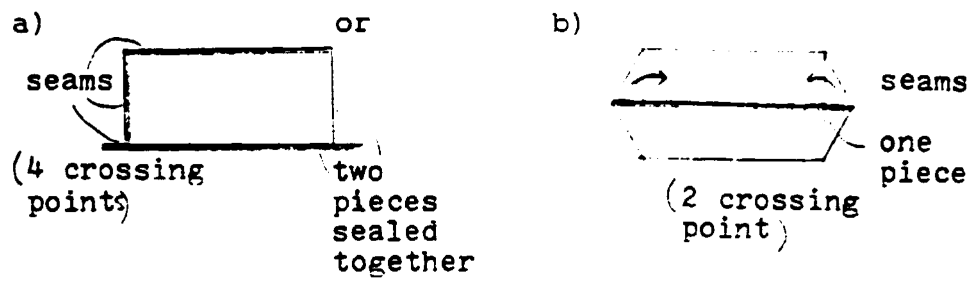
WVTR at 20°.... 40°......

strength at 20°.. 40° ....

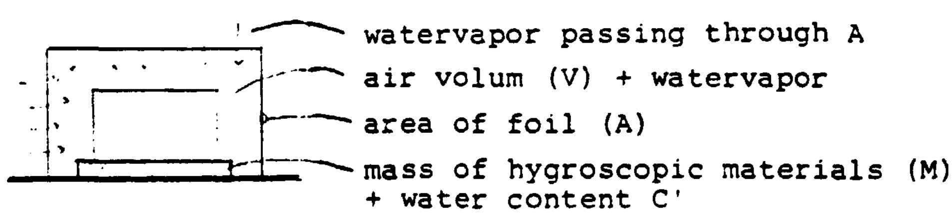
prices.....

b) The method to produce the cover :

the seam must be airproof.



c) The amount of desiccant material (M_{total})



$M_{total} = M_V + M_A + M_M$

$M_V = 5 \cdot 17 \cdot V$: negligible as to $M_A + M_M$

$M_A = WVTR \cdot A \cdot days \cdot 5$

$M_M = 5 \cdot M \cdot C'$

The calculation of M_A can be simplified as follows:
P.E.-foil 0.15 mm thick, transport through and storage in warm humid climate duration 1 month:

$M_A = 150\ g/m^2 \cdot month$

d) The type of desiccant material

(1) silica gel
(2) bentonit
(3) artificial zeolit (molecular sieve)

e) The type of confectioning

(1) bags, insignificantly porous for powder filled with 1/6, 1/3, 1/2, 1,2,4,8,16, 32 units
(2) bags as above, but with humidity indication
(3) bags, powder-proof
(4) pills, 5 .... 18mm
(5) carton 1.5 mm thick   for small packages

f) The kind of arrangement

(1) In each case. fixed, equally distributed in the upper part of the cover, not in contact with unprotected metal.
(2) Fastening at appropriate points of the good
(3) Fastening at additional elements

e.g. vaulted plates of hardboard fitted on top of the good keeping the foil free from the good.

g) The kind of airproof testing

(1) Sucking out the air, that must not come back during 24 hours.
(2) Inflate the interior with air that must not evade during 24 hours
(3) Putting the package into water; no bubbles must occur.

h) The kind of supervision of relative humidity inside by indicators.

(1) humidity indicator 
(2) " " 
(3) " " 

i) The kind of fixing the product in the package in connection with the requirement of the drying materials.

Table 1 Transport Hazards

Means of transport	stacking height (H), m		vertical (g) acceleration Av frequency of Av Fv (Hz)		horizontal (g) acceleration Ah horizontal velocity of bumping Vh (m/S)	
frequency	normal	rare	normal	rare	normal	rare
sea-ship conventional	3.5	6	0.1 0.1	0.3 0.2	0.1	0.2
			0.1 8.0	0.2 8.0	0.1	0.1
sea-ship with container	2.0	2.0	0.1 0.1	0.3 0.2	0.1	0.2
			0.1 8.0	0.2 8.0	0.1	0.1
aircraft	1.8	1.8	0.29			
truck	2.5	3.5	0.5	1.0		
			2.... 15	30... 1000	1.5	2.7
railway	2.5	2.5	0.3	0.3		
			2... 15	2.... 30	1.8	5.0

* Concerning dangerous goods-packages see IMDG-Regulation climate corresponding to the climatic zone, the season, the neighbouring load, kind of storage, ventilation, pollution of the outside air.

Table 2 Handling

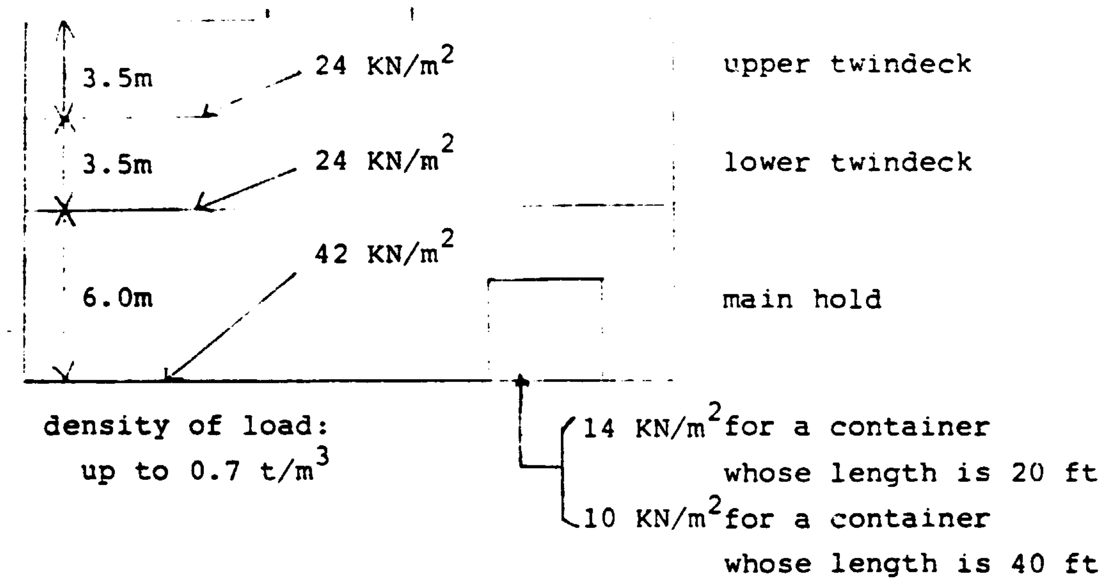
mass of the package (Kg)	drop height	
	normal	rare
25 max.	0.8	1.2
26... 100	0.4	0.6
100 min.	0.2	0.3

Table 3 Storage

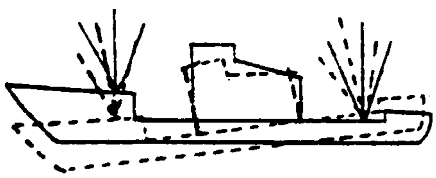
means of storage	stacking height	
	normal	rare
warehouse, any place outdoors	3.5	7
warehouse with racks	1.5	2

Data based on ISO 4081,2 and BFSV, Hamburg

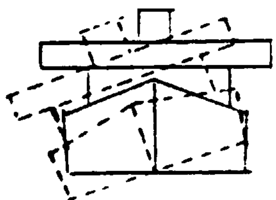
* Vertical forces per a unit of area (m^2) near the bottom in a conventional freight ship and comparation with a container whose height is 2.43m.



* Hazards produced by movements of a ship at sea on the base of 6 test voyages.



pitching



rolling

accelaration during pitching (and dipping)	accelaration during rolling (and dipping) : 0.15G angle
max. : ± 0.6 G (1.)	max. : ± 32° (40)
rare (up to 1%) : over 0.3G	rare (up to 1%) : over 25°
normally: up to ± 0.1G	normally : up to ± 15°
frequency: 0.1 - 0.2 Hz	frequency : 0.05 - 0.15 Hz

Table 4 Fields of application of the methods described in 9,5,7,b.....e.

characteristics to be taken into consideration		desiccant together with package			VCT + package (cover)	coating by		
		completely water and water vapor proof	Al-P.E. film water proof	P.E. P.P. film		thick+ temp. resistance material +cover	thin+ temp. dependent material +cover	thick+ temp. resistance material
surface of the product	iron					0	0	
	steel				0	0	0	
	Al.							
	Cu.				X			
	one-layer varnish							
	multi-layer varnish							
	combination of different surfaces	0	0	0	X			
	rough surfaces							0
distribution hazards	high temp.	0	0			0	X	
	high relative humidity	0	0			0	0	
	changing temp.	0	0	0			X	
	short duration					0	0	
	long duration	0	0		0		X	X
	polluted air	0	0		X	X	X	X
	water rain	0	0		X	X	X	X

not completely water proof covers used:

explanation of the symbols used :

[ ] :may be used [X] :should not be used

[0] :normally optimal solutions

Table 5 Packaging material, means, and functions and producers of these materials etc..

Function	Packaging means	Wood		Paper		Plastic	
		cut timber	ply wood	s.fiber board	c.fiber board	P.E	P.P.
wrapping materials & packaging materials	Films						
	plates						
	boards						
protection against forces	cases						
	crates						
	trays						
	other protective elements						
protection against loss	bottles						
	cans						
	jars						
	drums						
	barrels						
	bags						
protection against impacts	wool						
	particles						
	cushions						
protection against humidity, water, fungus, & rodents.	corrosion inhibiter						
	fungicide						
	raticide						
	insecticide						
means to close, fix, combine, etc.	strapping						
	tapes						
	nails						
	cramps						
	pallets						
		susceptible to humidity				susceptible to temperature	

Table 6 Behaviour of possible package materials
under the influence of distribution hazards.
(=their properties from the packaging point of view)

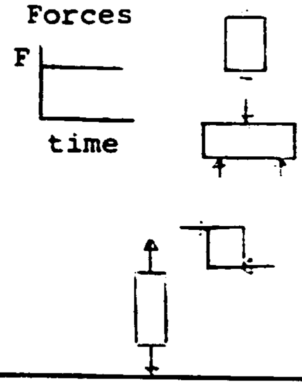
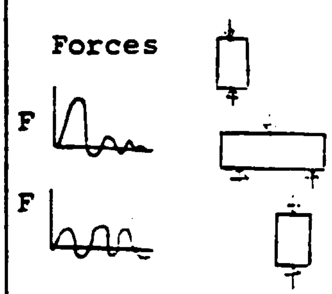
distribution hazards		materials on the basis of					
		wood		paper		plastic	
		cut timber	ply-wood	s.fiber board	c.fiber board	P.E.	P.P.
Forces  time							
Forces 							
Temperature and radiation	low						
	high						
relative humidity and water	low						
	high						
insects rodents fungus							

Table 7 Analysis of a product/package with reference to the distribution process.

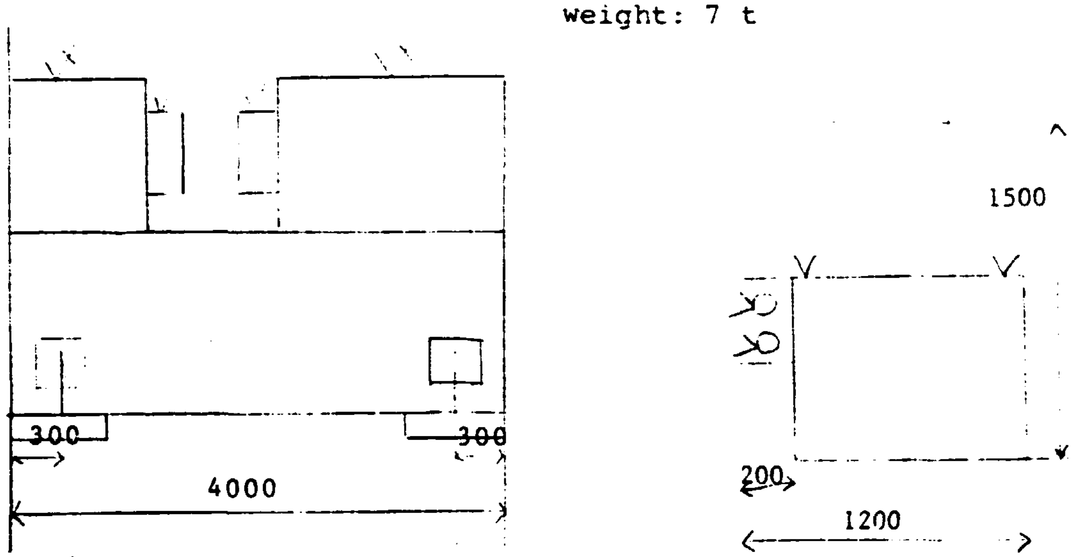
name
size
shape
state of aggregate
weight
materials
surfaces
resistance against static vertical force
resistance against dynamic vertical force
resistance against different temperatures
resistance against high humidity
resistance against fungus, bacteria, rodent, insect.
restrictions and requirements of the customers

Table 8 Analysis of distribution

Itinerary
Transports
Handling
Storages
Hazards
Static vertical force
Dynamic vertical force
Dynamic horizontal force
Drop height
Temperature
Relative humidity
Rain, Water
Duration

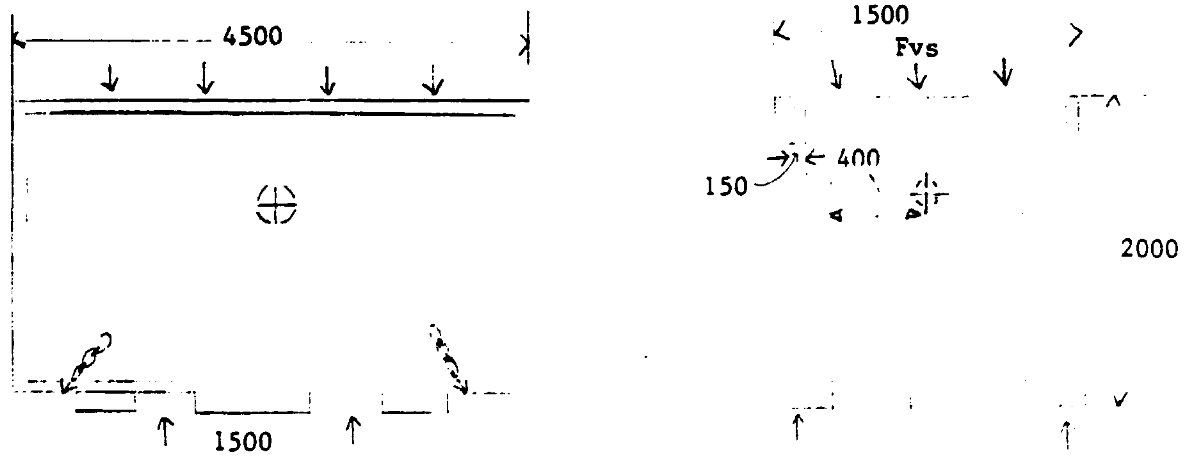
Table 9 Example for the analysis of a product and a distribution process.

weight: 7 t



✓̸ loading not allowed

✓ unprotected iron surface



height of storage:

d= density (t/m^3)

H_{max} = 6m d= 0.7

$\frac{Fvs}{A} = (6-2)0.7g = 28\ KN/m^2$

very often used: $\frac{Fvs}{A} = 20\ KN/m^2$

or $10\ KN/m^2$

Fvs=28x4.5x1.5 = 198 KN

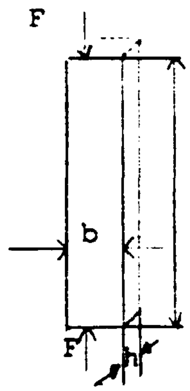
or 20 x 4.5 x 1.5 = 135 KN

or 10 x 4.5 x 1.5 = 67.5 KN

Fv total= Fvs (1 ± 0.1) depending on information or assumptions

* distribution process:
  - transport: sea ship, truck
  - storage: port ware-house
  - handling: fork lift truck and crane
  - duration: 3 month
  - climate: 25° 85%

Table 10   W-method for calculation referring to folding.



$\sigma_w = \frac{wF}{bh} \leq \sigma_{d\parallel}$ admissible

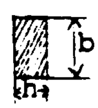
$\sigma_{d\parallel}$ admissible   see table 13.

$w = f(\lambda)$
see the following table
for pinewood:

λ	0	10	20	30	40	50	60	70	80	90	100	110	120
w	1.0	1.04	1.08	1.15	1.26	1.42	1.62	1.88	2.2	2.58	3.0	3.3	4.32

$\lambda = \frac{l}{i_{min}}$

i_{min}: minimal inertia radius $(= \sqrt{I_{min}/A})$
= 0.3h for



Procedure:

one may begin with the assessment of w or bh.
e.g.; w = 2.2 assessed, then:

$\lambda = 80$

$i_{min} = \frac{l}{\lambda} = \frac{100}{80} = 1.3$ Cm   with l = 100 Cm

$h = \frac{i_{min}}{0.3} = 4.3$

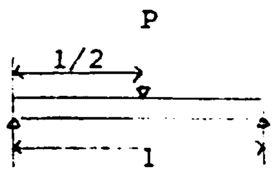
$b \cdot h \leq \frac{w \cdot F}{\sigma_{d\parallel} \text{ adm.}}$ with F = 5000 N assumed

$\sigma_{d\parallel}$ adm. = 750N/Cm^2 sccording to table 13.

$b \cdot h \leq \frac{2.2 \times 5000}{750} = 15 \text{ Cm}^2$

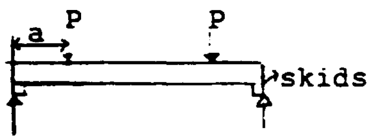
$b = \frac{15}{4.3} = 3.6$ Cm

Table 11 Possibilities of load distribution and calculation of bending stre-ses

1) 

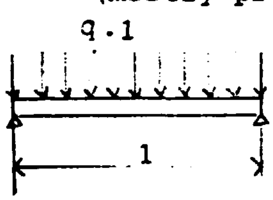
$Mb_{max} = \frac{P \cdot l}{4}$

hanging in ropes,
standing on skids,
concentrated force in the middle
(not very probable)

2) 

$= P \cdot a$

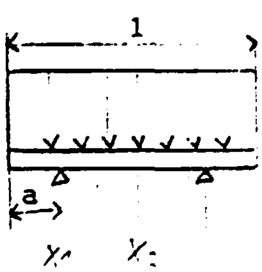
as1) but two forces
(mostly produced by rigid load on skids)

3) 

$= \frac{q \cdot l^2}{8}$

q = load/length

for example: beam in the lid

4) 

at x_1 $M_{bmax} = \frac{q \cdot a^2}{2}$

at x_2 $M_{bmax} = \frac{q \cdot l}{2} \left(\frac{l}{4} - a \right)$

<u>Table 12</u> Admissible values for stresses in wood and materials on the basis of wood.

τ and σ adm. (N/mm^2)	european pine wood class III	european pine wood class II	Plywood Plate	Chip plate	hard board plate	compact paper board	corrugat-ed paper board
σ_B bending	8.75	12.5	16.3 6.2 11.3 7.5	13... 20mm thick 20... 25mm 3.7 25... 32mm 3.0			
σ_t tensile	0	10.6	10.0 5.0	2.5	5		
σ_c compression	7.5 2.5	10.6 2.5	10.0 5.0	2.5	3.8		
τ shearing	1.1	1.1	22.5	0.6	0.4		
	According to DIN 1052 +1.25		DIN 68705 +1.25	DIN 68761 +1.25	DIN 68754 +1.25		

Table 13 Standard wooden boxes No. 1....12 (dimension: cm)
(Part number: according to Table 18)

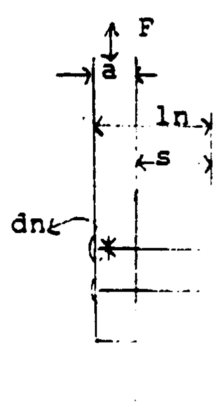
No.	weight in Kg	thickness of board		number of skids section with rubbing strip rubbing strip until No. 9: 10x5 cm until No.12: 10x6 cm				end floor member	number of top section cross member				
		TST	B	width of the bottom, until					for the length of the top, beginning with				
				100	150	200	250		200	400	600	800	999
1	100- 300	1.8	2.0	2/6x8	3/6x8	4/6x8	5/6x8		2/10x5	3/10x5	4/10x5	5/10x5	6/10x5
2	300- 500	"	2.4	2/8x8	3/8x8	4/8x8	5/8x8		"	"	"	"	"
3	500- 725	2.0	"	"	"	"	"	2/10x8	"	"	"	"	"
4	750- 1000	2.4	"	2/8x10	3/8x10	4/8x10	5/8x10	"	"	"	"	"	"
5	1000- 2000	"	3.0	2/10x12	3/10x12	4/10x12	5/10x12	2/12x10	"	"	"	"	"
6	2000- 4000	3.0	"	2/12x12	3/12x12	4/12x12	5/12x12	"	"	"	"	"	"
7	4000- 6000	"	3.5	2/12x14	3/12x14	4/12x14	5/12x14	2/14x12	"	"	"	"	"
8	6000- 9000	"	4.0	2/14x14	3/14x14	4/14x14	5/14x14	"	"	"	"	"	"
9	9000-13500	"	4.5	2/14x16	3/14x16	4/14x16	5/14x16	"	"	"	"	"	"
10	13500-18000	3.5	"	2/16x18	3/16x18	4/16x18	5/16x18	2/16x12	"	"	"	"	"
11	18000-24000	"	5.0	2/18x22	3/18x22	4/18x22	5/18x22	"	"	"	"	"	"
12	24000-30000	4.0	6.0	2/18x24	3/18x24	4/18x24	5/18x24	"	"	"	"	"	"

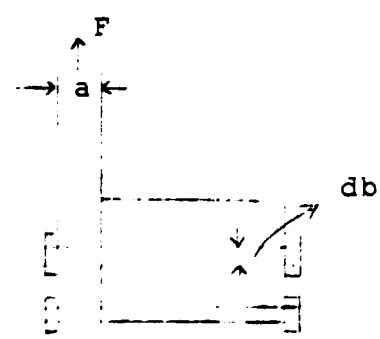
length of the box (m)	2	3	4	5	6	7	8	9	10
number of spacing	1	1	2	2	3	3	4	4	5

Table 14

Admitted shearing forces for nails and bolts

size of nails	minimum thickness of the board		minimum driving depth	admitted shearing forces Fs for pine-wood	
dn x ln (mm x mm)	not bored (mm)	bored (mm)	(mm)	not bored (KN)	bored (KN)
2.2 x 45 2.2 x 50	24 20	24 20	27	0.28	0.35
2.5 x 55 2.5 x 60	24 20	24 20	30	0.35	0.434
2.8 x 65	24 20	24 20	34	0.42	0.525
3.1 x 65 3.1 x 70 3.1 x 70	24 20	24 20	38	0.525	0.644
3.4 x 90	24 22	24 22	41	0.60	0.756
3.8 x 100	24	24	46	0.735	0.91
4.2 x 110	26	26	51	0.875	1.08
4.6 x 130	30	28	56	1.02	1.27
5.5 x 140 5.5 x 160	40	35	66	1.37	1.70





dn : diameter of nail
ln : length of nail

$F_{adm.} = 2400\ db^2$

Table 15 Distances between nails parallel and vertical to the direction of the forces.

location of the nails		direction of the fiber	holes not bored	holes bored
among themselves	b1	parallel to the direction of the fiber	$10.d_n$	$5.d_n$
	b2	vertical to the direction of the fiber	$5.d_n$	$5.d_n$
between nails and loaded side	b3	parallel to the direction of the fiber	$15.d_n$	$10.d_n$
	b4	vertical to the direction of the fiber	$7.d_n$ ... $10.d_n$	$5.d_n$
between nails and unloaded side	b5	parallel to the direction of the fiber	$7.d_n$	$5.d_n$
	b6	vertical to the direction of the fiber	$5.d_n$	$3.d_n$

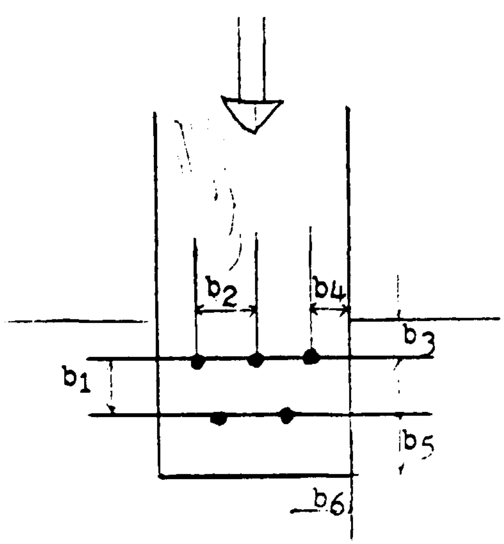
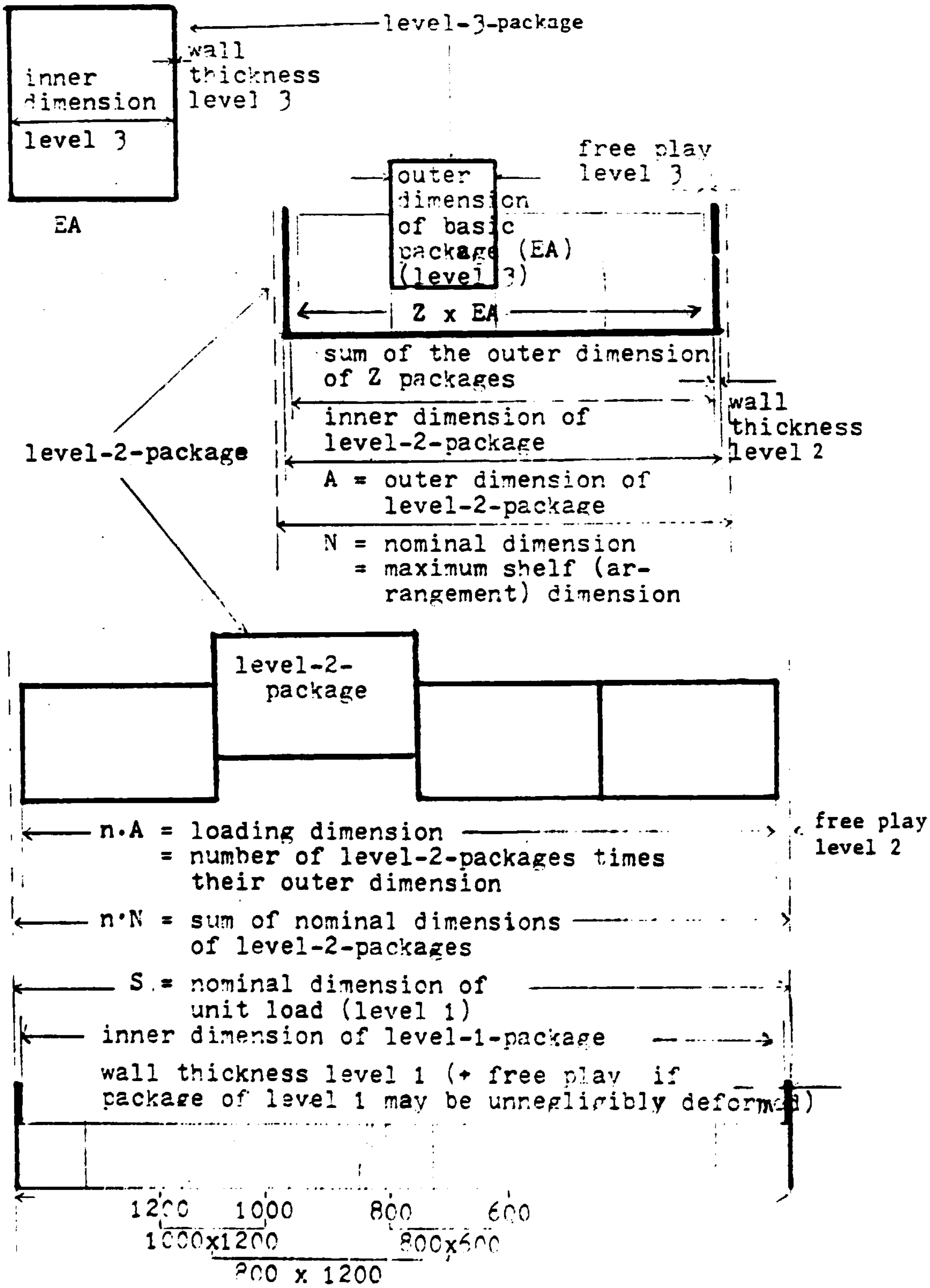


Table 16

UNIT LOADS

Dimensional structure (according to RGV, Frankfurt)



Appendix 9

Abstracts of the seminar at the KDPC

Title : Experiences made during my stay in Korea

1. Experiences as to the lectures.

The lectures were performed using paper charts visible to all participants of the lectures, models of packages and slides representating distribution hazards and insufficient packages observed mostly in the port of hamburg.

The first series of charts describes verbally, by diagrams and drawings the functions of packaging, the distribution processes and hazards, the possible behaviors of goods, packaging materials and packages occurring during the distribution processes.

The second series dealt with design details of wooden boxes for heavy goods.

The contents of the charts had been reproduced on the normally used format of paper. Each participant of the lectures has got a copy of all these reproductions.

During the lectures the contents of the charts had been dealt with rather broadly. The language used was English but partially during the lectures translations were given. It is provided to translate the English text completely into Korean language.

The topic of the first series should be considered as basic knowledge of every engineer or scientist working in the field of packaging. The second series of the charts covers topies for specialists in heavy good packaging.

The degree of efficiency of the lectures could not yet be checked. This should be done by answering some questionnaires.

It would be advisable previously to finish the translation of the first series of charts into the Korean language, in order to avoid misunderstanding arising from language difficulties.

2. Experiences mad. during visits to various companies.

It seems that heavy good companies mostly have a packaging or shipping department that uses the services of one or more packaging companies to accomplish a more or less great part of the packaging task especially to cover peaks in the demand of packaging work.

The examples dealt with during the visits to companies to following ones;

packaging of tubes in crates
packaging of steel structures
packaging of machine tools.

Some companies have made experiences with unsufficient packaging. They are eager to avoid further bad experiences by eliminating their causes.

Especially the packaging companies seem to have developed already a rather good state of the coresponding know-how.

Nevertheless they should keep learning and collecting information about the essential details of packaging procedures.

3. Experiences as to the research work of the KDPC

3.1 Research work as to the essential properties of packaging materials, packages and auxiliary packaging means with reference to heavy good packaging.

3.1.1. To find out compression and bending resistance of wood used in the country for manufacturing crates and boxes.

3.1.2. To find out strength and water vapor transmission rates of the foils offered in the country not only under normal conditions but also under coditions occurring during the distribution processes.

3.1.3. . To find out the protective properties of coatings and V.C.I. under standardized testing conditions but also under conditions corresponding to different distribution processes.

3.2 Research on goods with reference to the behavior under the influences of distribution hazards.
A questionnaire should be sent to all companies producing heavy goods asking for information with reference to the distribibition properties of the products, their packaging methods and the experiences they have made.
On the basis of the answers to these questionnaires the appropriate research works should be planned.

3.3 Research as to the distribution hazards.

The following sources of information should be used for this work;

3.3.1. Corresponding answers to the questionnaires.
3.3.2. Observations in the ports referring to the state of export and import packages.
3.3.3. Information from representatives of Korean industry in foreign countries with reference to the state of packages arriving from Korea.
3.3.4. Observations and measurements made during experimental voyages of the KDPC.
3.3.5. Publications of other packaging institutes and I.S.O.

3. Research as to packaging problems having occurred and occurring constantly in the exporting industry.

These problems must be sought and found by the KDPC if they are not brought to it for instance during visits to the various companies more or less routinely made.

It is a specific and very important capacity to be able to recognize a problem, be it a situation that is not clear develops itself unsufficiently or a question that an answer is sought for b cannot directly be found or not with needed security.

During the visits to some companies the following problems could be recognized;

a) How to avoid splitting caused by nailing of the wood used in the country for packaging purposes?
b) The influence of splitted boards on the accomplishment of their functions.
c) Is it necessary to protect galvanized steel parts that are in contact with one another in a crate against wear by vibration?
d) Determination of the probability that small holes may occur in plastic foils and in hot sealed seams and of their possible consequences.
e) Effectiveness of different methods to counteract the occurrence of small holes in foils.
f) To find out the optimal method to test waterproofness of a sealed foil.
g) To find out the influence of watervapor, water and corrosion products on the properties of coatings of oil and wax.
h) To find out the experiences the production and packaging companies have made concerning packing heavy goods in containers and determine the optimal method.

4. Experiences made on the occasion of discussions with staff members of KDPC.

4.1 Standardization of the sizes of packages.

According to the actual state of standardization in Europe and in I.S.O. documents the basis for standardization of package sizes should be the modulus 600mm x 400mm and that means also that should be used the pallets 1,200mm x 800 mm and 1,200mm x 1,000mm. The pallet 1,200mm x 1,000mm utilizes the area inside a 20 foot container better than the pallet 1,100mm x 1,100mm that does not correspond to the modulus 600mm x 400mm.

The modulus system of packages is described in a publication of the German RKW. An explanation of this system in English was prepared. (See Appendix 10)

4.2 Development of reusable fruit packages.

Some reusable packages made of wood were discussed. The task was to diminish the cost of these packages As to reusable packages it is possible to diminish the packaging cost.

a) either by decreasing the production cost of the packaging
b) Or by increasing the number of uses.

With reference to a) one should

aa) Find out the cost structure of the package and the possibilities to diminish the cost that account for the greatest part of the total cost.

ab) Find out if the material used is equally and well utilized.

With reference to b) one should find out and eliminate the weak points of the package by investigating the packages that have been used already several times and by collecting and dicussing the experiences already made with packages.

4.3 Finding out the range of application for different means and methods to avoid corrosion during a distribution process.

Testing methods apt to comply with this general requirement must fulfill the following specific requirements;

a) The test conditions must correspond to the possible distribution conditions or exaggerate them so that the relative evaluation of the test specimens is not changed and the correlation to the real conditions is known.
b) All the possible means and methods should be tested under the same conditions in order to be able to compare

them with one another and to find out the limit of their usability.

c) The efficiency of the preservatives should be measured by the average number of rust points per square cm or the percentage of rusted surfaces in the rust free surface, but not by the loss of weight.

d) The test specimens should be prepared with utmost cleanness but the influences of definite faults often made in practice should be determined seperately.

e) The test specimens should be subdued to the environmental conditions being in a plastic cover according to the reality and well seperating one specimen from the other (absolutely necessary for V.C.I.)

5. Experiences and observations as to the combination of design, development, research, production, teaching in the KDPC.

I do not intend to describe the existing relations between the above mentioned activities existing. I would like to demonstrate only what could be made out of this very helpful situation, because it covers a great deal of my activities during the last 20 years.

The definitions of "design" vary largely but they have in common, although not always explicitly said, that the design of product, especially of a technical product, has to determine its shape, size, structure so that definite functions are accomplished, e.g. easy opening of a package.

The development of a product also has to determine its shape, size, and structure so that definite functions are fulfilled e.g. a definite resistance against compression for a package.

The research of materials, products, and production processes has to provide design and development with the needed information especially by testing what are the properties of materials, products, and processes and how they can be controled and improved.

The production of the products has to realize what design, development, and research have planned, the production quality being checked by adequate tests.

The general teaching of research, design, development, and production may be performed very conveniently and effectively using packaging technology as a model technology.

Thinking in functions, finding out and evaluating technical solutions on the basis of knowledge and testing are the essential capacities needed and to be taught to achieve industrial development.

The combination of the activities of research, design, development, production, and teaching under one organizational roof is a good basis for the realization of the above mentioned relations between them so that each of the activities is promoted by the other ones.

Appendix 10

Explanation of the modulus system

Explanation and comments concerning the draft (in German) "Modulus recommendation" of the RGV (association for rationalization in packaging), Frankfurt, 1981

1. Packaging modulus 600mm x 400mm

According to ISO 3394 the nominal dimensions (length and width) of distribution packages should be based on the area 600mm x 400mm. This area is called "Modulus" or "Modular area" because it determines a series of package dimensions that are compatible with one another. That means: Modular area or modular packages are "Multiples" of "Sub-multiples" of 600mm x 400mm (see table 2) and therefore can be arranged on the areas 1200mm x 800mm and 1200mm x 1000mm (pallets standardized according to ISO/R 198 and ISO/R 329) so that they just fill this area completely.

The height of packages and unit loads is not subject of the modulus system, but there are recommendations (e.g. DIN 55511,1) and limits given by transport and storage room height.

The sequence in describing the basic area of a package should correspond to ISO standard demanding to denominate at first the larger dimension (and that is the dimension of the length) and then the smaller dimension (this is the dimension of width). Besides that it should be clear that the unit of length is mm, that of an area mm^2.

2. Unit loads

The term "unit load" described already by the words used what is essential for it:

a) It means a thing that is one piece or is as if it were one piece,

b) It means a thing that is part of or compatible with a bigger system and therefore is standardized appropriately

c) It is a thing that is a load or a mass that is shipped.

Unit loads in this broad sense may be:

a) Loads consisting of one piece or mostly of more pieces bound together so that they can be economically handled,

b) Loads arranged on the bases of definite areas (1200mm x 1000mm , 1200mm x 800mm, etc.) fitted with different means to facilitate the handling (pallets, preslung devices, loads in freight containers).

c) ISO containers

Tendencies to denominate as unit loads only those built on the area of 1200mm x 800mm or 1200mm x 1000mm act against the full comprehension and recognition of unitization as a general and important concept of the rationalization of distribution systems.

"Unit loads" should not be interpreted as "loading units" i.e. a unit that is made and used for loading and unloading purposes. On the base of this interpretation the formula "loading unit = transport unit = storage unit" has been created as a rule for the rationalization of distribution processes.

But this formula neglects the above mentioned feature of the unit-load-concept or unitization that a unit load is or may be part of a bigger system. The formula therefore should be :

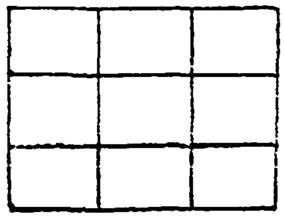
The level of unitization (see chapter 7) should be for each phase of the distribution process the most appropriate one.

Therefore it should be possible and necessary to change the level of unitization if it is advantageous.

3. Stacking pattern of palletized unit loads

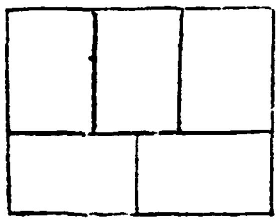
3.1 Horizontal pattern

3.1.1



"regular" pattern
(see table 15 and 16)

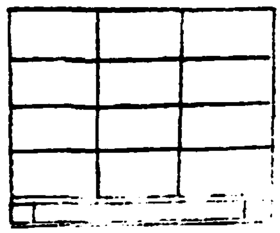
3.1.2



"crosswise" or
"complementary"pattern
(see table 15 and 16)

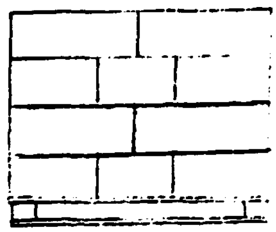
3.2 Vertical (multilayer) patterns

3.2.1



Subsequent layers are
equally arranged =
"columnwise" pattern

3.2.2



Subsequent layers over-
lap one another =
"compoundwise" pattern

3.3 Possibilities to combine 3.1. and 3.2

3.3.1 can be realized together with 3.1.1. and 3.1.2.

3.3.2 cal be realized together with 3.1.2. but not
with each 3.1.1. depending on the dimensions.

4. "Molular and non-modular, compatible and non-compatible" dimensions.

4.1 Modular dimensions according to ISO 3394 are dimensions that are the results of a division or multiplication of 400 or 600 with a whole number (see chapter 1)

800	400	200, 133, 100
1200	600	300, 200, 250, 120, 100

4.2 Non-modular dimensions that are compatible with 1200 x 800 but are not included in 4.1 are the result of a division at 800and 1200 by a whole number : 1200 : 240

4.3 Non-modular dimensions that are compatible with 1200 x 1000. These dimensions do not belong to 4.1 but are results of divisions of 1000 by a whole number:

1000: 500, 333, 250

4.4 Non-modular and non-compatible dimensions.

These dimensions (see table 17) cannot completely cover and utilize the surfaces of pallets 1200mm x 800mm and 1200mm x 1000mm. Table 17 decscribes dimensions that still have the degree of utilization of these pallets between 93 and 99%.

5. "Nominal" dimensions, "outer" dimension, "inner" dimension of package.

"Nominal" dimensions are specified in the tables 15,16 and 17.

They equal the maximum outer dimensions.

"Outer dimensions are the length and width of packages that are ordered and produced with correponding tolerances.

The differences between nominal and outer dimension is needed by bulging as a consequence of filling and compression by stacking.

Inner dimensions are length and width available inside the package to be used by the good and by auxiliary packaging means. (Wrapping, Cushioning).

They depend upon outer dimensions and wall thickness.

The system of nominal and outer dimensions on the base of 600mm x 400mm is to guarantee that the pallet nominal dimensions are not exceeded, what is essential for loading them in trucks, railway wagons and containers. Besides that each package is to be easily put into and taken out of the bigger packages.

To guarantee the fitting of pallets in trucks, railway wagons, containers and storage racks there are only minus tolerances for length and width. Until the decision of ISO for wooden pallets tolerances of plus minus 3mm are used because of shrinking and expansion by humidity.

6. Decision process concerning the determination of package dimensions.

6.1 Roughly assessing the inner dimensions according to the dimensions of good, cushioning, wrapping, etc. (Ir)

6.2 Finding out the most appropriate nominal dimensions (N).

6.3 Finding out the wall thickness needed to avoid damage of the good or too great deformation. (W)

6.4 Finding out the production tolerances. (T)

6.5 Determining the effective inner dimension. (Ie)

$$Ie = N - 2W - T - D$$

D: deformation

6.6 Checking if Ie is appropriate for the good otherwise choosing another N and repeating the process.

Referring to the influences of the structure or the number of stages of unit loads on this decision process see chapter 9.

7. Flexibility, stiffness, rigidity, deformation.

The difference between outer and nominal dimensions is based partially on the bulging of the package and the necessity to facilitate the withdrawal of packages out of a larger package also when they are deformed. The upper limits for these deformations are for dimensions.

until 300mm : 5 - 6mm
from 300 to 500 : 10 -11 mm
from 500 to 800 : 14 -16 mm

To what degree this part of the free play is utilized in each case depends upon the stiffness of the filled package and the load applied.

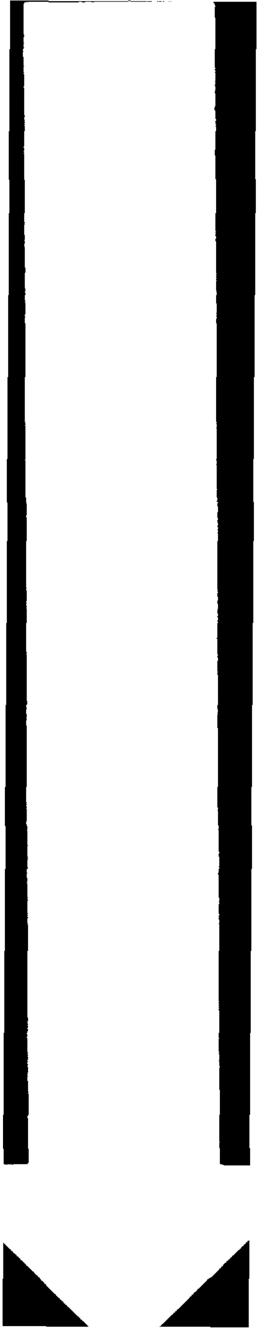
In this context it is necessary to define the following terms:

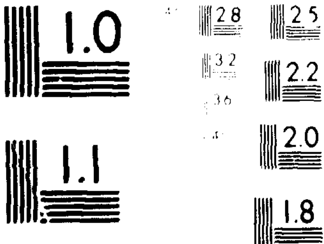
"stiffness" is the stress/strain ratio especially in the first nearly linear part of the stress-strain curve of a body, e.g. a package.

"rigidity" is the maximum stiffness for unlimited stress/strain ratio. In reality rigid packages do not exist, only packages that are more or less stiff.

"stiff packages" are packages, the essential property of them is to have a definite resistance against deformation.

"Flexibility" is the other limit of stiffness that is to say for strain/strees ratio going to zero.





1.0
2.8
2.5
3.2
2.2
3.6
2.0
1.1
1.8

Resistance against "deformation" is the maximum force or stress that can be withstood without taking into consideration the deformation.

The amount of deformation to be taken into account as to the determination of outer dimensions depends only upon the load-deformation curve (i.e. the stiffness) and the load applied but not upon the strength, length, or width of the package. The load-deformation curve itself depends upon the material and the dimensions of the walls of the package.

Packages not yet deformed by a stacking load will be stacked tightly one beside the other leaving the sum of free spaces on the outside of the whole row of packages. It is not to be expected that they will shift under the influence of compressive forces. Therefore the effective deformations visible outside of the row will be only the deformations of the outer walls of the outer packages. This should be checked by tests.

For example the free space provided for six packages of a modular length of 200 mm will be 6 x 6 mm = 36mm. This free space will be used only to a small part for the deformations.

If the same package sizes are used for non-supporting and rather yielding and also for completely supporting and very stiff goods the free space will not be used at all by the very stiff filled package.

In both cases the result is the same: the pallet will not be covered completely by the packages.

If a producer utilizes for a whole production lot the tolerances for the outer dimensions in the same direction, the gap between the row of stacked packages and the pallet size will be still greater.

The greater the gap the more liable to deformation by horizontal forces the unit will be if not appropriate measures are taken.

8. "Levels" of unitization

According to picture 8 "level 1" is the unit load on the basis of 1200mm x 800mm or 1200mm x 1000mm.

"Level 2" are packages that are smaller than 1200mm x 800mm and 1200mm x 1000mm but fitting on this area.

"Level 3" are packages packed in level 2 packages.

According to picture 2 the denomination of the levels is exactly the opposite one. Big freight containers have been added and level 2 packages of picture 8 have been eliminated.

"Level" or better "unitization level" should mean the relative size of the package or unit load within the unitization system. In this case it seems to be reasonable that "unitization level 1" is the basic package, "unitization level 2" an intermediate package, "unitization level 3" a transit package, "unitization level 4" a palletized load or similar unit load "unitization level 5" a freight container" unitization level 6" a barge.

Beginning with "unitization level 2" a package or unit load may contain no, one or more other levels. The RGV draft introduces the term "stage" to describe how many levels are realized in a unit load of definite level, e.g. the level 13 unit of table 8 is a unit of 3 stages but it could also be a unit of 1 or 2 stages.

9. Problems connected with more than 1 stage in a unit load. packages with modular or compatible dimensions can be arranged directly on the pallet to utilize its dimensions.

If they are to be put at first into other packages with modular or compatible dimensions the outer dimensions of these packages must be diminished according to the thickness of the walls surrounding them.

This means that for each modular package size variations of this size should be available according to the number of stages that are possible for it.

But from the logistical point of view it seems to be of major importance to be able to alternate the number of stages to be realized in a unit load.

That means that in this case only level 1 modular packages are produced and levels 2 and 3 are realized only by means the wall thickness of which is negligible, e.g. strapping, wrapping in paper, shrink and stress wrapping in foil

10. Number of packages to be standardized.

From the point of view of utilizing with 100 percent the standardized pallet 1200mm x 800mm and 1200mm x 1000mm there are

according to table 3 : 23 nominal dimensions of packages
according to table 4 : 27 nominal dimensions of packages
according to table 5 : 25 nominal dimensions of packages
75

Packages that utilize the area of 1200mm x 800mm only with 93 to 99 percent are anumerated in table 17. There are 12 nominal dimensions of packages.

If one assumes that it is necessary to have on the average for each package size 3 different wall thicknesses that cover different requirements of resistance against compression, 87 x 3 packages with different inner dimensions should be standardized.

For each type of package 261 packages would be subject to standardization.

Another multiplication of this number would be necessary if one takes into account the variations of the above given dimensions determined by the requirements to be apt for use in unit loads with different number of stages.