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ASSISTANCE TO THE PACKAGING CENTRE

DP|TUR|81|013|11-03

TURKEY

Technical report: Transit Package Testing and Development *

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

Based on the work of Zdzislaw I. Kostro,
Expert in transit package testing and development

Backstopping officer: J. Belo, Agro-based Industries Branch

United Nations Industrial Development Organization
Vienna

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VII - Annexes

I. ABSTRACT

A. Title and number of the Project:

The title of the project-Assistance to Packaging Centre DP/TUR/81/013. It has been commenced in 1983.

B. Objective and duration of the activity:

The expert entered the field on 17-th September after being briefed by Mr J.Belo at UNIDO in Vienna on 15-th and 16-th of September 1986.

The objective of the activity was the evaluation, testing and development of transport package.

The work plan was discussed with the Project Coordinator Mrs GUlden TARHAN in view of adaptation of job description to the actual possibility of its realisation - see Annexes 4 and 5.

The chief of the counterpart staff has been Mrs GUlden TARHAN, Director of the Packaging Research, Development and Testing Centre.
Details of the counterparts are given in Annex 3.

The activity commenced of the field on the 17-th of September 1986 and concluded on the 28-th of November 1986.

C. Main conclusions and recommendations

Turkey, adequate to it s territory, population and industrial strength needs proper Packaging Centre as other developed countries.
In order to fulfill these requirements the Packaging Research Development and Testing Centre should be an autonomcus body within the Turkish Standards Institution.

II . INTRODUCTION

A. Background

1. The Packaging Research Development and Testing Centre

The Packaging Research Development and Testing Centre was established in 1986, acting in the frame of the Turkish Standards Institution - TSE - see Annex 1.

The TSE was set up in 1954 within the body of Union of Chamber of Commerce, Chambers of Industry and Commodity Exchanges. The TSE became a Statutory Body on the 18-th of November 1960 by statute no. 132 passed by the Grand National Assembly.
According to the Statute the TSE is an autonomous public institution subjected to private law.
The headquarters and laboratories of the TSE are located in Ankara.
The TSE has two regional offices in Istambul and Izmir and eighteen other smaller representative offices spread over the country.
The Secretary General appointed by the Board of Directors administers the services of the Turkish Standards Institutions - TSE.
Eleven departments work under the secretary general, one of which is the Department of Laboratories and Quality Control. So far the Packaging Research Development and Testing Centre is situated from administrative point of view on a level of other laboratories under this Department - see Annex 2.

The First stage of UNDP/UNIDO aided Project to set up the Packaging Laboratory commenced in 1977 and concluded in 1982. The second stage of the project - current one, commenced in 1983 is in the process of implementation up to the end of 1986.

2. The Project Acitivity

The general activity of the Project Ref. No.DP/TUR/81/013 is to further equip the testing laboratories in order to develop packaging knowledge and application of packaging technology to the Turkish Industry.

The particular activities of the ongoing project have been just elaborated by the National Project Coordinator - Mrs GUlden TARHAN in the Terminal Report as well as by Mr Suresh R.Bharucha /UNDP-New York/ and Mr Luis F.G.Madi /CETEA-Campinas, Brazil/ in the report Deep Evaluation conducted on October 1986 /therefore Expert does not find justification to repeat it s again/.
The current project commenced in 1983 will be implemented after one month only in the end of December 1986.
The sub-activity involves the examination of the test methods in use and advise on development of transit packages according to the Job Description - see Annex 4, and work plan of the Expert prepared by the National Project Coordinator - see Annex 5.
The sub-activity on transit package, testing and development commenced on the 17-th of September 1936 and concluded on the 28-th of November 1986.

3. Fulfillment of the objectives

The general objectives of the project were fulfilled in substance.
The same intermediate objectives are still under development but it should be noted with satisfaction the acceleration of implementation, in particular in the last months.

As for example, increase of substantial staff - about 30 %, development of training, speed up adaptation of testing equipment, creation of awareness of the Packaging Centre activities by immediate and frequent contacts with industry. Development cooperation in packaging field at international level - the Secretary General of TSE has been elected Vice President of the World Packaging Organization in October 1986 in Tokyo.

III - RECOMMENDATIONS

A. General

1. Director of the Packaging, Research, Development and Testing Centre should be situated at a level with more autonomy within the TSE hierarchy /at present level sixth - see Annex 2/.
2. As soon as possible to employ additional professional staff, minimum double to compare with present quantity /at present about 10 testing apparatus is fit for one person/.
3. To establish strongeconomy section in order to commence research in marketing and prepare prognosis of packaging development in Turkey.
4. Start to work on a basis of hours working schedule.
5. To organize "Working Group Committee" consisting of people from foreign and domestic trades, communication, road, railway, air and industry in order to elaborate "guidelines" for performance of transport packages as a preparatory work to elaborate the National Standards in the future.

6. To elaborate propositions for the Government on the matter of issuing regulations about "Quality Certification" of packages manufactured by the Turkish industry.

7. To elaborate a programme of coordination system in the packaging field on a country level.

8. To organize "restricted" exhibition with examples of wrong performance of packages for selected representative people from government and industry by explaining real losses for the national economy or their effects to human health.

9. To prepare an application document to the International Trade Center /ITC/ - UNCTAD/6 AD in Geneve in order to involve the Packaging Centre to the needs of International Computer Information System in Packaging Field on a basis of small scale Project.

10. To join IAPRI - the International Association of Packaging Research Institutes. It enables to access to some research papers and technical specifications which were done by other more developed packaging institutes.

11. It is suggested that after about one year, it means in the half of 1988 in practice, UNIDO should arrange the mission to the Centre in order to evaluate the progress in the development of the overall activity and to make decision about the third stage of the project - Extension of the PRD and TC.

B. Particular

1. Implement as soon as possible all the remaining tasks concerned with adaptation and proper utilization of all the equipment in transport package testing laboratory.

2. Commence research works in the field of mechanical and climatic hazards occuring in transportation and storage in the country.

3. In order to render the possibility of carrying out of above mentioned research /p.2/ it is needed to purchase urgently indispensable apparatus and accessories - see Annex 13.

4. To speed up the repairing of the compression tester or to purchase the new one.

5. The transport package testing laboratory must be urgently equipped with thermohygrograph or other instruments measuring temperature and relative humidity as well as with auxiliary facilities as: fork lift truck, one-man push-cart, water tank for checking leakage of testing plastics bottles or drums, release device for testing heavy packages on the drop tester.

6. To bring about finishing foundation constructions to enlarge foundation plate under vibration tester and fulfill the gaps /up to about 150 mm width/ between the foundation of the floor and the particular plates of the foundations under each of the transport testing equipment.

IV. REPORT ON THE MISSION ACTIVITIES AND OUTPUTS

A. Main duties and objectives of the Job Description - see Annex 4 and Work Plan - see Annex 5.

The main duties covered by the mission were:

General: Evaluation and development of transit package for specific products, to enable the counterpart staff to continue the work in the future.

Specific:

1. Assisting the Counterpart staff in adaptation and improvement of existing transport package testing equipment.

2. Elaboration of stacking test and compression test as well as evaluation of the test results.

3. Preparation of the technical document about:
   - General transport package test
   - Wood and wooden packages performance

4. Improvement and cost reduction work on the package of some industrial products.

5. Conducting technical discussions on transport methods, transit packages in the common use.

6. Preparing the seminar for other laboratory staff and technical personel from the Turkish industry on the subject: "Design, performance and testing of wooden cases."

B. Substance of the activity

The substance of activity was based on the transmission of the knowledge aimed at the proper performance of transport packages in order to assure their resistance to the hazards occuring during transport and storage.

It was implemented by delivering practical method of designing, performance and testing of transport packages.

C. Results of the activities

In all the above mentioned activities some of the counterpart staff were involved. The implementation and results of the activities are summarized in the following points.

1. Testing equipment

After examining existing equipment in the transport testing laboratory as:

- inclined plane impact tester
- compression tester
- vibration table
- drop tester /release trap platform tester/ small one up to 2 m
- drop tester /release trap platform tester/, big one up to 4,5 m

It was stated that most of them require adaptation, adjustment as well as calibration in order to bring them to full working capacity and enable that tests results will be in comparison with other packaging laboratories in the world.

a. Inclined plane impact tester, required:

- the bumper wall should be covered from front side by hardboard, plywood or some similar sheet of material,
- the buffers of the bumper wall as well as of the dolly should be exchanged on some more elastic material,
- the upper plate of the dolly ought to be covered by hardboard or plywood sheet to be equal and smooth, the steel buffers should be changed with some more elastic material. It was suggested to change the sliding bearings of the dolly with the ball or roller bearings.

b. Compression tester, required:

- to speed up the repair of the test recorder /about one year delay in repair by some indigenous firm/,
- to make auxiliary facilities in order to enable performance tests with packages of dimensions smaller than 500 mm.

c. Vibration table, required:

- to enlarge foundation plate from engine side in order to ascertain proper fixation of the vibration table botton frame to the foundation plate,
- after proper fixation of the vibration table, it should be conducted particular calibration by accelerometers and auxiliary facilities - see Annex 13.

d. Drop Tester /small/

The equipment has been ready to test. It was suggested only to make some specific protection of metal sheets on the bottms against broken glass and liquid which could occur during testing some kind of packages with real products as bottle or similar.

e. Drop Tester /big/

In principle the equipment has been ready to test. But in order to enable to carry out tests on heavy packages at different positions of the drop on corner edge or other precisley predetermined places of samples /according to the testing method/ it should be provided a release device /ASTM-D 997-80/ special predestined for this purpose.
A lot of above mentioned tasks have been implemented already,as for example:

- the bumper wall was covered with a kind of hardboard sheet,
- the buffers of bumper as well as of the dolly were exchanged with rubber ones,
- the upper plate at the dolly was covered by hardboard sheet,
- the auxiliary facilities for compression tester were performed - see Annex 12 ,
- the purchase negotiations with supplying firms in order to buy accelerometers and auxiliary facilities have been started.

2. The guidelines for stacking test and compression test have been elaborated - see Anexes 8 and 9.

3. The specific technical elaboration on the subject of general tranport package testing methods on a basis of the actual Polish standard was implemented - see Annex 11.

4. The technical guidelines on wood and wooden packages performance were elaborated - see Annex 10.

5. The tasks concerning the cost reduction work on the packages of some of the industrial products were implemented partially due to the lack of time.

   The problem was broadly discussed during the industry visits - see Annex 15 as well as with the counterpart staff.
   Some particular "technical guideline" were done on the concrete sample of packaging of electrical equipment in wooden crates for the needs of AEG factory which should be the basic information for the counterpart staff, enabling them to design properly the wooden transport packages for industrial products.

6. Technical discussion on transport packages and other essential packaging problems were implemented on special sessions - see Annexes 6 and 17 as well as during industrial discussions with the counterpart staff.

7. The seminar on the subject "Desing, performance and testing of wooden packages" was implemented on the 20-th of November with the presence of about 50 participants from industry, science and commerce - see Annex 10 .

8. The factory visits at Ankara Esenboga, Bolu, Hendek, Gebze, Istanbul and Antalya were implemented - see Annex 15.

During these visits an attempt was made to do fast assessment and after then to suggest to help them in performance and designing of proper transport packages for industrial products. Many interesting discussions with representatives of the industry led to some essential remakrs:

a. there is a lack of national standards or other technical specifications for variety of packaging materials.

b. the most of manufacturers are not convinced of the importance of quality needed for their packages, because the users do not demand it.

c. some of the packages for industrial products are manufactured by subsuppliers with very low technical knowledge.

V . CONCLUSIONS

1. The Turkish Standards Institution undertook recently essential steps in order to speed up the development of the Packaging Centre by:

   - increasing substantial staff /about 30 %/
   - accelerating provision with auxiliary means
   - undertaking renovation of premises
   - giving priority in performance by administration and workshops
   - allocating additional funds for purchase of indispensable equipment and accessories /fork lift, accelerometers/
   - devoting special attention to the every day works of the Packaging Centre

2. The quantity of the staff in comparison with tasks and installed equipment of the Centre is still not adequate. It should be minimum doubled.

3. The weight of the Packaging Centre work has been concentrated up to now rather on retail packages and packaging materials testing rather than on the transit packages. Although it should be rather reverse, because with retail package and material testings any other branch institutes could be involved while equipment for transport package testing exists only at the Packaging Centre.

4. There is a lack of basic data on the subject of development in particular branches of the packaging industry. The data should be gathered by the Statistic Centre and transmitted to the Packaging Centre. It enables proper programming of long term research works and concentration on tasks requiring urgent improvements, for example - method of recycling of waste plastic packaging materials etc.

5. There is a lack of their own standardised methods for packaging testing that are specially important for conducting tests on transport packages. It should accelerate elaboration of standards concerning testing methods as well as quality of package and packaging materials /some basic documents on this subject were handed over to the counterparts/.

6. There is a lack of any data or even information on the subject of mechanical and climatic hazards typical for the country conditions.

7. In the last period of time the Packaging Centre has conducted hard works in training for industry and in spite of the shortage of the staff the Centre made intense contacts with the packaging users and manufacturers.

8. The Packaging Centre must speed up the works concerning transport packaging testing laboratory in connection with the provision of indispensable auxiliary facilities as well as the provision of the existing testing equipment in order to carry out tests in accordance with the conditions existing in other packaging testing centres in the world.

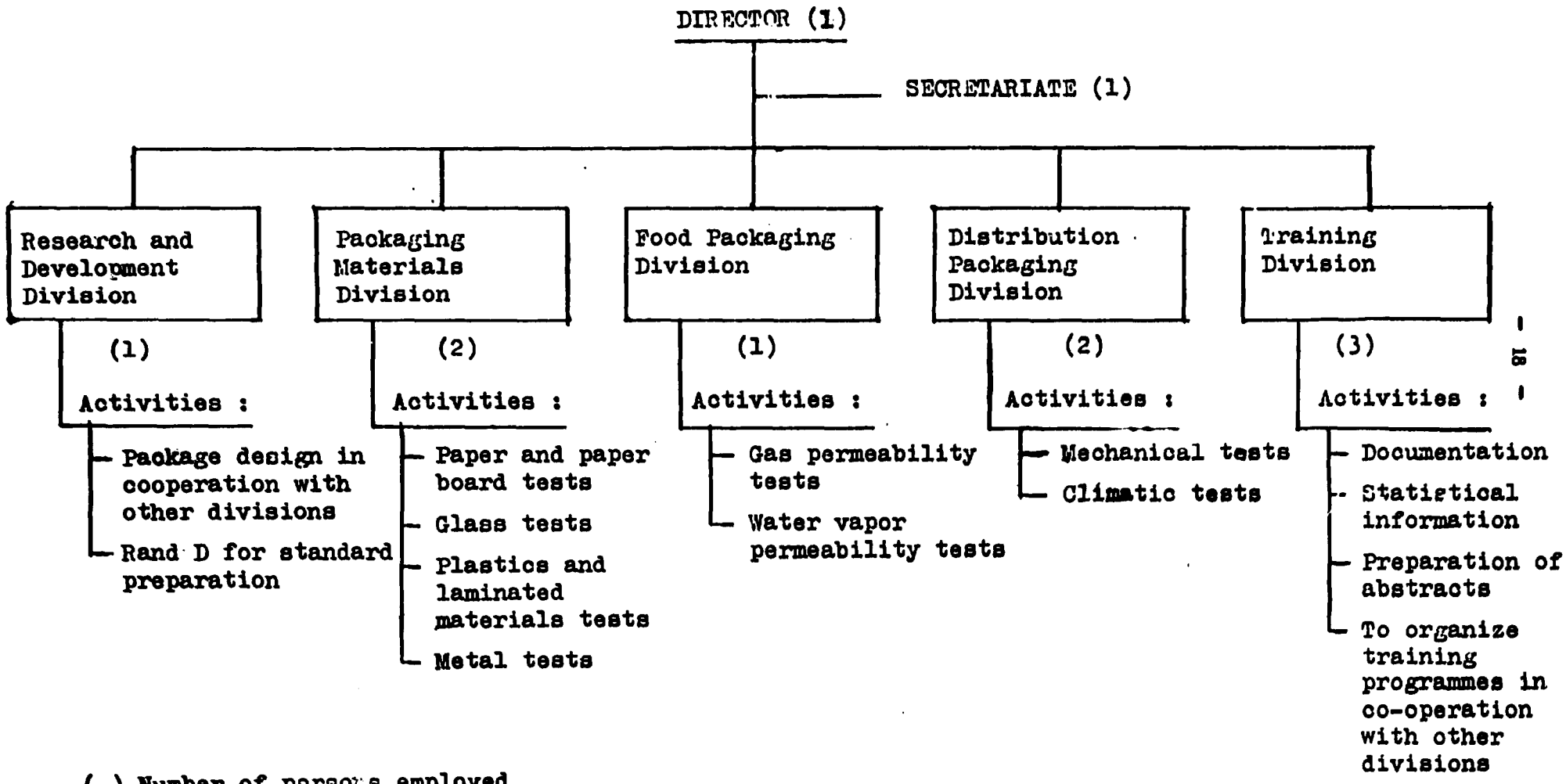
VI . ACKNOWLEDGEMENTS

The expert very much appreciates the support he received from the counterparts /Annex 3/ and other staff of the Packaging Research Development and Testing Centre, without whose close cooperation it would not have been possible to complete the mission satisfactorily.
The assistance extended by the management of the TSE and guidance given by the UNDP officials in Ankara, particularly by the Programme Development Officer, rendered the tasks easier and effectively.

ORGANISATIONAL CHART

Annex 1

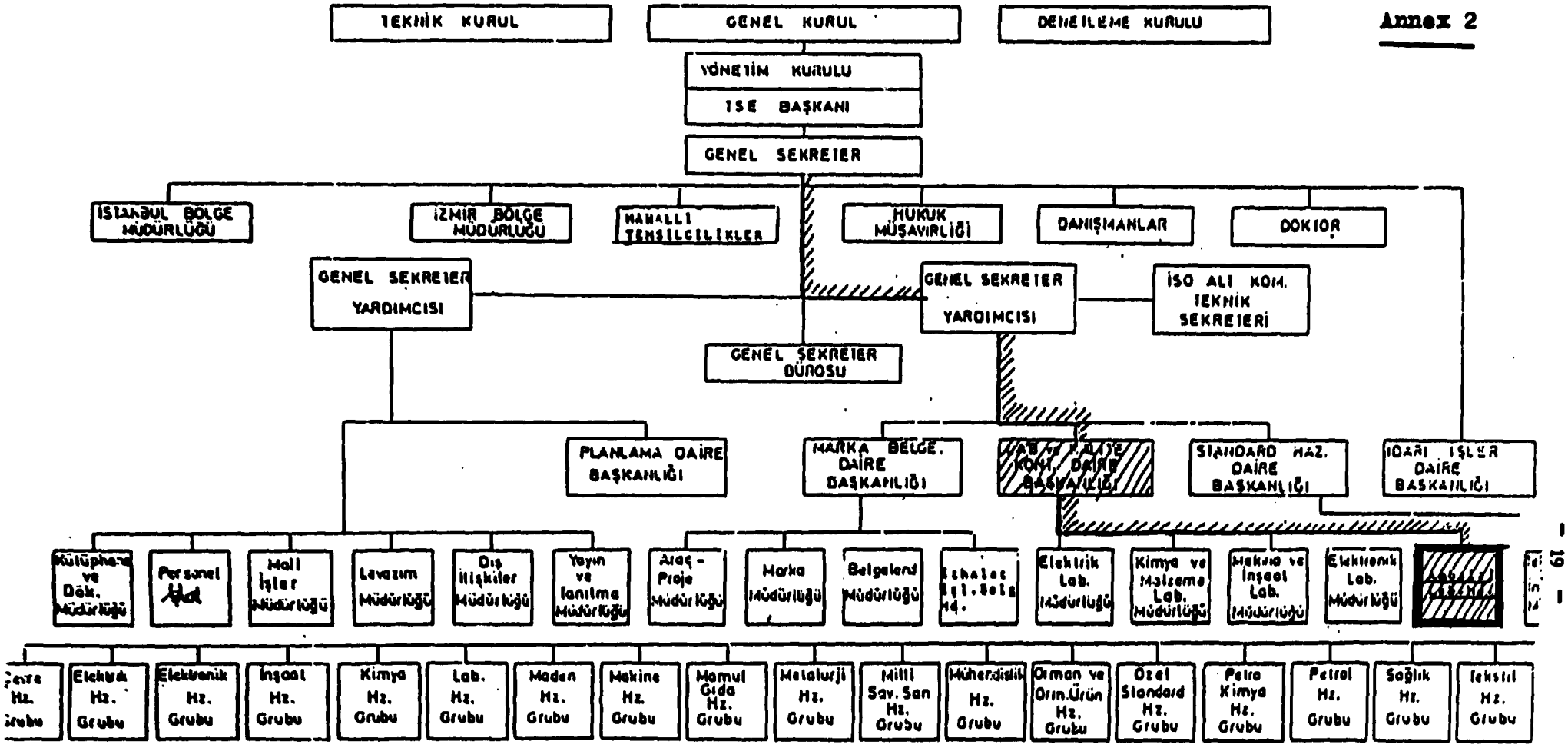
Packaging Research, Development and Testing Centre



( ) Number of persons employed

TSE ORGANİZASYON SEMASI

Annex 2



(TRANSLATION OF RELEVANT PORTIONS)

TSE ORGANİZASYON ŞEMASI - TSE ORGANISATIONAL CHART

GENEL KURUL - GENERAL ASSEMBLY

YÖNETİM KURULU - BOARD OF DIRECTORS

TSE BAŞKANI - TSE PRESIDENT

GENEL SEKRETER - SECRETARY GENERAL

GENEL SEKRETER YARDIMCISI - ASSISTANT SECRETARY GENERAL (TECHANICAL)

LABORATUVARLAR VE KALİTE KONTROL DAİRESİ BAŞKANI - HEAD OF LABORATORIES AND QUALITY CONTROL

AMBALAJ LABORATUVARI - DIRECTOR, PACKAGING LABORATORY

(THIS LABORATORY IS KNOWN AS PACKAGING RESEARCH, AND DEVELOPMENT AND TESTING CENTRE A FEW 86)

Annex 3

National Counterpart Staff

(Packaging Research Development and Testing Centre of Turkish Standards Institution)

Name	Qualification	Discipline	Experience In Packaging as of Nov. 1986
Ms. Gülden TARHAN	M.S.	Chemical Engineering	11 yrs
Mr. Hasan Salih ACAR	B.S	Chemistry	7 yrs
Mr. Recep DEVECİ	B.S.	Mechanical	4 yrs
Mr. Abdülkadir Yıldırım BULDU	B.S.	Physics	0 yrs

UNITED NATIONS

Annex 4

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

UNIDO 7 January 1986

PROJECT IN THE REPUBLIC OF TURKEY

JOB DESCRIPTION

DP/TUR/81/013/11-03/31.7.E

Post title	Expert in Transit Package Testing and Development
Duration	2.5 months
Date required	April 1986
Duty station	Ankara, Turkey. With travel within the country.
Purpose of project	The Government has set up a Packaging Laboratory with a view to assist the industry to improve the standard of packaging and develop a quality assurance programme. The project is concerned with the further equipping of this laboratory and training laboratory and industrial personnel in the application of packaging technology.
Duties	The expert will work with a team of counterpart personnel on the evaluation of transit packages and the development of transit packages for specific products. More specifically the expert will be expected to:

1. Examine the test methods already in use in the laboratory for simulated travel tests, the techniques used for evaluating test results and their applications to actual performance predictions, elaborating and increasing as necessary.

2. Advise on the development of specifications and standards for transit packs for selected products, with special emphasis on cost reduction techniques.

3. Further develop the survey of transport packaging systems presently being used in Turkey for specific products, analyse their cost effectiveness and suggest modifications and a work programme designed to bring about improvements.

..../..

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

Project Personnel Recruitment Section, Industrial Operations Division
UNIDO, VIENNA INTERNATIONAL CENTRE, P.O. Box 300, Vienna, Austria

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4. Conduct technical discussion sessions on transport methods, transit package performance evaluation, materials and transit packages in common use.

5. Co-operate with the training expert in preparing visually aided courses in transit packaging for use in training other laboratory staff and technical personnel from Turkish industry. These courses will cover the principles, methods of use and applications for the principle pieces of transit test equipment in the Institute.

The expert will be expected to prepare a final report setting out the findings of the mission and making recommendations to the Government on further actions that might be taken.

Qualifications University degree in science or engineering with a good knowledge of transport packaging materials and systems; extensive experience in the field of testing, performance evaluation, standardisation and development of transport packaging systems.

Language English

Background information The Packaging Laboratory has been operating since the beginning of 1982 and the usual transit test equipment for vibration, impact, drop and compression simulation has already been installed. A transit packaging expert worked with the laboratory for 2 months in 1982 focusing on inclined plane impact, drop and long term compression testing in particular and transit package design and testing in general. The equipment for short term compression and vibration testing were not available at that time and therefore will be the special subjects for this next consultancy visit.

Annex 5

WORK PLAN DURING THE MISSION OF TRANSPORT PACKAGING EXPERT

1/ The improvements and adaptation of
- Inclined impact test system
- Compression tester
- Vibration tester
- Drop testers
- Stacking test system

2/ Elaboration of stacking test and compression test then evaluation of the test results.

3/ Preparation of the technical documents about
- General transport packages tests
- Wood and wooden packages

4/ Improvements and cost reduction work on the package of some industrial products /pumps,electrical motor, etc./

5/ Conduct technical discussion sessions on transport methods, transit package performance evaluation, materials and transit packages in common use.

6/ Preparing the seminar for other laboratory staff and technical personnel from Turkish industry
- Subject of the seminar : Design,performance and testing of wooden cases.
- Date of the seminar : 20.11.1986

7/ Factory Visits
- Bolu,Hendek,Gebze,Istanbul 13 - 17/10/1986
- Antalya 20 - 30/10/1986.

Annex 6

Session 1

Subject : Transit Packages - The Purpose and Conditions of Performance

Definitions of packaging

There are many packaging definitions,but one tolds that packaging may be defined as a means of ensuring the safe delivery of a product to the ultimate consumer in good conditions at a minimum cost.

This definition will be particular suit for us during discusing on transit package problems -but- newertheless if it is retail or transit package we always should treated its as a integral part of a product.

Than in order to properly designing any new package we should be acquainted with sam facts concerning to the problem namely.

- facts about the product
- facts about the method of distribution
- facts about package economy and marketing

Briefly it is necessary to know many particular information concerning with the product as; kind, quantity and quality, sensativity, shapes, shelf life, cost and many others.

It is important to consider the ways in which the product can be damaged mechanically and climatically; and to consider these in relation to the hazards which the package will meet during transport storage and distribution.

Having also under consideration the marketing question as sales appel, display aspect, satisfactory of utilizer as well as economical said of the problem it is mean cost of production, cost o shipment, after use of container as well

as possibility of repeatedly use, recicling and the like. Let's consider some of the facts separately.

Facts about the products

Generally the physical properties of the product requiring concideration will be; fragility, rigidity, surface finishing weight, size, unit quantity to be package, as well as susceptibility to water, water vapour, oxygen, odours, heat and could and the ability of the product to deteriorate, by virtue of its own nature, will also require concideration. This provide to the details which makes the answers to the following three sets of questions:

How can a product be damaged mechanically

How can it be damaged climatically

Are there any compatibility questions which must be concidered when the product is in contact or in close proximity to a specific packaging medium.

Let's consider briefly sam product for example an apple. How can apple be damaged mechanically? This is our first concideration.

It is obvious that an apple can be considerably damaged mechanically and that the bruises so produced are like by to make it deteriorate rapidly.

It is also well know that apples and similar products are living material and there-fore require to breathe.

Fruits in general absorb oxygen and expire carbon dioxide, and if they are shut in clouse containers, then they are liable to "suffocate"; consquently will have the problem of delivery for this in the packaging.

Further consideration will lead us to enquire in to possible contamination of the apple by packaging materials, not only because that toxic products might be eaten, but also because some time harmless materials may affect the flavor of the products (fruits).

Facts about the method of distribution

It will be convenient to divide the hazards of any journey into four main groups:

1. The hazards of loading and unloading
2. The hazards of movement (while a package is left in vehicles)
3. The hazards of warehousing
4. The climatic hazards

1. The hazards of loading and unloading

Two mein hazards occur in such operations:

- drops and
- impact of one package against another

For this reason a prefered range of weight should be of between about 15 and 30 kg.

Some average drop height is illustrate below:

Weight kg	Nature of handling	Drop height m
1 ÷ 10	1 man throwing	1,00
10 ÷ 20	1 man carring	0,80
20 ÷150	2 man carring	0,50
150 ÷500	light equipment handling	0,40
above 500	heavy equipment handling	0,30

Practically havier packages of 100 kg weight and above will generally require mechanical equipment for their movement and drop hazards will be considerable reduced.
Export hazards of loading and unloading are normally much greater, but depends of a country of destination.

2. Hazard of movement in vehicles

2.1 Rail transport

There are three main hazards to be considered:

- shunting shocks when trains are assembled in sidings and marshaling yards
- snatching which occurs when starting and stopping loosely coupled wagons
- vibrations under stacking loads (limited by the height of the wagons)

2.2 Road transport

The principle hazards during morement in road transport vehicles are:

- vibrations and
- bouncing of the load

2.3 Sea and river transport

Main hazards are:

- compresion stress and
- vibration

These depend mainly on the method of storage and stacking height of cargo may be 5 ÷ 10 m height and subjected at the same time low frequency vibration from engines and propellers.

Pitching and rolling of the vessel can result stresses in the lower levels of cargo.

2.4 Air transport

Main hazard are:

- low temperature and pressure
- high frequency vibrations

Generally handling is good, becuse aircraft usually carry loads on pallets, but the usually hazards occur on the journeys to and from the airport, particularly at same overseas destinations in the tropic countries.

The vibration hazard is common to all forms of movement and can cause:

- loosening of fastenings and components of items
- abrasion of surfaces of items or print on packages
- fatique of cushoning materials

3. Hazard of warehousing

Normally not provide any serious damage in the country where facilities are available and stacking is limited to a safe height.

The stacking hazard are for more significant on package made of paperboard materials and some time plastics package -"creep".

The compresive load on the bottom package in stack will be

$$W\ (\sum h - h)$$

W weight of one package, quantity
$\sum n$ of all package in stock
h one package

4. Climatic hazards

Climatic hazards will be related to the route and the country of destination of goods.

Climatic hazards can be consider under three headings:

1. Exposure to liquid water(rain, sea spray, condemation)
2. Exposure to high and low humidity
3. Exposure to high and low temperature and suddenly temperature changes.

The rapid drop in temperature may affect on condensation inside the package and accelerate corrosion and mould growth.

5. Other hazards

It my also be necessary to consider two hazards which are indirectly related to transport:

- pilferage and
- attack by insects and rodents

Both these occur mainly during storage of cargo in ports or warehousing in tropical countries.

Brief assessement of journey hazards

The hazards of any specific journey may be assessed in broad outline by observation and deduction, and in detail by the use of specific instruments.

It must be remembered that the size, shape and weight of the container can have a considerable effect on hazard during a journey as well as the different method of transport accentuate particular hazards and give different levels of each of them. Protection against the very rare drop from great height does not usually justify the increased cost of

the package, a small percentage of damage my be moust preferable than to increase the cost of package.

Some time the absence of damage to any consignment my be indicative of overpacking.

Protection is require only against the normal hazards.

The session an the transit packages but particularlly discussion on journey hazards was supported by the demonstration of 32 slides of the Polish Packaging Research and Development Centre in Warsaw.

The slids were concerned with the mechanical and climatical hazards which occured during the testing journey in the vessel on the route from Gdansk to Calcutta and Storage in India.

Annex 7

Session 2

Subject : 1 The purpose of testing

In order to obtain the best result and make the best use of packages it is essential to understand the purpose for which they may be employed.
It must always be remembered that the proof of any package lies in it's performance, in the field for which it was designed, over a relatively long period of time.

Therefore two essential question must must be consider the purpose of package and packaging test - and of course how these tests can be made?

2 Why Test ?

There are three major reason for making tests :

1. To predict performance in practive
2. To control Quality
3. To obtain information to modify and improve design or reduce the cost of thepackage

3 How to predict performance ?

In order to predict performance a measure of correlation is needed between the tests carried out in the laboratory and the behaviour of the package or material in practice.

4 Three main correlation are required

- between the field performance of the package and laboratory transport test. (e.g. - test journey)
- between the laboratory transport test on the filed package and test on the empty container.
- between the strenght and other properties of the various materials used in making the container and the tests on the empty container (e.g. mullen test for corrugated fibre-board box)

Let's consider the first correlation on a basic of same samples from practice for example two test journey conducted by Polish Packaging Research and Development Centre to Japan and South America (Brazil, Argentina)

As we know a cargo during storage, transport and reloading are effected by a complex of physical factors known as mechanical hazards and expressed by means of so called overload factor G.

The overload factor G is expressed by the ratio of the value of acceleration given to the mass of the cargo to the value of gravity acceleration.

What it can express in formula:

$$G = \frac{a}{9,81}$$

The G factor is also called the impact load factor

$$F = m.a$$

$$a = \frac{F}{m} \quad m/sek^2$$

m- mass

a- acceleration

9.81 - gravity accelevation

Looking at the problem in another way we realize that since the weight of any articel is simply due to the pull of gravity than if it has G times pull of gravity acting on it, it's weight will appear to be G times as great as normal.

In each of the considered kinds of transport overload factor of different value are appering.

This is caused by diametrically different conditions appearing in particular kind of means of transport used for shipment of cargoes.

As it has been mentioned before in order to define the size of mechanical hazards affecting the cargoes forewarded by sea, measurments have been carried out during two scientific - testing voyages.

Within the period from the 2nd December 1975 to the 15th March 1976 on the route Gdynia - Japan -Gdynia on the vessel of the tonnage 10.930 BRT-(1 BRT = 100 cub.feet)

The total distance of the route amountet to 50.500 km.

The second voyage was undertaken within the period from the 6th February to the 15 th April 1978 an the route Gdynia- South America - Gdynia on the vessel of the tonnage 8.680 BRT
The total lenght of the route amounted to 26.000 km.

During the a forementioned voyages besides the fundamental tests, observations in the range of methods of reload handling used in particular ports were also carried out, and one has got acquainted with equipment of these ports with reloading and handling devices.

Measurments of mechanical hazards which were carried out during these both voyages consisted of :

a) measurement and registration of values of accelerations caused by the longitudinal and transversal sway of vessels.
b) measurement of level of vibrations of vessel's construction.
c) measurement of angles of longitudinal and transversal tilts of the vessels.

More over, collection of additional data having essential influence on the size of measured accelerations was made. An every day the following data were registered :

- the real rout of the vessel.
- speed of the vessel.
- direction and wind power
- state of the sea
- mass of the transported cargoes on particular sections of the voyage routes.

5 Measuring apparatus

For the measurment of the values of acceleratious caused by the longitudinal and transversal sway of the vessel the electronic measuring set of the firm Brüel-Kjaer was used, which consisted of:

a) piezoelectric accelerometers transforming accelerations into electric impulses proportionally to their values
b) charge amplifiers enabling the measurement under application of cards of suitable length linking the measuring points with the central registration stand.

c) electronic voltometers and frequency analysers, serving for the control of the regularity of function of measuring path and for carring out of direct read - out of values of accelerations appearing in particular measuring points.

d) Tape recorder serving for magnetic tape record of the course of changes of sizes of accelerations and vibrations in the time function.

e) portable vibration meter serving for measurment of vibration of vessel's contruction.

f) special constructed devices and chnograph for measurement of longitudinal and transversal angles of tilts of the vessels as well as periods of oscillation.

6. Performance of measurements

Measurement of accelerations caused by the longitudinal and transversal sway of the vessel.
In both voyages the same method of measurements was used.
The value of accelerations caused by the longitudinal and transversal sway of the vessel were measured by heads (sensors) having pizoelectric accelerometers.

The measuring heads were situated at places where the maximal values of accelerations are appearing.
In Fig-1-Appendix 1 the scheme of distribution of measuring heads and stands for measurment speeds of vibration of vessel's construction has been illustrated.

The scheme of the path of simultaneous measurement of acceleration components caused by the longitudinal or transversal sway of the vessel is illustracted in Fig-2-App.2
The measurment of the angle of transversal (α) tilts as well as of the longitudinal (β) of tha vessels were carried out as illustrated in Fig 3-App.3

7 Analysis of test results of mechanical hazards

The results of tests of acceleration values deriving from transversal and longitudinal sway of vessel were set together in the tables which allowed marshaling receiving data.

TABLE- 2

Vessel	Component	Value of the component in g				
		a 0,01	0,01 a 0,1	0,1 a 0,3	a 0,3	Maximal Value
		Frequency of appearance in %				
1	2	3	4	5	6	7
Japan	Transversal a_z	47,3	36,1	8,3	8,3	0,630
	Vertical a_y	51,5	37,5	8,3	2,7	0,300
South America	Transversal a_z	32,5	35,0	27,5	5,0	0,525
	Vertical a_y	37,5	30,0	22,5	10,0	0,415

From the above table results that during the sea transport by the vessels acceleratinns deriving from transversal sway of the lower value than 0,3 g represented about 98 % of the total number of the registered vertical accelerations and about 92 % of the total number of transversal acceleration:

In Table-2 was illustrated the relative frequency of appearance of accelerations of components/a_x and a_y/- in particular ranges of their values-deriving from the longitudinal sway.

TABLE- 2

Vessel	Component	Value of the component in g				
		a 0,01	0,01 a 0,1	0,1 a 0,3	a 0,3	Maximal Value
		Frequency of appearance in %				
1	2	3	4	5	6	7
Japan	Longitudinal a_x	51,5	30,5	16,6	1,4	0,400
	Vertical a_y	57,0	30,5	11,1	1,4	0,300
South America	Longitudinal a_x	48,2	31,6	14,4	5,8	0,425
	Vertical a_y	54,3	29,5	12,8	3,4	0,345

From the table ..?... results, that the acceleration of the lower value than 0,3 g deriving from the longitudinal sway registered on the vessel on voyage to Japan represented about 99 % of the total number of accelerations both measuremend of the parallel directions to the longitudinal axis of the vessel and of the vertical direction. But on the other hand during the voyage by the vessel on the route to the South America accelerations of the lower value than 0,3 g represented about 97 % of the total number of the registred vertical accelerations and about 94 % of the total number of longitudinal accelerations.

From this analysis results that in both voyages the registered values of accelerations are similar.

But the accelerations of higher value were appearing a little more often during the voyage to the South America.

From tha above results that under nearly similar weather conditions the dimensions of the vessel have essential influence on the size of accelerations and the frequency.

8. Conclusion from tests carried out during both voyages

a) The greatest mechanical hazards arising on account of transversal tilts affect the product and packages being at the vessel side, but the greatest hazards caused by the longitudinal tilts affect the loads placced in bow or stern parts of the vessel.

The values of mechanical hazards caused by the tilts of the vessel increase proportionally to distance from axis of the ships.

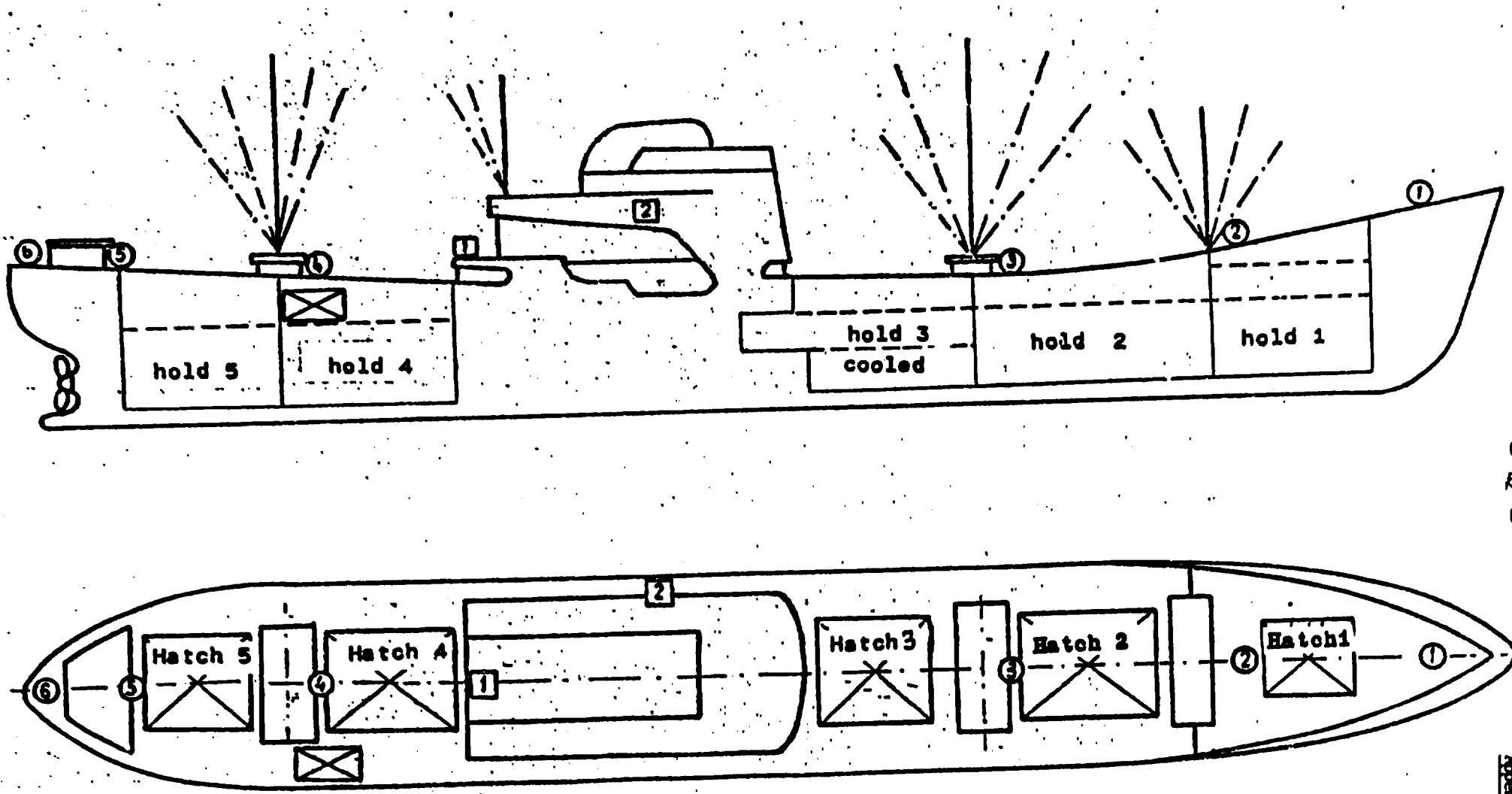
The absolute values of the measured accelerations in both voyages did not exceed 0,7 g. The tests have indicated also that without regard to the type of the vessel and the rout of the voyage the greatest number of accelerations - more than 90 % did accur of the value within the range from 0,01 - 0,3 g. Accelerations having the value of more than 0,3 g did appear rather sporadic from 1% - 10% of the total number of the measured accelerations.

b) Mechanical hazards caused by dynamic loads, arising as result of vessel's sway and function of driving system depend also on many variable factors as : state of the sea, wind power, the angle beween wind direction and the route of the vessel, speed of the vessel place where the load was located and degree of utilization of vessel cargo carring capacity.

c) The maximal tilts of the vessel during the voyage to Japan reached to 20° and during the voyage to South America reached to 18°.
At such tilts of the vessel, packages stowed irregular can be damaged on account of shifting and striking one against other packages being in the neighborhood of same.

The session on - "The purpose of testing " has been supported by the demonstration of 14 th slides of the Polish Packaging Research and Development Center in Warsaw.

The slides was concerned with carry on, some years ago, resarch field testing on the research station in India and the tests journeys on the vessels to South America and Japan.



1 2 - heads for measurement of acceleration caused by transversal and longitudinal sway of the ship.

①...⑥ - stands for measurements of vibrations of ship's construction.

⊠ - testing box

Fig. 1 SCHEME OF DISTRIBUTION OF MEASURING STANDS

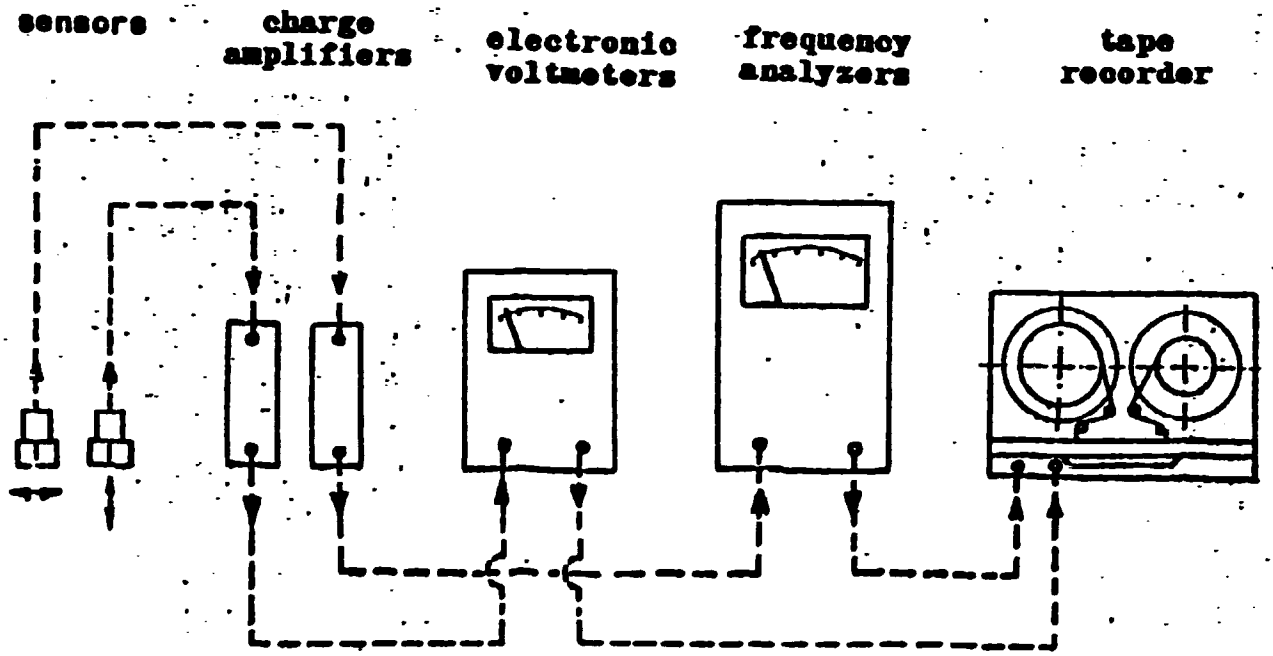


Fig. 2 Scheme of the measuring path of acceleration

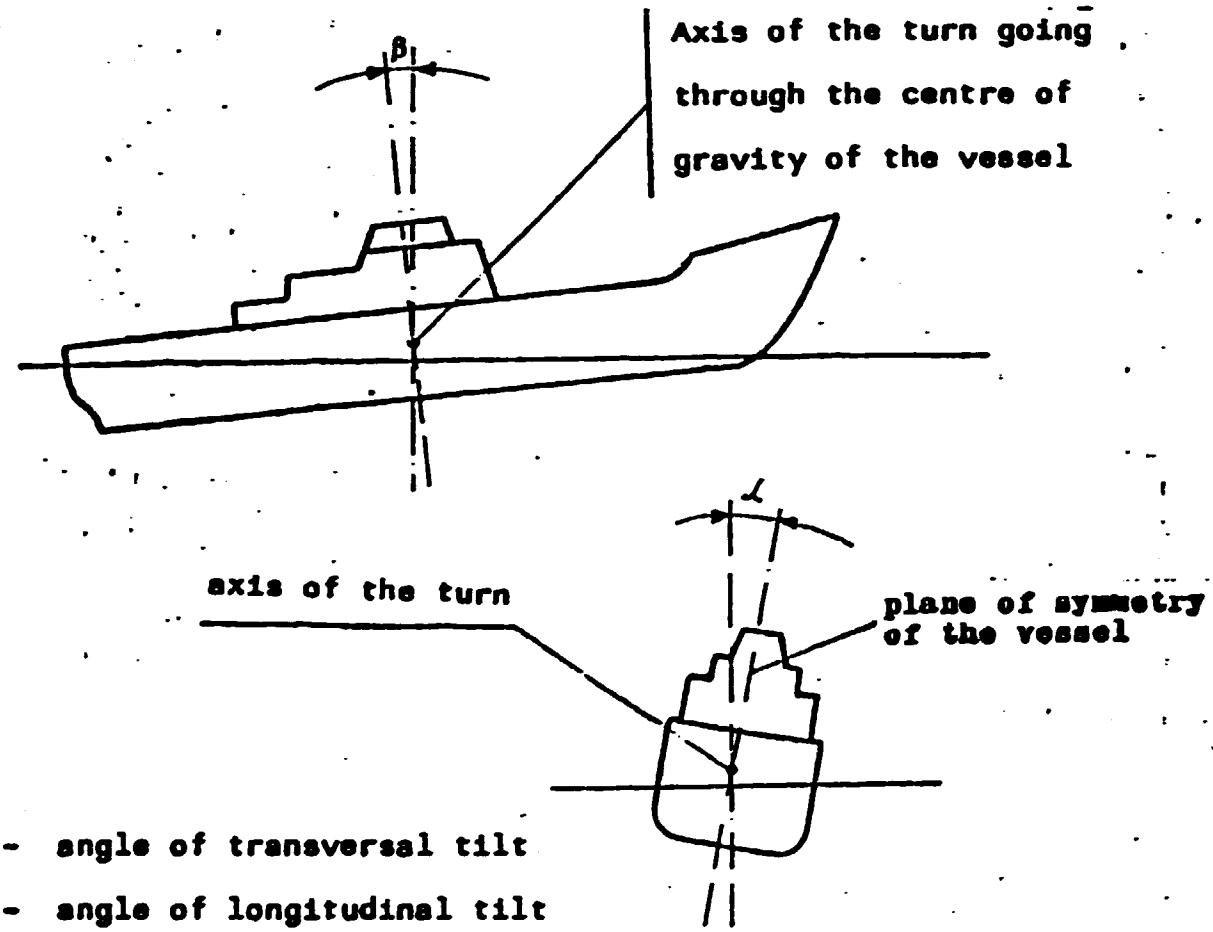


Fig. 3 Scheme showing the angles of transversal and longitudinal tilts of the vessel measured during the voyage

Annex 8

TRANSPORT PACKAGING STATIC STRESS RESISTANCE TESTING METHOD FOR STACKING TEST

Principle of method

Package ready to test put on flat horizontal surface should be loaded by predetermined load in required time.

At the beginning of test should be determined:

- value /great/ of load by which the package will be subjected to damage or by which it overcomes allowable value or when damage of packed product in kg appears,
- time during which load exerts on package in hours h,
- deadline of deformation in horizontal and vertical planes in mm.

Test can be conducted as an individual test or as a part of multi-test schedule.

Testing equipment

Should consist of horizontal base, set of weights /loads/ and load platform /plate/ with handles to hang the weights. Surface of the base should be equal and rigid. Difference between two points of the surface, the highest and the lowest ones should not overcome 2 mm.
The load platform should be sufficiently rigid and equal. Difference between two freely chosen points of load platform should not overcome 2 mm.

Edges of the load platform after placing the packages /samples/

for tests should protrude over the edges of these packages /samples/ not less than 100 mm.
The load plaform should have weights on it.fixed in such a way that the stress of compression forces influenced packages /samples is equally disseminated in order to secure the safe work during testing in case of deformation or damage of the packages /samples/.

Equipment for the measurement of deformation of package /sample/ should have accuracy of measurement amounting to +- 1 mm.
Number of packages /samples/ for testing should be taken according to the requirements determined in corresponding standards. If the standard does not determine numbers of samples or if the standard does not exist at all, then minimum 8 packages /samples/ should be taken for tests.

Conditioning

All packages /samples before testing should be conditioned according to ISO-2233 /or PN-74/O-79156/.
The packages /samples/ should be filled with proper product or tested empty /in case when proper /real/ product does not effect the rigidity of package/ and should be closed this way as it is used in reality /practically/.

It is allowable to use dummy product, but dummy product must be a real substitution for proper product, e.g. it should have the same propoerties as: weight, density, interaction with walls of package and others.

Performance of the test

Climatic conditions during the test should be the same as during conditioning of the packages /samples/.
The packages should be placed in proper attitute on flat horizontal base.

The load platform should be situated on teste packages this way that the center of gravity of the load platform should overlap with geometric centre of the top surface of packages /samples/.

Distribution of supplementary weights on load platform should be implemented very carefully and equally on all these parts of load platform which are in direct contact with packages /samples/.

Deviations in weight of load should not overcome 2 % of predetermined value of the load.

Distance between the center of gravity of load and lower plane of load platform should be not more than 50% of the height of the package /sample/. Time of test should be in accordance with corresponding standard conc. package or product. If in the standard time is not determined, so not less than 24 h should be applied or up to the damage of the package /sample/.

In the table 1 below there is given tentatively time of storage of transport packages in warehouse and in table 2 time of shipment of cargos in various modes of transport.

Table 1

Type of warehouse	Time of storage /24h/
Warehouse - railway road air	7
Warehouse in river port	15
Warehouse in sea port	30
Warehouse in net of trade	120

Table 2

Kind of transport	Time of transportation in days /24h/		
	country	continental	intercontinental
railway	8	16	25
car /road/	2	5	10
river	4	18	-
sea	-	5	60
air	0,1	0,4	1

The results of test

Assessment of package: Package is resistant to static stress if after testing it is not damaged, deformation /bigger than predetermined in the standard/ did not take place as well as product in the package is not damaged.

All packages subjected to testing should be resistant to stacking /static stress/.

If even one package does not withstand the test, it should be repeated once again.

If during the repeated test more than one packed /sample/ does not withstand the test, so the package should be assessed that it does not meet the requirements of conditions for transportation and storage.

The test report

The test report should include the following particulars:
a/ number of replicate packages /samples/ which have been tested,

b/ full description of the package, including dimensions, structural and material specifications of the package, its fittings, cushioning, blocking, closure or reinforcing

arrangements as well as reference to the standard on a basis of which the test has been conducted.

c/description of contents - if simulated or dummy contents were used, full details shall be given,

d/gross mass of package and net mass of contents in kilograms /kg/,

e/relative humidity, temperature and time of conditioning, temperature and relative humidity of the test area at the time of test as well as whether these values comply with the requirements of standards conc. conditioning,

f/the attitude in which the packages /samples/ were tested, according to the standard concerning identification of parts during testing /ISO-2206/,

g/mass/in kilograms / of total load, including mass of loading platform and the period of time during which the packages were under load,

h/location of deformation measuring points on package and stage of test at which measurement of deformation was made,

i/type of measurement facilities used,

j/record of the results, findings with all observations which may assist in correct interpretation,

k/date of testing.

Annex 9

TRANSPORT PACKAGES TESTING METHOD FOR COMPRESSION TEST /QUASISTATIC TEST/

Principle of method

The method determines resistance of package to hazards appearing during compression of package by rigid plates of compression tester up to the moment when damage occurs or predetermined value of load or linear deformation are attained.

Test can be conducted as an individual test or as a part of multi-test schedule to measure the ability of package to withstand a distribution system which includes a compression hazard.

In order to test resistance to compression following data should be determined:

- damage load in kg /N/ under exertion of which package /sample/ is damaged, looses its rigity or linear deformation of package overcomes predetermined value or packed products become damaged,
- relative damage load in $kg/m^2/N/m^2$ which is expressed by the ration of damage load to the surface or package /sample/, determined by outside dimensions,
- linear deformation of package in m/m, which is determined by magnitude of displacement of compression tester plate from the moment of applying of the load 20 kg /196N/,
- capability of package to withstand predetermined load without damage, loosing of rigidity or witnout overcoming predetermined linear deformation.

TESTING EQUIPMENT

Compression tester.

Usual testing equipment is compression tester which should be suitable to measure value of force with deviation not bigger than +- 2% of measured value and with a percentage of error not exceeding +- 2 % of load /compression force/ and accurancy of plates displacement +- 1 mm.

Other technical requirements for compression tester:

1. Compression tester should be suitable to compress load through uniform movement of one or both plates at a relative speed of 10^{+3} mm/min.
   Up to the moment of attaining 20 kg /196N/ it is possible to apply higher speed of plate movement but it should be not more than 80 mm/min.

2. Compression plates should be horizontal in the range from 2 to 2000 as well as flat and rigid. In time of testing the deformation of working surface of plates should not exceed +- 1 mm from geometrical flatness.

3. Compression tester should be equipped with facilities for measurement of deformations with accuracy not smaller than +-1mm as well as with recorder plotting diagram during the test implementation /loading deformation/.

4. Dimensions of plates should be so extended over the whole area of the package /sample/ with which they are in contact that the distance of the every point of the package from the edges of plates should be not less than 10 mm.

Samples

The samples of packages for testing should be taken in accordance with requirements determined in particular standards. If the standard does not determine the number of samples or if standard does not exist at all, then minimum 3 samples of packages should be taken for testing but it is advisable to take 5.

Conditioning

All packages /samples/ should be conditioned before testing according to ISO-2233 /or PN-74/O-79156/.

Performance of the test

The packages should be filled with proper product or tested empty /in case when proper real product does not effect rigidity of package /sample/ and closed in this way as it is used in reality.
It is allowable to use dummy product, but dummy product must be real substitution of proper product e.g. it should have the same properties as: weight, density, interaction with walls of package and others.

Climatic conditions during the test should be the same as during conditioning of packages /samples/.

It is permitted to test packages in climatic conditions different from conditioning, but the distance of time between the end of conditioning and the beginning of the test should be not more than 5 min.

The tested package should be situated between plates of compression tester in proper position - see Appendix 1.

In case of fibre board boxes testing /or similar in logic/ the manufacture joint should be always done from right side of the package /sample/.

The upper plate should be moving down and up to attain the load value of 20 kg /196 N/.

From this moment the deformation of package should be counted and the speed of upper plate moving down with velocity equal to 10 +- 3 mm per minute.

At this moment the recorder of the compression tester should be switched on.

If the recorder is not available, so without stopping the compression tester there should be made an observation of every 2 mm of deformation and after ending of tests the diagram should be plotted.

The test should be performed in order to obtain predetermined load of linear deformation.

The test should be given up, however, if the package is damaged, looses its rigidity or if such damage occurs that can effect the protection of the contents.
At this point, value of load should be also determined.

Each package should be tested only once.

The result of test

The resistance of package to damage load.

In order to determine damage load and relative damage load as a result of test we should take mathematical mean from all results of tests, but if the standard predicts the determination of character of results dispersion, so the value of "standard deviation" should be defined. This value is calculated according to the formula:

$$\sigma = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}}$$

Where:

X_1 result for each package

$\bar{X}$ mathematical mean of tests result

n number of packages tests

The result of testing should be considered as positive if values of mathematical mean characterizing resistance of tested package to the damage load is not smaller and value of standard deviation is not higher than the value predetermined in appropriate standard for the given package.

The resistance of package to predetermined load

The resistance of package to predetermined load should be considered as positive if number of packages which withstand testing is in accordance with the number of packages /samples/ predetermined in appropriate standard for the given package.

The test report

The results from the conducted tests should be described in a form of tests report which includes the following particulars:

a/ the number of packages /samples/ tested

b/ full description of the package including dimensions, structural and material specifications of the package, its fittings, cushionings, blocking, closures or reinforcing arrangements as well as reference to

the standards on a basis of which these tests have been conducted,

c/ description of contents - if simulated or dummy contents were used, full details should be given,

d/ gross weight of the package and net weight of the content in kilograms /kg/,

e/ relative humidity and temperature of the room, where tests were carried out,

f/ the position in which the packages /samples/ were tested, described according to the standard concerning identification of parts when tested /ISO-2206 or PN-74/O-79155/,

g/ distribution of measuring points on the package /sample/ and the method of measurement,

h/ type of measurement equipment with description of manner of working,

i/ record of results, findings with any observations which may assist in correct interpretation,

j/ date of testing.

Annex 10

DESIGN, PERFORMANCE AND TESTING OF WOODEN CASES.

Introduction :

Wood was one of the first structural materials used by man in primitive days and it continues to be used till today for various purposes.

The phenomenal expansion of industries after the World War II ever since, to result that the demand and consumption of timber rose to such heights that popular species of wood from many forests were almost spent up. due to some time unplanned deforestation.

It is obvious, that even proper aforestation alone, would not be able to meet the large and increasing demand of timber required for various purposes.

It must be supplemented by improved utilization to achieve economy of the material without sacrificing the functional aspect of the object made of timber. This is particularly important now, due to the permanent increase in demand, higher freight rates.

The first type of shipping container to be manufactured was from wood. Although nowadays, use of wood for packaging purposes has been lessened by the substitution of other more sophisticated materials, (as for example plastics) it still has an important place in industrial packaging for heavy or fragile item which require rigidity and strength.

Packaging consumes upto 20 % of the timber in the form of cases, crates, plywood, hardboard, fibreboard, and papers.

Now it is proposed to discuss various facts that would govern the construction of a wooden and wood derived containers for all kinds of commodities, but general guidelines are given which would be helpful in designing a functional container for a particular requirement.

Some of the Turkish Standard specifications of wooden and derived containers as well as materials are given below :

TS 51 Coniferous saw timber

TS 820 Oak lumber

TS 801 Beech lumber

TS 1249 Lumber of Black Poplar

TS 3635 Fibre Buildingboard- definitions

TS 46 Plywood- Veneer plywood with rotary cut, veneer, for General Use

TS 1465 Wood - for packing materials

TS 1891 Wood Packages, terms, definition.

TS 1508 Vocabulary of terms relating to pallets

TS 343 Wood preservation (terms and definition)

TS 344 Basic rules for wood preservation

TS 1351 Wood for producing fibre chip and wood wool

TS 1250 Sliced veneer

TS 305 Wood Wool slabs

TS 1142 Steel stripping for package.

2. Materials :

Wood is a structural material developed by nature to support the foliage and fruit of the tree, and it is remarkable strong to compare with its weight. Being a natural material it is not very uniform in its physical characteristics, however and it becomes necessary to select and treat it in a manner that will make it useful as a packaging material. Some types of wood are better than others even the growing conditions of a particular tree will have an effect its own strength and other properties.
Fortunately, by selecting the proper variety sorting it for knots hard and soft rottenness and other defects. Drying it carefully and laminating it to make plywood or chipping with physico-chemical treatment to make hardboard we are able to get a fairly uniform material for our purpose. There are hundreds species of trees of which about 100 are commercially useful, but only about 10 are really important, as for example : pine, spruce, fir, poplar, alder, willow, birch, cedar, beech, elm, oak, hornbeam.
Wood varies in density from 0.32 to 1.15 the heavier woods above 0.55 density are stronger and have greater nail-holding power, but they are harder to work and have greater tendency to split and shrink. It should be remembered that wood is about 5 times as strong with the grain as it is across the grain.

Moisture of Wood :

The fresh cutting trees contain a large amount of water, the coniferous 40-170 % and the deciduous 35-130 % in relation to dry mass of wood.
Since the properties of wood depend so much on the amount of moisture it contains. It is necessary to know the exact moisture content of a particular part of the timber before it will be subjected to performance in practice.

There are several ways of determining the moisture content of wood for practical purpose the most useful are the electrical moisture meters.

With roughly speaking , there are water in wood in three forms.

- as a water chemically connected
- as a water physically connected
- as a water free water.

When timber starts drying, the " free water" evaporates but the cell walls including those of wood fibres are yet saturated with water. This point is called "Fibre Saturation Point", and is in accordance with about 30 % of water.

After further drying natural or artificial wood becomes more dry. By 15 to 20 % of moisture, wood is so called " Air Dry Wood", it depends on the climatic conditions.

Wood from its structure is hygroscopic. That is, it absorbs moisture from humid or damp atmosphere.It also loses water when the atmosphere is dry. In other words there is a permanent transfer of water between wood and surrounding air. But in some constant atmospheric condition equilibrium occurs between wood and ambient air, this point is called " hygroscopic equilibrium point" and to attain usually level 15 to 20 % moisture of wood.

In this condition the wood has the best nail-holding power. It should be stressed that wooden boxes nailing at high moisture content for example at 30 % of moisture after dried during storage in atmospheric conditions lose at least 75 % of their resistance to handling. It should be remembered also that the weight of the green wood especially of soft wood like poplar, alder, willow is 40 % higher than the same dried wood.

It is very important that wood has very good shock and compression strength resistance and overall toughness. Generally speaking the wood has very good resistant to mechanical hazards occuring during transportation, loading and handling in all distribution system independing practically of climatic conditions.
For this reason wood is especially predestinate for packaging purpose.

Principle of Designing :

The best timber of which should be manufactured the wooden boxes and crates should have about 15 % moisture : it should not have knots larger than one third the width of the board and should not have any knots at all in nailing area and on the edges.
There are various methods of constructing a nailed wooden boxes and crates depending upon the type of service required.
One of the essential problem in constructing a nailed wooden boxes and crates is proper joint of the particular clats - batten or boards in order to form main elements of boxes or cases.
Let's consider some of the typical joint (see appendix 1)

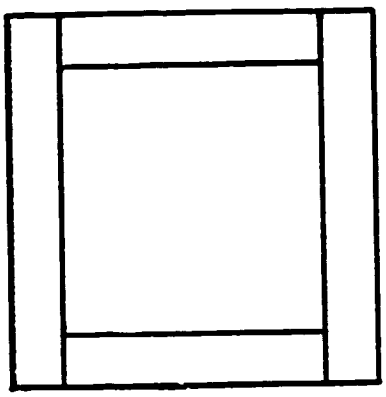
a) Butt joint
b) Ship lap or rabbet joint
c) Tongue and groove joint
d) Linderman joint (dovetail)
e) Comb joint

The main elements of boxes or crates are bottom and heads. Generally people realize essential task of the bottom of the packages and strengthen it by the cross battens or skids. But proper constructions of heads are often forgotten that we remind.

If we assume that costruction of the frame (see Fig. 1) Type 1 will have 100 any unit of strength.

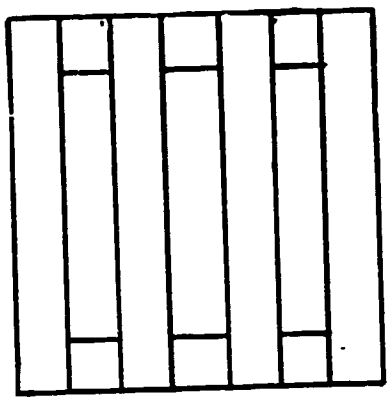
Fig 1

Type 1

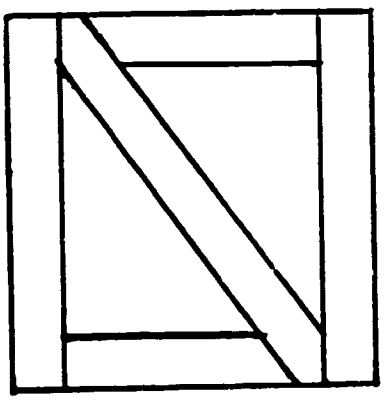


100

Type 2

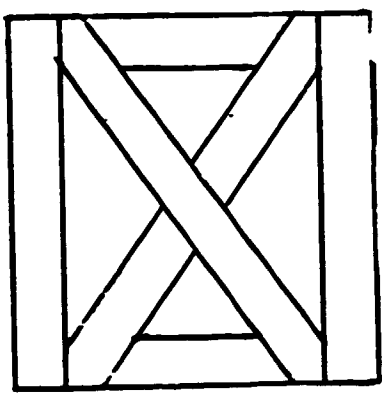


110



600

Type 3



1200

Type 4

Very important place of any boxes, cases, or crates is joint of head, top and side, because that place is a very often subjected to mechanical hazards during reloading, handling in time of transportation.

The best construction system of joint in that place is so-called "three way corner". A typical example of them are shown in Fig. 3.

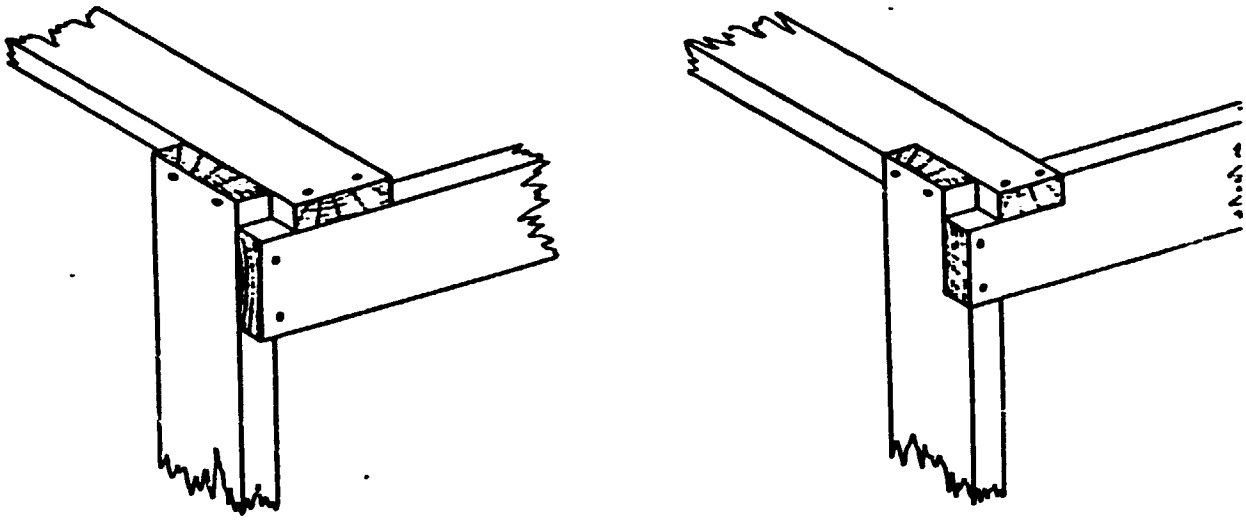


Fig. 3

The three way corner joint is very strong because every nail goes into side grain and each member is locked in by the other two members so that the nails are not likely to work loose.

Wooden boxes and cases :

Wooden boxes depend on its destination for packaging products of different weight. (See App. 2)

It can be classified in four groups:

I - up to 150 kg

II- from 151 kg to 1000 kg

III- from 1001 kg to 20000 kg

IV- above 20,000 kg

The first group consists of five construction form of wooden boxes. All of them are nailing excluding one which is glueing and nailing this form has got horizantal edges joint by "Lindeman" methods (dovetail joint) or comb joint.

The basic requirement told that minimum thickness of elements of each crate main elements should not be less than 9 mm. But depend of gross weight of the cargo and kinds of the product a thickness of the elements for sides, top and bottom should be calculated on basic of formula.

$$m=K\sqrt{\frac{G}{b}} \qquad (\text{No. 1})$$

where, m - thickness of elements for all elements, mm

G - gross weight of the box, kg

b - sum of wideness of all elements consist one element, mm

K - coefficient depends on kinds of product to be packed.

Value of coefficient K :

a) 25 -for a product cooperate with box, is not sensitive to shocks (soap)

b) 35 -for a product do not cooperate with box, sensitive on shocks, simply become damaged, (glass jar)

c) 30 -for a product average between a and b.

e.g. product packed in individual fibreboard boxes.

Thickness of elements of sides, top,and bottom can be less than in calculated on a basic of formula if we use steel bands,

about 25 % in case of one band

about 40 % in case of two bands

The bands should be placed on one fifth to one sixth the length of the box from the end. Outside elements of the boxes should have smooth surfaces. The thickness of the nails should be wellmatched to the thickness of the elements in order to avoid the cracks of the elements.

Thickness of head elements of the boxes should always be minimum, 1.5 to 2.5 times as thick as thickness of side elements.

The second group consists of seven construction forms of wooden cases (see app. 3).

All of them are nailed and strengthened by steel bands, all boards of basic elements together with ship lap.

This group of wooden cases for seven construction forms are made dependent of kinds and weight of the products. Table 1.

Construction Form	Weight of package contents in kg	Characteristics of Packaged Product
Form I	151-200	Many pieces products, not regular shapes, is not fastened to the elements of the cases.
Form II	151-250	Many pieces products of regular shapes, is not fastened to the elements of the cases.
Form III	250-400	Many pieces as well as one piece products, not regular shapes fastened to elements of cases.

Construction Form	Weight of package contents in kg	Characteristics of Packaged Product
Form IV	151-500	One or many pieces product, fastened to the elements of cases.
Form V	501-1000	One or many pieces product, not regular shapes, fastened to the elements of the cases.
Form VI	501-800	One or many pieces product of regular shapes, fastened to the elements of the cases.
Form VII	501-1000	Very long products, fastened to the elements of the cases.

Thickness of sheathed boards for sides, top, and bottom of case should be calculated on a basis of formula,

$$m = N\sqrt{\frac{G \cdot L}{H}} \qquad (\text{No. } 2)$$

where, m - thickness of sheathed board, mm

G - weight of products, kg

L - internal length of cases, mm

H - internal height of cases, mm

N - coefficient depend on construction form of case

N=1 , for the cases form I,II,III, and IV

N=0.71, for the cases form V,VI, and VII

The width of the sheathed board in all elements including board by edges should not be less than 70 mm, but board by edges should not be less than 100 mm.

The width of skids should be calculated on a basis of formula,

$$b_s = 1.25 \frac{G \cdot l_s}{m_s^2 \cdot n} \qquad (\text{No. } 3)$$

where, b_s - width of skid , mm

G - weight of products, kg

l_s - length of skid , mm

m_s - thickness (height) of skid , mm

n - number of skids

Thickness of skid should be 0.8 ÷ 1.0 of width of the skid .

The third group of cases for weight of product over 1001 kg up to 20,000 kg is characterized on a basis of different design of each main element.

The most important element for heavy cases is always bottom, because the heavy product must be fixed to the bottom by screws or other durable ways.

The bottom of this type of case should always have two skids at least. The distance between two neighboured skids should not be more than 1200 mm. Each of skids should has sliding batten and end of a skid should be cut off under 45° angle to the bottom. The width of sliding batten should not be less than 0.5 of skid width, but thickness not less than 38 mm. The skids should be connected by the joints, number of joints depends on the dimension of the case and predicted place and ways of fastenning of the product.

Joint of the bottom should be connected with the skids by screws, whose diameters should be selected according to table 2.

Table-2

Max. weight of case content, kg	Number of joints			
	2	3-4	5-6	6
	Min. diameter of screws in mm			
3,000	12	12	10	10
5,000	16	12	12	10
10,000	20	16	12	12
15,000	-	20	16	14
18,000	-	24	20	16

Calculation of Dimension of Cross-section of Particular Parts of Construction Elements of Cases :

General Consideration :

For calculation cross sections of particular parts of elements of cases should be taken allowable stress K_a in accordance with table-3. It was determined for pine wood at 15 % moisture and taken into account safety coefficient at value 5,25.

Table-3

Type of Stress Indication, K_a	By bending across fibres , K_c	By compressing along fibres, K_c
Great of stress, MPa	15.0	8.5

In case of using other kind of species than pine as well as depends on the type of transportation value of allowable stress K_a should be calculated in MPa in accordance with formula given below,

$$K'_a = K_a \cdot \alpha_1 \cdot \alpha_2$$

where : α - coefficient depends on kind of species
α_2 - coefficient depends on type of transportation
α_2 - 1.0 for surface, river and air transportation
α - 0.85 for sea transportation
α_1 - 1 for pine
for common α_1 - 0.6 $\pm$ 1.3 for common use species

The cross-section of skid :

The width of skid b_1 should be calculated on a basis of formula,

$$b_1 = 0.68 \frac{Q \; L}{n \; K_b \; h_1^2} \qquad (\text{No. } 4)$$

where , Q - weight of content of the case,N

L - internal length of case , mm

n - number of skids

K_b - admissible bending stress,MPa, Table-3

h_1 - established thickness of skid, mm

The thickness of sheathed boards of cases are shown in Table-4.

Table-4

Weight (mass) of contents of cases,kg	Min. thickness of sheathed boards depend on transportations in mm	
	Surface	Sea
below 5,000	18	21
above 5,000	21	24

Above illustrated values are determined by assumption that product is fixed upto joint of bottom or skids.

The thickness of joint h_2 in mm should be calculated :

a) In case two skids of bottom on formula

$$h_2 = \sqrt{\frac{3P\,(S-C)}{2b_2\,K_b}} \qquad (\text{No. } 5)$$

b) In case three or more skids of bottom on formula

$$h_2 = \sqrt[3]{\frac{P\,S}{2b_2\,K_b}} \qquad (\text{No. } 6)$$

where : P - Parts of force exerts on one joint, N

S - internal width of cases , mm

C - distance between points of fixed up the products to the joint, mm

b_2 - established width of joint,mm

K_b - admissible bending stress, MPa.

In case unequal distribution of load for calculation should be assumed the highest value of force exerts on one joint at the bottom The width of vertical beam of frame of sides of cases b_3 in mm should be calculated according to the formula.

$$b_3 = \frac{P_1}{K_c h_3 \beta} \quad \text{(No. 7)}$$

A value of force P_1 depends on internal height of case,H should be determined.

a) for H < 1,000 mm according to $P_1 = \frac{0.04\ L\ S}{3n-4}$ (No. 8)

b) for 1,000 < H < 1,500 mm according to $P_1 = \frac{0.035\ L\ S}{3n-4}$ (No. 9)

c) for H > 1,500 mm according to $P_1 = \frac{0.03\ L\ S}{3n-4}$ (No. 10)

where : P_1 - force exerts on vertical beam of side,N

K_c - admissible compression stress by compressing along fibres, MPa

h_3 - thickness of vertical beam , mm

β - coefficient of lateral bending which figural value depends on slenderness of beam($\acute{s}$) is given in Table-5.

H - internal height of cases, mm

L - internal length of cases, mm

S - internal width of cases,mm

n - number of verticah beam in one side of case.

Slenderness of beam($\acute{s}$) should be calculated according to formula

$$\acute{s} = \frac{H.2\sqrt{3}}{h_3} \quad \text{(indication as above)} \quad \text{(No. 11)}$$

Table-5

ś	β	ś	β	ś	β	ś	β
5	1.00	55	0.75[illegible]	105	0.281	155	0.129
10	0.99	60	0.712	110	0.256	160	0.121
15	0.98	65	0.662	115	0.234	165	0.114
20	0.97	70	0.608	120	0.215	170	0.107
25	0.95	75	0.550	125	0.198	175	0.101
30	0.93	80	0.484	130	0.183	180	0.096
35	0.90	85	0.429	135	0.170	185	0.091
40	0.87	90	0.[illegible]65	140	0.158	190	0.086
45	0.84	95	0.343	145	0.147	195	0.082
50	0.80	100	0.310	150	0.138	200	0.077

Intermediate value should be linear interpolated.

The cross-section dimensions of horizantal beams of sides as well all beam of frame of heads as top of case, should be taken the same as cross-section of vertical beams of frame of sides calculated according to the formula for b_3.

Wooden Crates for Product of Weight up to 1,000 kg :

The most important thing for designing wooden crates is to be aquanted with basic principles of crate construction as a whole what it was about at the begining.

The wooden crates depend on construction could be **classified into nine** construction forms as it was illustrated on figure 2-10 (see appendix 4) and Table 6.

Table-6

Symbol of Constr. Form	Construction of Crates	Applications	
		Weight of Package Content, kg	Characteristics of Packaged products
1	2	3	4
I	Acc. fig.2; set up from individual batten; relation between the biggest and the smallest internal dimension of the crates should be as 1÷1.5. Three way corner.	upto 80	One piece products regular shapes is fastened to the elements of crates
II	Acc. fig.3; set up from individual batten; difference with form I, batten in the middle position are parallel situated to the extreme batten. Three way corner.	upto 80	as form I
III	Acc. fig.4; set up from elements performed in shapes of frame; three way corner.	up to 100	as form I
IV	Acc. fig.5; as form III,but each one of frame elements is strengthened by one cross batten in the middle,three way corner.	up to 150	as form I
V	Acc. fig.6; as form III but each of frame elements is strengthened by two cross battens in the middle,three way corner.	from 100 upto 300	as form I
VI	Acc.fig.7; each one of elements is strengthened by one cross batten on the both sides,bottom and top of crate are strengthened by two girthing battens, relation between the biggest and the smallest internal dimension of the crates should be 1÷ 2.5 .	upto 200	one or many piece products,with possibility to fastening to the bottom of crate.

1	2	3	4
VII	Acc. fig.8; A crate is set up from elements : heads - performed as in form V. sides - all stringer batten are situated from outside of the element joint and cross batten from inside.Gap between two joints not more than 800 mm.top and bottom - all joint battens are situated from outside of the crate,stringer from inside; Gap between stringer batten of sides, top and bottom not more than 1÷ 3 of width of the batten,between joint batten of top and bottom not more than 2÷4 of width of the batten.	150-500	one or many piece products with lengthen shapes
VIII	Acc.fig.9; A crate is set up from elements : heads - all joint battens are situated from outside of the crate,stringer and cross batten from inside.sides and top - as in form VII. bottom - full sheated by board in length and a basis of three skids in width , distance between two skids not more than 800 mm. Gap between batten (board) of each elements not more than 1÷3 of width of the batten (board), outside of the crate and 2-4 inside of the crate.	500-800	one or many piece products fastened to the bottom of the crate
IX	Acc.fig. 10; A crate is set up from elements : heads - all stringer board are situated from outside of the crate joint and cross board from inside of the crate. sides - all joint board situated from outside of the crate, stringer and cross board from inside. top - all stringer boards are situated from outside of the crate joint board from inside. bottom - full sheated by board in width on a basis of two skids in length, distance between two skids not more than 1,000 mm. Gap between board of each elements not more than : -1-3 of width of the board outside of the crate (heads,sides,top), - 2-4 inside of the crate (top).	500-1000	one or many piece products with lengthen shapes fastened to the bottom of the crate

Thickness of the batten (board) of the crate should be the same (equal) for all elements of the crate and calculated according to the formula but not less than 16 mm.

$$m = K\sqrt{\frac{G.p}{r}} \qquad (\text{No.5})$$

where, m - thickness of batten (board) , mm.

K - coefficient depends on construction form of the crate and kind of transport acc. table-7.

G - weight (mass) of contents, Kg

p - the biggest dimension of the crate, mm.

r - the smallest dimension of the crate, mm.

Table-7

Construction form of the crates	Common Transport	Container Transport (home-home
	Value of coefficient, K	
I	2.0	1.7
II	2.0	1.7
III	1.8	1.5
IV	1.5	1.2
V	1.2	0.9
VI	1.0	0.8
VII	0.6	0.5
VIII	0.5	0.4
IX	0.5	0.4

Thickness of the boards of the bottom of the crate should not be less than 19 mm. Dimensions of the cross section of the skids should be counted according to the formula on page 12 .

e.g.

$$b_1 = 0.68 \frac{G \ L}{n \ K_b \ h_1} 2 \qquad (\text{No.4})$$

Performance :

All elements of the crate can have karf surfaces and should be joint by nailing. All joining nails should be banded and hammered to the wood again. (nails-see App. 5)

Evaluation of performance of wooden containers :

Purpose of Testing :

It must always be remembered that the proof of any package lies in its performance in the field for which it was designed over a relatively long period of time,only in this way a package can be evaluated.

Why test ?

There are three major reasons for doing tests on packages :

1- To predict performance in practice

2- To control quality

3- To obtain information to modify, improve or reduce the cost of the package.

But the first reason is the most important and affects the other two.

In order to predict performance a measure of corelation is needed between the tests carried out in the laboratory and the behavior of the package in practice.

Three corelations are required.

First , between the field performance of the package and laboratory transport test.

Second, between the laboratory transport test on the filled package and test on the empty package.

Third, between the strength and other properties of the various materials used in making the package and the tests on the empty container.

All these are required in order to obtain information about the pack's strengths and weaknesses when subjected to specific hazards.

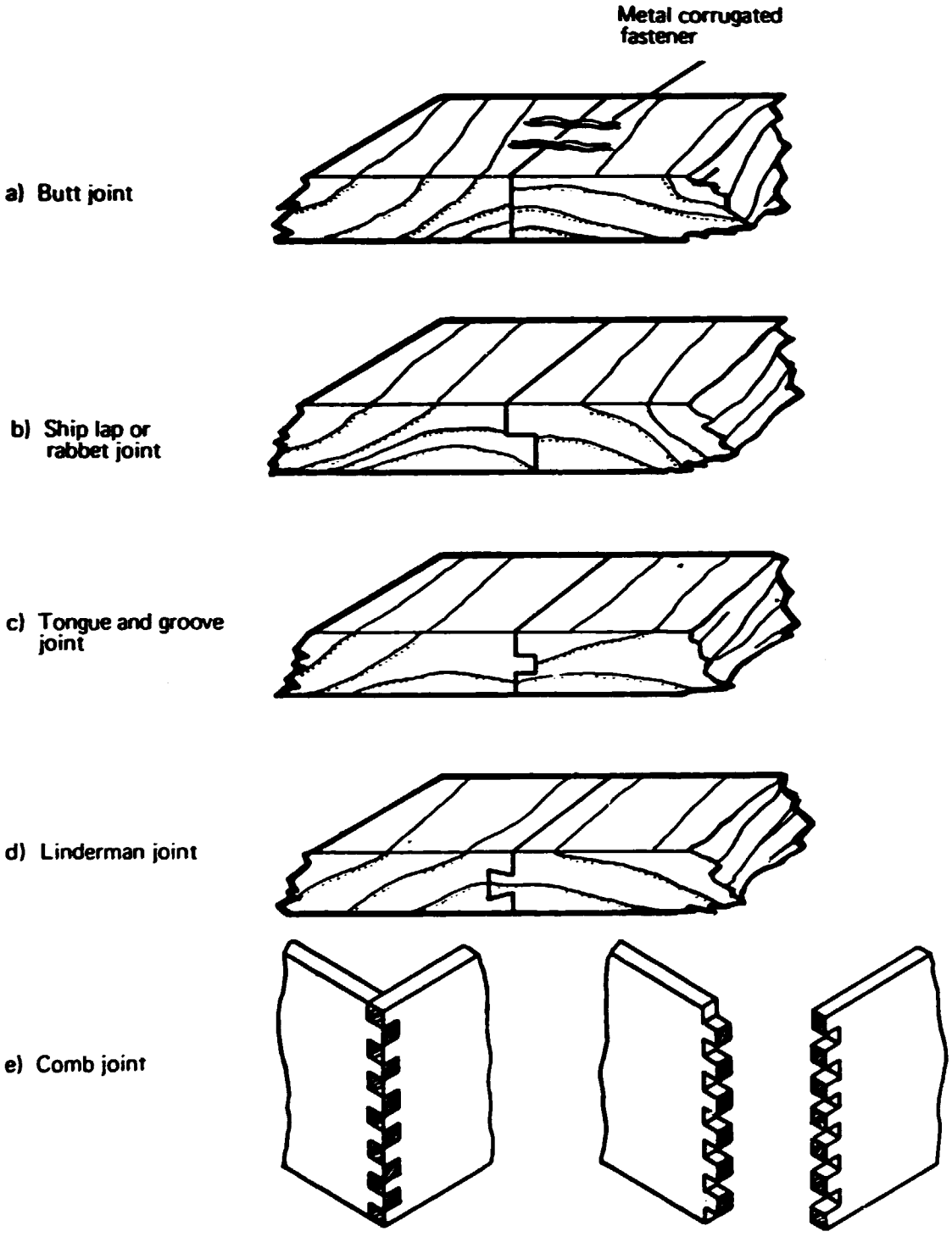
How to test ?

On a basis of many years experiences in the field and laboratory Polish Packaging Research and Development Centre elaborated tests (among others) for wooden containers.They test wooden containers according to the basic standards,
PN-70/O-79100 for containers with gross weight upto 150 kg,
PN-84/O-79101 for containers with gross weight above 150 kg.
The first standard PN-70/O-79100 foreseen individual test schedule as well as multi test schedule (simulating hazards occur in distribution system of cargoes) on a basis of main test concerning with mechanical hazards as :

- drop test	-ISO 2248	
- drum test	-ISO 2876	ASTM D 782-82
- inclined plane test	-ISO 2244	
- compression test	-ISO 2872 ISO 2234	
- vibration test	-ISO 2247	

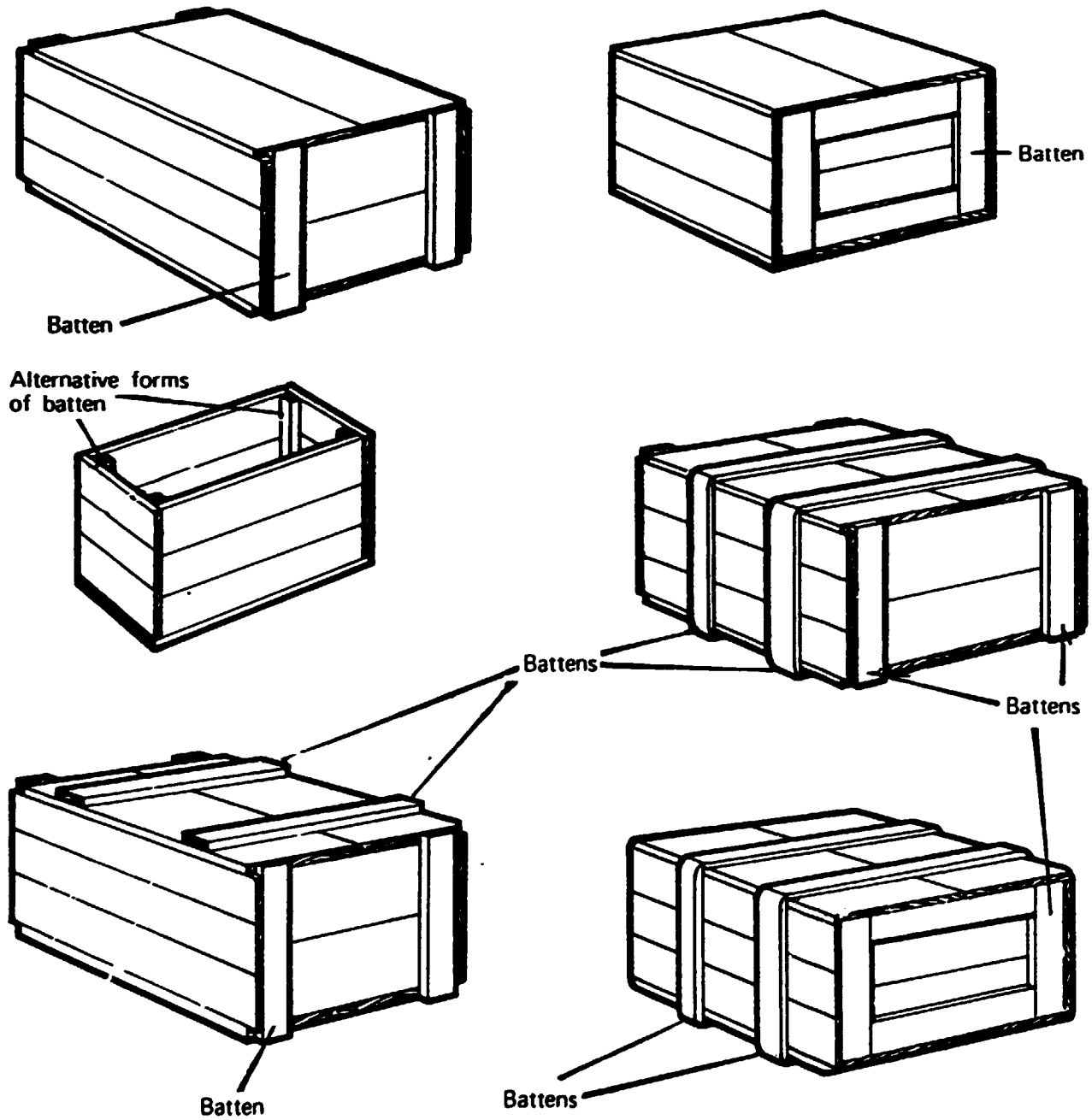
The second standard PN-84/O-79101 on a basis of practical experiences concentrated on a mechanical hazards occur in case of :
- drop tests and
-tests on resistance of package against pressure force exerted by strops during reloading.

Fig. Types of glued joints used in fabricating "one-piece" parts Appendix I



Appendix 2

Fig. Typical examples of batten and board construction



Appendix 3

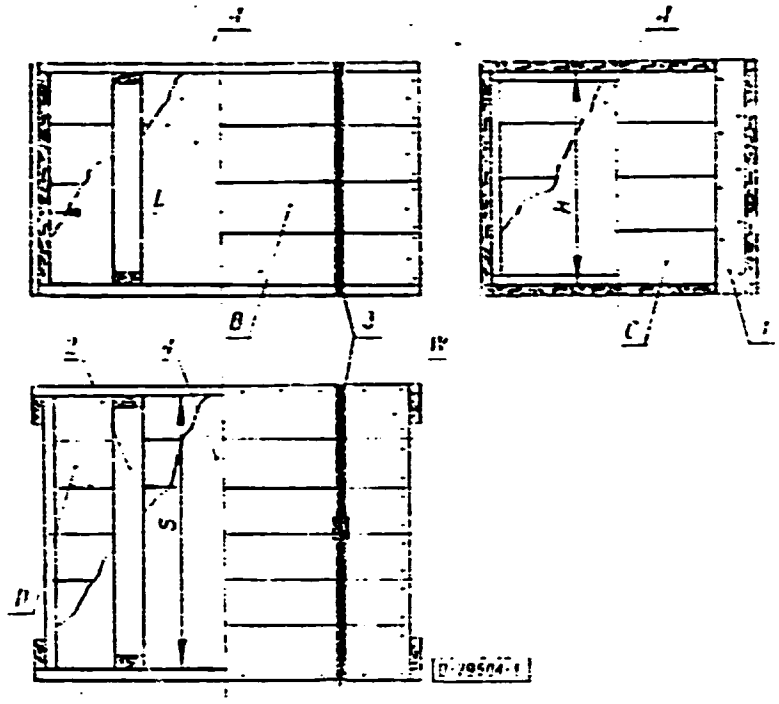
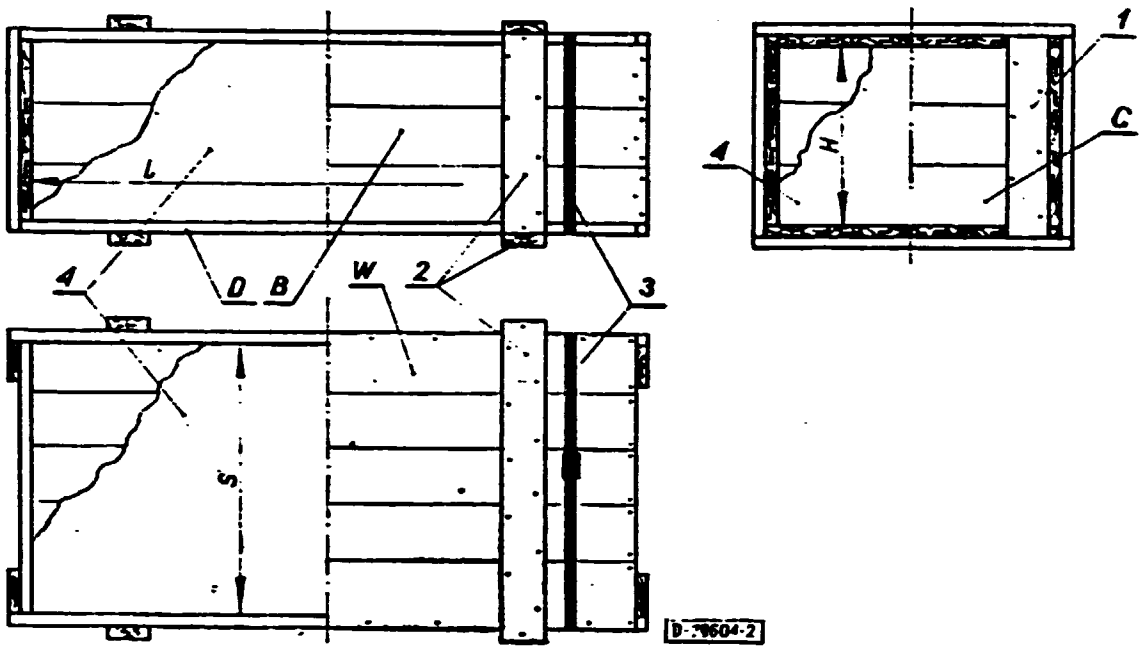
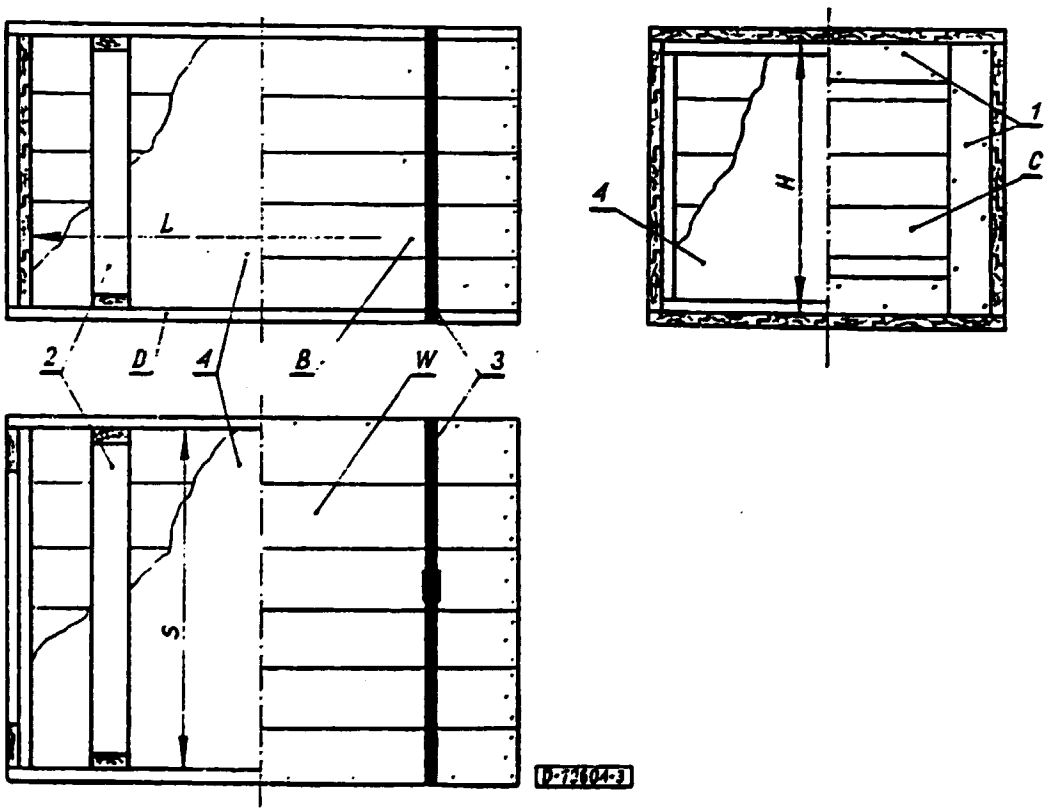


Рис. 1



Rys. 2



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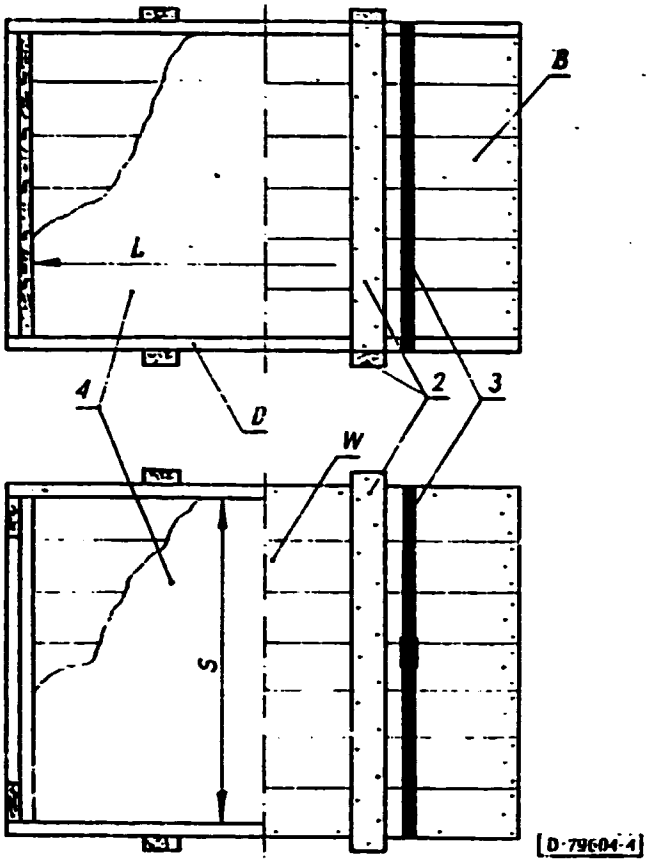

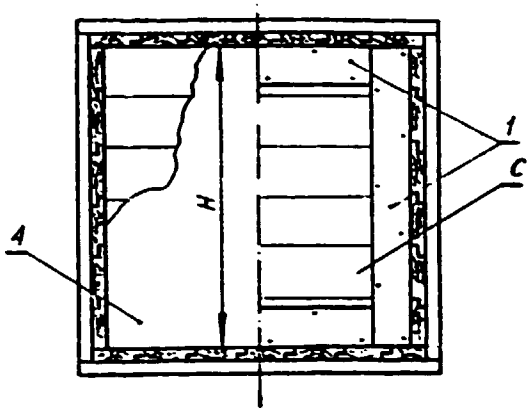

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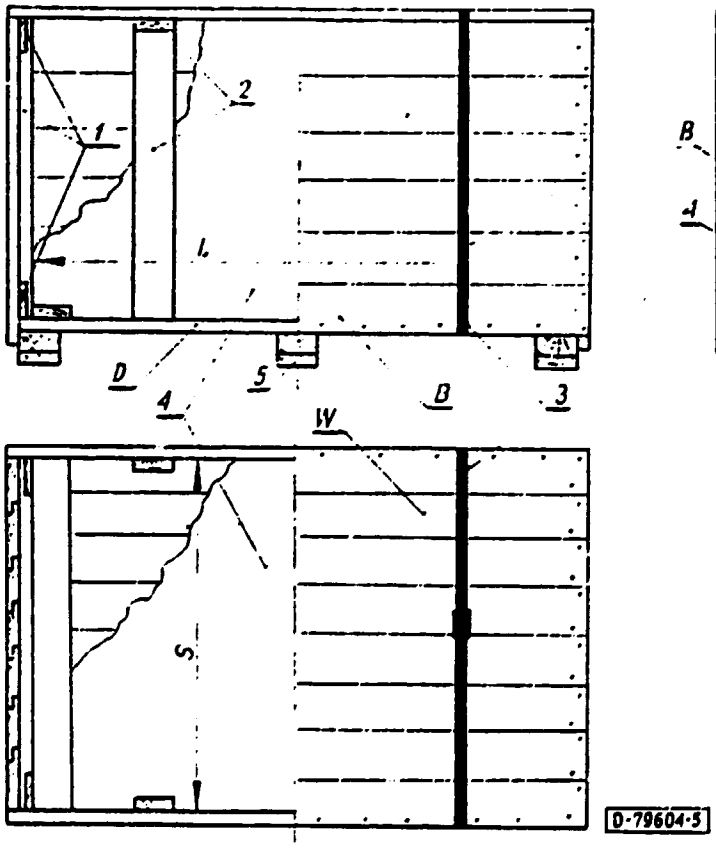

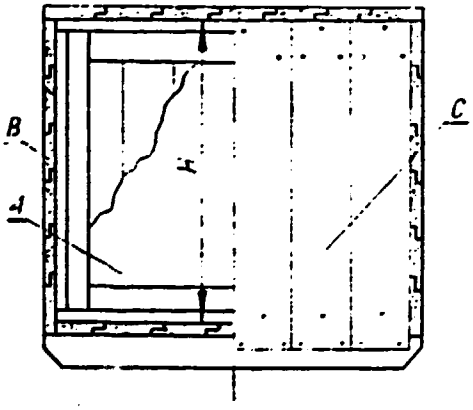

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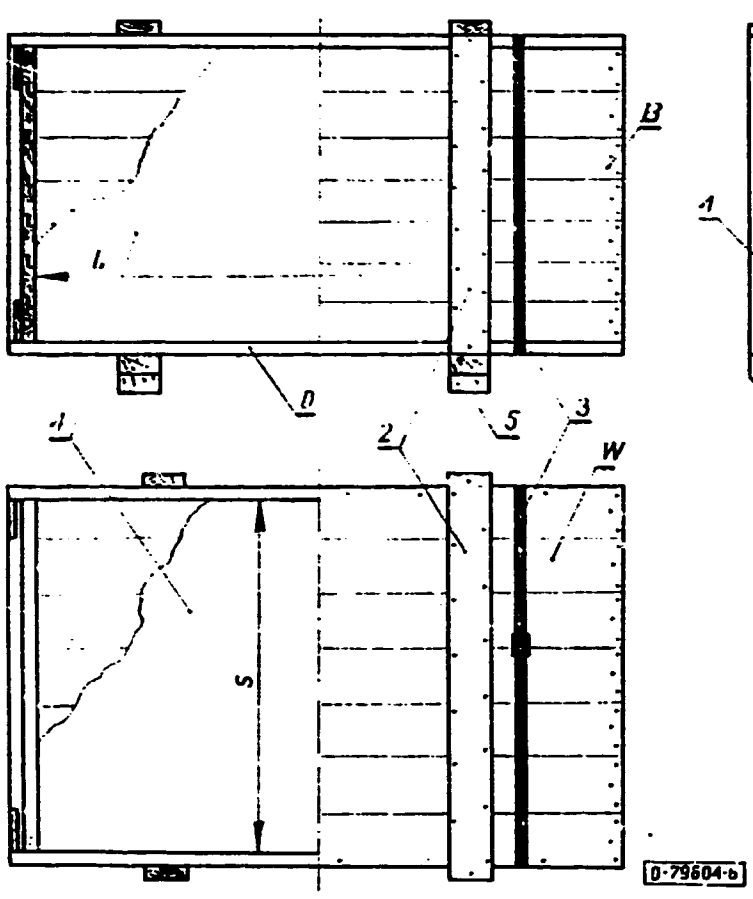

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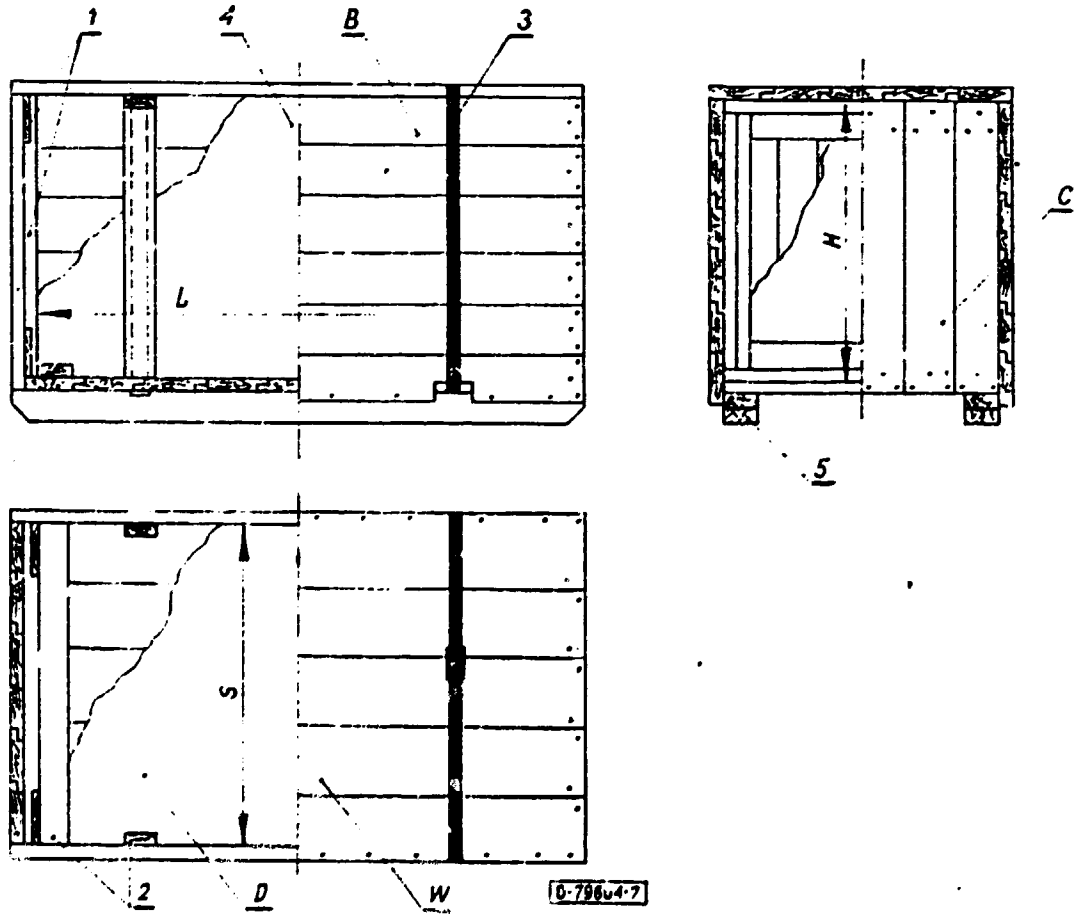
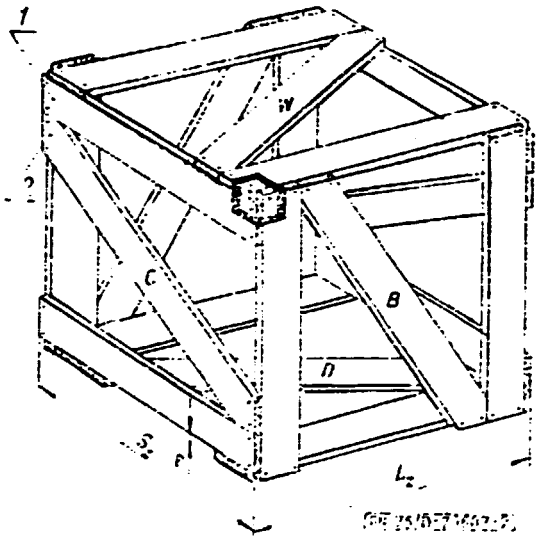


Rys. 7

Appendix 4



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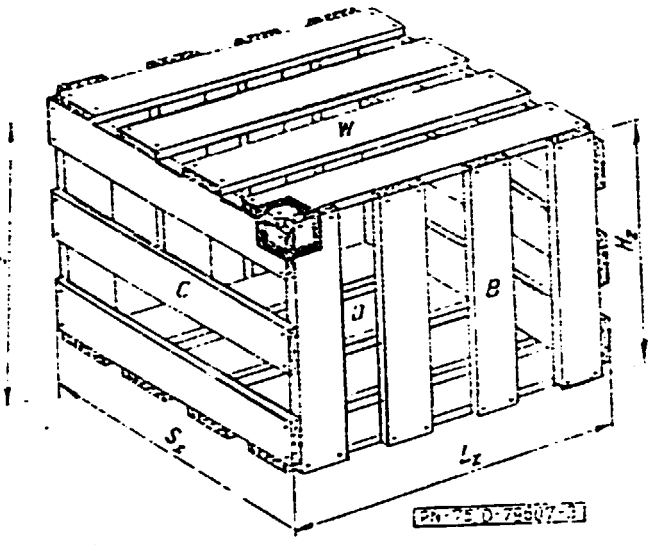

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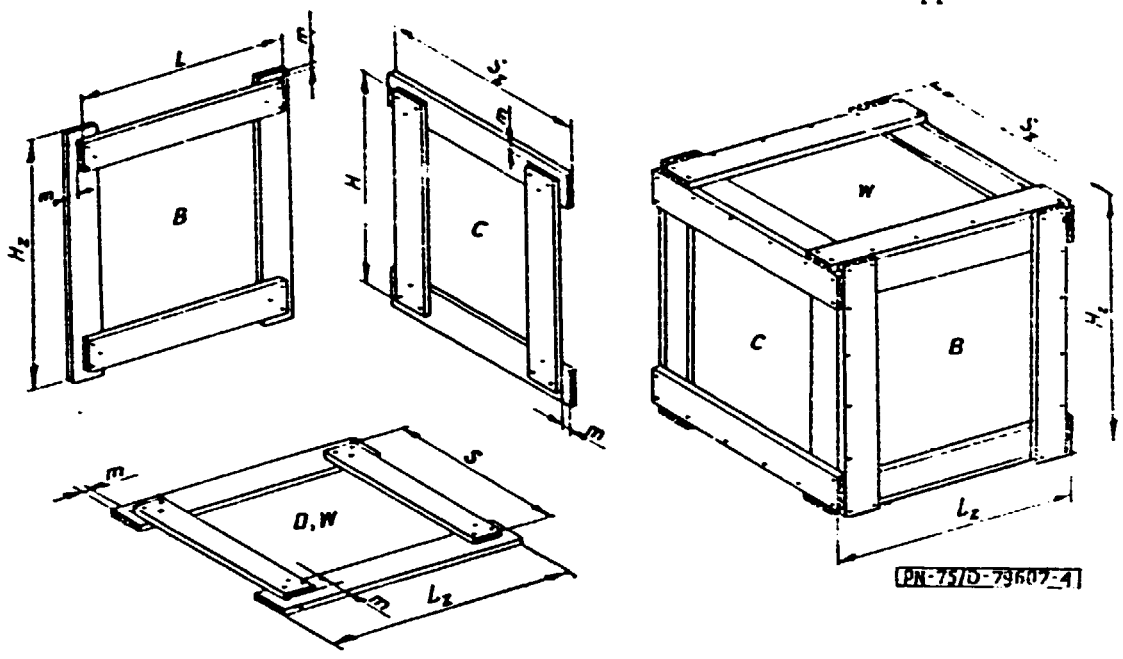

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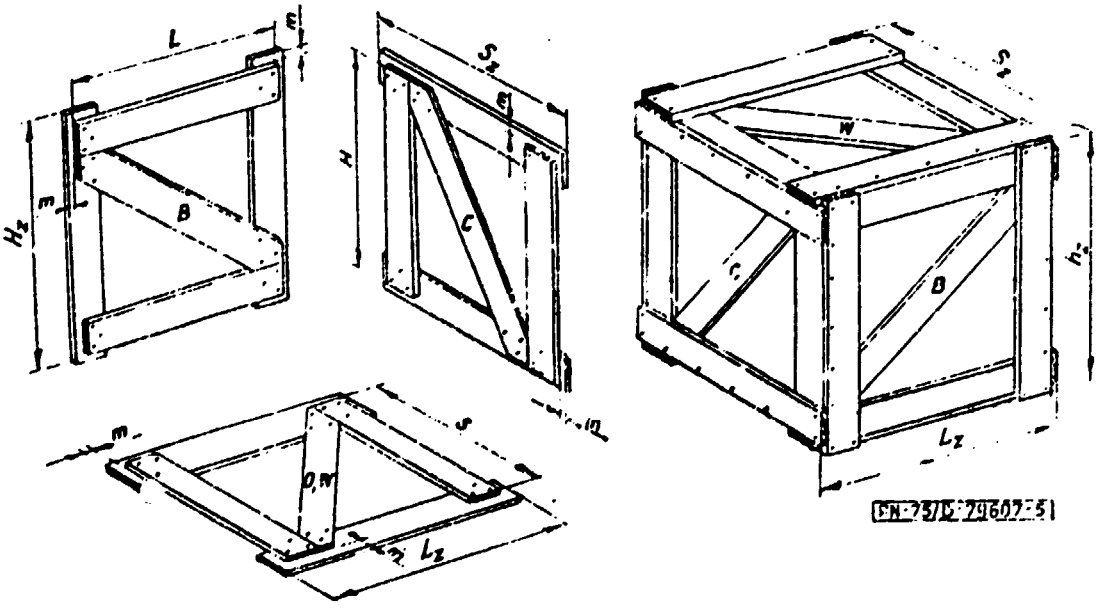

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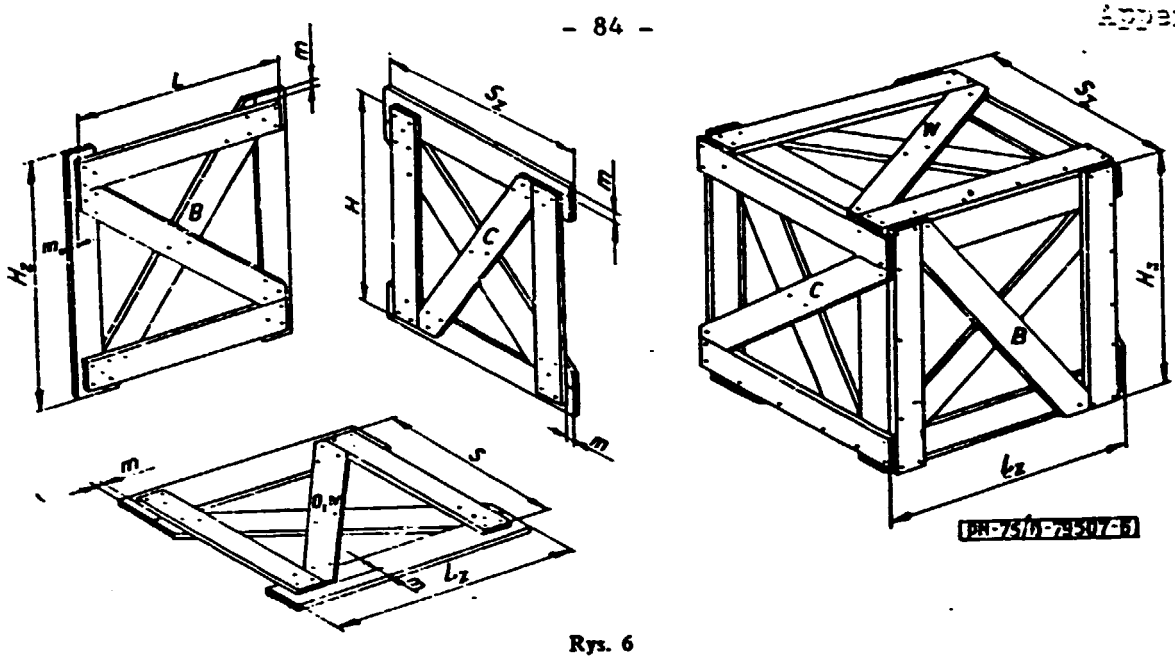

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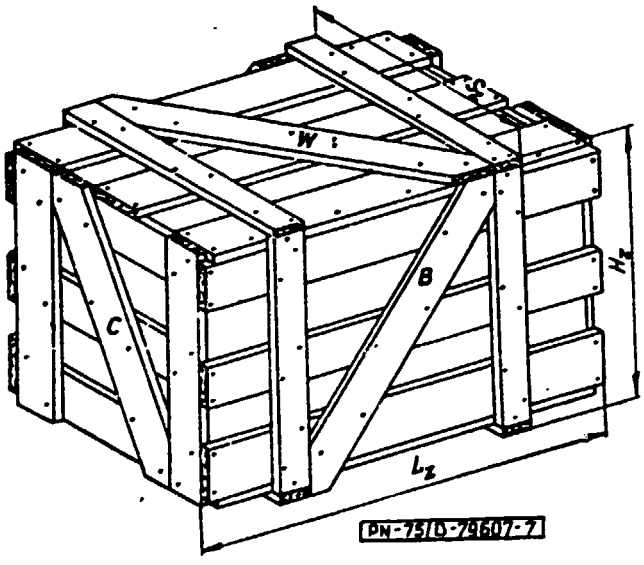

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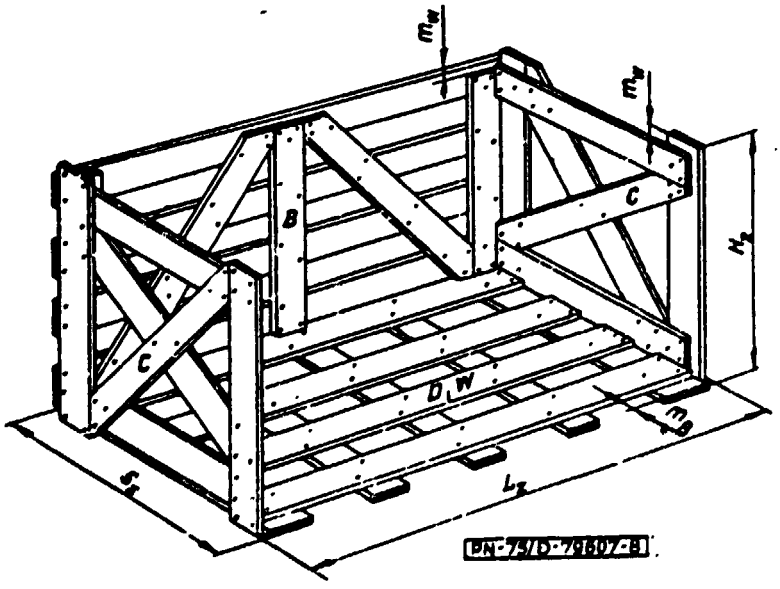

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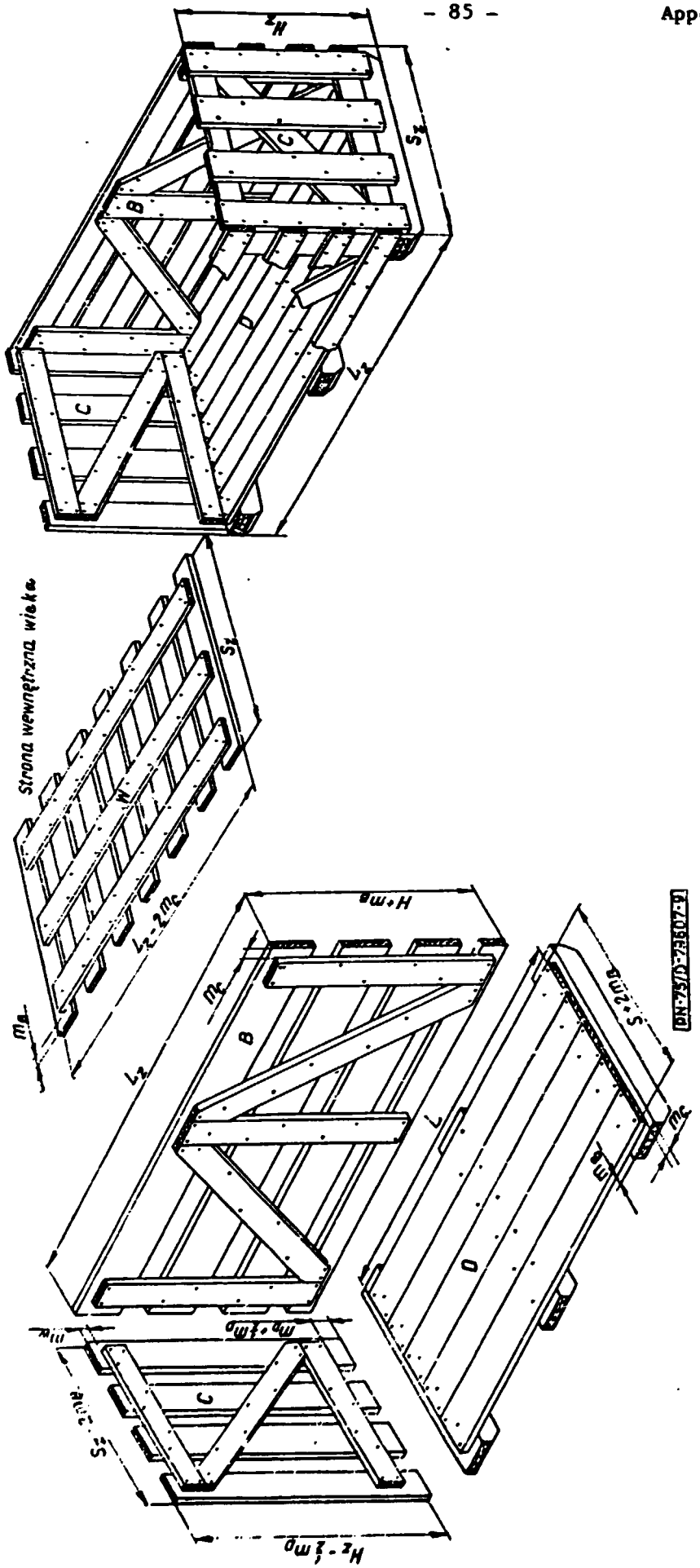

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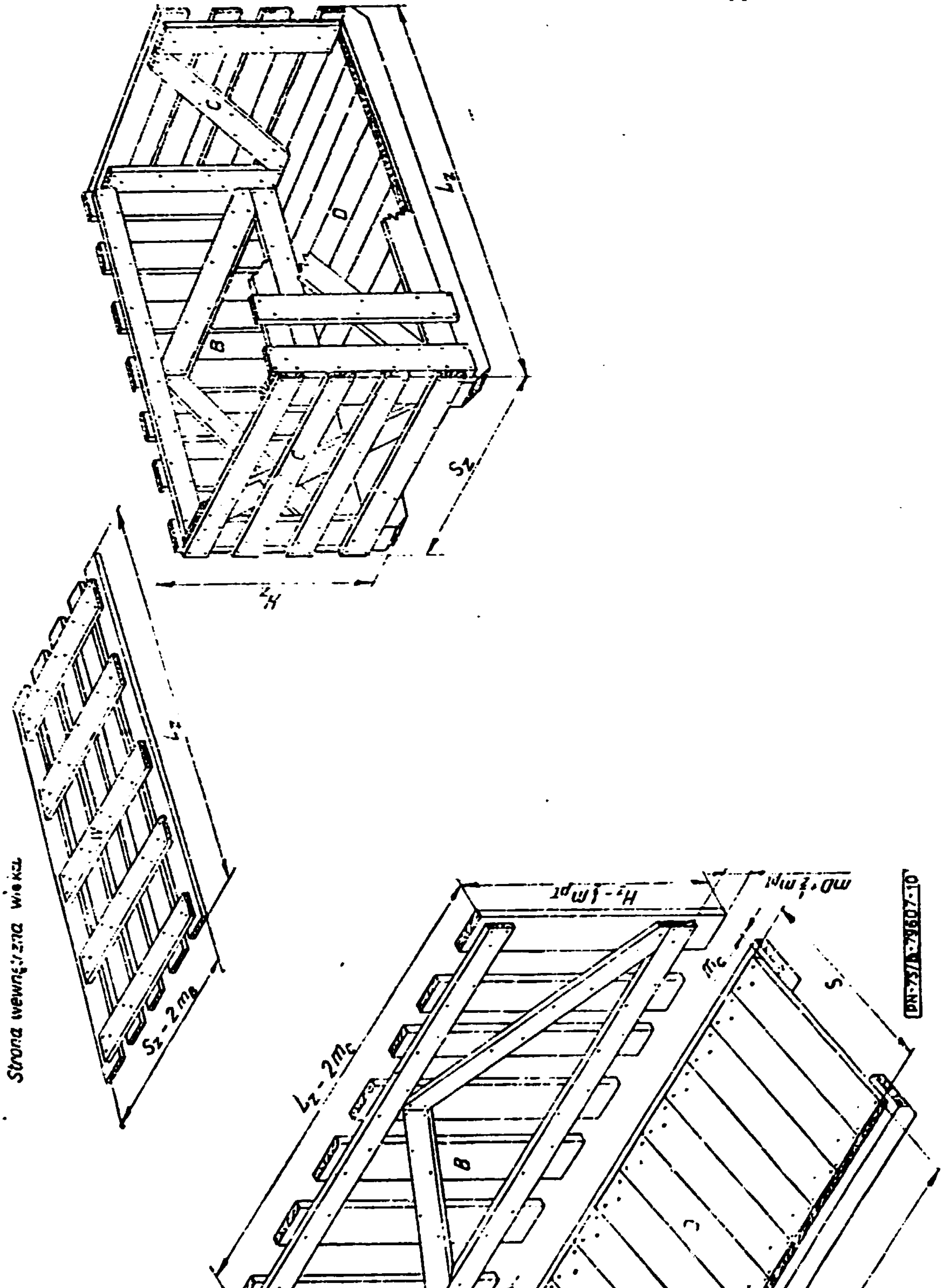
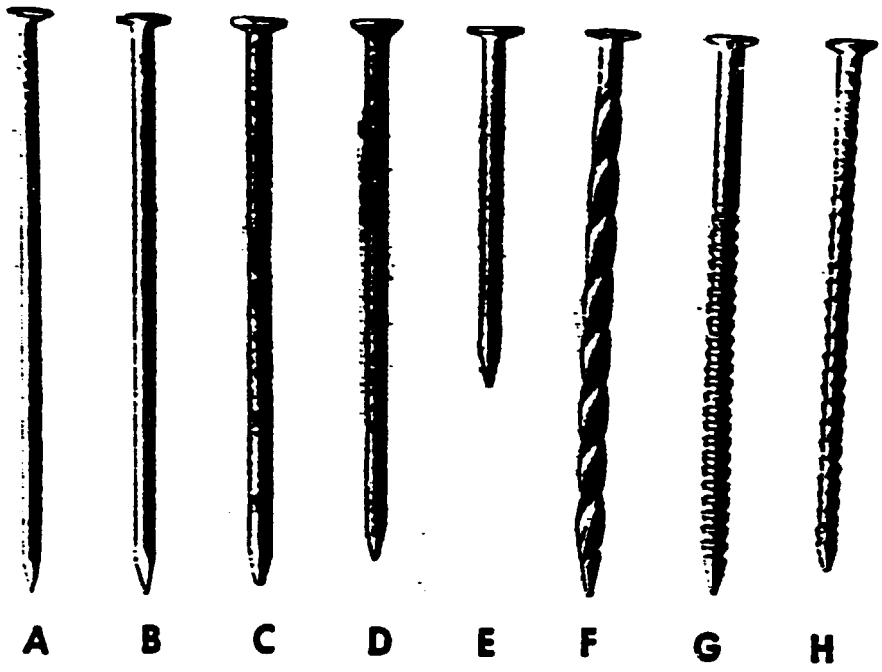

Strona wewnętrzna wieka
$S_z - 2m_B$
L_z
H_z
S_z
$L_z - 2m_c$
$L + 2m_c$
$H + m_{wD}$
B
C
D
DN-75/D-79607-10

Rys. 10

Appendix 5



Basic types of nails: A. Common; B. Bright box; C. Cooler; D. Sinker; E. Clout; F. Spirally grooved; G. Annular grooved; H. Barbed.

LIST OF PARTICIPANTS TO THE

WOODEN PACKAGES SEMINAR

Name of Participant	Name of Establishment
1- Ahmet YAVUZ	Emek Elektrik Endüstrisi A.Ş.
2- Rıfat İLHAN	Hacettepe Üniversitesi
3- Ramazan KONTAY	İstanbul Üniversitesi Orman Fakültesi
4- A. Yalçın ERCAN	Makina Kimya Kurumu Makine Sanayi Müessesesi
5- Şükrü GÖKHAN	Ardem A.Ş.
6- Yaşar CEYLAN	M.S.B. Teknik Hizmetler
7- Misak KEDİLERLİ	Sevan Vana Sanayi
8- Mehmet ÖZBEK	Emayetaş Madeni Eşya, Saç ve Emaye Fabrikaları T.A.Ş.
9- Muammer ERYILDIZ	Emayetaş Madeni Eşya, Saç ve Emaye Fabrikaları T.A.Ş.
10- Faruk ULAŞ	Teba
11- Gürsel ÇOLAKOĞLU	Düzce Meslek Y. Okulu
12- İsmail AŞAN	Yazar Pompa
13- Kamil KATLANDUR	Orta Anadolu Seramik
14- Abdurrahman PALAZ	Orta Anadolu Seramik
15- Aziz EKŞİ	Ziraat Fakültesi
16- Hasan Tahsin ÇEHRELİ	Düzce Meslek Yüksek Okulu
17- Atamur BAYDAR	İGEME
18- Muzaffer ALACAOĞLU	İGEME
19- Asuman SOYU	İGEME
20- Osman TAŞKIN	Ormancılık Araştırma Ens. Müd.
21- Pamir ERTEN	Ormancılık Araştırma Ens. Müd.

22- Zeki USAL	Sanayi Bakanlığı
23- Servet BAĞCI	Sanayi Bakanlığı
24- Ali TİTREK	Sanayi Bakanlığı
25- Altan HUNCAL	ORÜS
26- Arslan ÖZKAPLAN	ORÜS
27- Ahmet DEMİRLİÇAKMAK	Milli Prodüktivite Merkezi
28- İsmail ÖZCAN	Çanakkale Seramik
29- Mehmet OLGUNPAJIK	Çanakkale Seramik
30- A. Hikmet AYHAN	Çanakkale Seramik
31- İsmet PARLAK	Hacettepe Üniversitesi
31- Kemal SERTKAN	Gama Pazarlama
32- Ahmet ŞENKAL	İstanbul Tic. Odası
33- Çigdem KEMAHLI	İGEME
34- İrfan REİS	Orman Genel Müd.
35- Ramazan ÖZEN	Teknik Eğitim Fakültesi
36- Mehmet MEMİŞ	Teknik Eğitim Fakültesi
37- Erol ÖZENÇ	İGEME
38- Yıldız GÜVEN	DESİYAP

Annex 11

TRANSPORT PACKAGES PERFORMANCE REQUIREMENTS AND TESTS OF RESISTANCE TO MECHANICAL DAMAGE PN-70/O-79100

1. Introduction

1.1. Subject of the standard

Subject of the Standard is concerned with performance requirements and tests of the transport packages resistance to mechanical damages occuring during handling, transporntation and storage of packaging product.

1.2. Scope

The procedures described in this standard are applicable for transport packages up to 150 kg gross weight, excluding sacks, metal cylindrical containers, glass containers, same kind of the packages for very dangerous good as weel as packages for which are determined other requirements in regards with resistance to mechanical damages.

1.3. Terminology

1.3.1. Individual test schedule : The hazard occuring in practice is simulated by a test on only one testing equipment in order to examinatio6n of a package resistance against this hazard.

1.3.2. Multi-test schedule : hazards occuring in practice is simulated by subsequently tests applied to the same tests specimens on a few testing equipments according to the specific test schedule in order to simulate hazards occuring one after the other during the distribution processes.

1.4. Applicable standard

PN - 74/O - 79155 or ISO - 2206
PN - 74/O - 79160 or ISO - 2248
PN - 70/O - 79161 or ISO - 2876 or ASTM O-782-82
PN - 74/O - 79162 or ISO - 2244
PN - 75/O - 79163 or ISO - 2872

	or ISO - 2234
PN - 70/0 - 79164	-
PN - 75/0 - 79166	or ISO - 2247

Height of drop depend on package classes is given in Table 2

2. Classification of transport packages

2.1. **Groups:** In depend of ways of utilization it is distinguished three groups of packages.

1. For one way utilization in the country.
2. For multitimes utilization in the country.
3. For export products.

2.2. **Classes :** In depend of kind of packaging product it is distingushed three classes of packages:

1. For safety products, don't resistance against schocks, excluding powder type products.
2. For safety products, don't resistance against schocks (fragile, breakable and sensatively on shake vibration as well as for this products which are packaging in don't resistance on schocks unit package (e.g. bottle and for make of glass)
3. For some kinds of dangereus goods (poisoned, caustic) without any regards on sensitivity on schocks, and powder type products.

2.3. **Variants :** Depending on basic shapes as well as kinds of meturials it is distinguished three variants of packages:

1. Perpendicular made of paperboard, fibreboard and moulded pulp.
2. Perpendicular made of various kinds of materials, excluding packages made of paperboard, fibreboard and moulded pulp.
3. With round and oval bottom made of various kinds of materials excluding metal package.

3. Requirements

3.1. The resistance of transport packages to mechanical damages in case of individual test schedule

3.1.1. Resistance of package against compression (by quasistatic loading)

Every single one transport package should be resistance against compression by quasistatic loading (F) expressed in newtons (N) count on formula

$$F = k \frac{H-h}{h} \cdot G$$

Where :

H, height of stacking, mm.
h- height of package, mm.
G- gross weight of package, kg.
k- coefficient

Height of stacking H, value of coefficient k and admissible deformation for particular modification of packages, depends on kinds of transportation is illustrated in Table 1.

Table 1

Packages Variants	Road and Railway Transport			transport		Sea transport
	k	H	max. admissible deformation (mm)	k	H	max. admissible deformation (mm)
1	1,25	3000	10	1,50	4000	10
2	1,25	3000	15			15
3	1,25	3000	20	1,50	4000	20

3.1.2 The resistance of transport package against schock resulting from a free fall.

Every single transport package of group 1 should be resistant to one cycle (set) of drops for package of variants 1 and 2 in accordance with Table-3 and for packages variant 3 in Table 4.

Every single one transport package of groups 2 and 3 should be resistant to two cycles (sets) of drops for package of variants 1 and 2 in accordance with Table 3, and for packages variants 3 in Table 4.

Height of drop depend on packages classes is given in Table-2

Table - 2

Height of drop cm	Class of package		
	1	2	3
Packaging	70 - G1	50 - G1	90 - G1
Minimum	20	20	30

G1 - coefficient expressed in cm, which its figural value to correspond with figural value of a testing package gross weight (mass), expressed in kg.

Table - 3

Successive number of drops in cycle (set)	Position Center of Gravity	
	Overlapping with symmetry center of package	Do not overlapping with symmetry center of package
1	Place of shock (impact) one of corner at a bottom of package	one of corner at a bottom of package situated much more close to center of gravity
	edges formation corner has applied in drop I, but in sequences:	
2	-longer edge of a bottom of package	
3	-short edge of a bottom of package	
4	-edge of height of package	
	a plane to form a corner which has applied drop I, but in sequences:	
5	-a bottom of package	
6	a plane has formed with longer edge of a bottom and heigh of package	
7	a plane has formed with shorter edge of a bottom and height of package	
drops 6 and 7 it is applied by test of package class 3 only		

Table - 4

successive number of drop in cycle (set)	place of schock (impact) in accordance with identification of parts of packages when testing - ISO 2206
1	Point 1
2	Point 4 place (face)number
3	Point 3 according to ISO
4	Point 4 2206
5	generating line (vertical line) in place of joint of side of package (container/

3.1.3. The resistance of transport package against impact subjected to test on incline impact

Every single one transport package of groups I should be resistant to one cycle (set) of impacts for packages variant 3 in Table7.

Every single one transport package of groups 2 and 3 should be resistant to two cycle (sets) of impact for packages of variants I and 2 in accordance with Table 6, and for packages variant 3 - in Table 7.

The distance (length) of dolly way in dependence of package class is given in Table 5.

Table - 5

Class of package	1	2	3
Length of dolly way (m)	2	1,5	2

Table - 6

Successive number of impact in cycle (set of test)	Place of impact in accordance with identification of parts of packages when testing - ISO 2206
1	Plane 5
2	Plane 6
3	Plane 2
4	Plane 4
5	edge formed by planes 5 and 2
6	edge formed by planes 6 and 4
7	edge formed by planes 5 and 4
8	edge formed by planes 6 and 2

Table - 7

Successive number of impact in cycle (set of test)	Place of impact in accordance with identification of parts of packages when testing - ISO 2206
1	generating line 1-2
2	generating line 3-4
3	generating line 5-6
4	generating line 7-8

3.1.4 The resistance of transpo6rt package against vibration

3.1.4.1. The resistance to vibration of packages group 1

Every single one transport package of group 1 should be resistant to vibration of parameters given in Table-8, it should be performed in joint time 35 min, but by the first 30 min vibration should be performed for parameters determined for road (car) transport in accordance with table 8 - row 2 or 4 and for further 5 min at parameters determined for railway (train) transport in accordance with table 8 row 3 or 5.

3.1.4.2. The resistance to vibration of package group 2

Every single one package of group 2 should be resistant to vibration of parameters given in Table - 8, it should be performed in joint time 70 min, but by the first 60 min vibration should be performed at parameters determined for road (car) transport in accordance with Table-8 row 2 or 4, by further 10 min. at parameters determined for railway (train) transport in accordance with Table-8 row 3 or 5

3.1.4.3. The resistance to vibration of package group 3

Every single one package of group 3 which is tansparted on a road up to 2000 km. should be resistant to vibration of parameters determined in point 3.1.4.2. for packages group 2.

Every single one package of group 3 which is transported on a road 2000-5000 km. should be resistant to vibration of parameters given in Table 8, it should be performed in joint time 180 min, but by the first 150 min. vibration should be performed at parameters determined for road (car) transport in accordance with Table 8 row 2 or 4, and by a further 30 min. at parameters determined for railway (train) transport in accordance with Table 8 row 3 or 5.

Table 8

Parameters	Height of packages, cm.			
	up 70		above 70	
	Type of transport			
	car	train	car	train
1	2	3	4	5
Frequency,Hz	6	8	6	8
Amplitude, mm	4	2	4	2
Vibration angle of plate in regard to horizontal level grade	50	30	50	30

Over loading,N	$F=(\frac{220}{h_1}-3).G$	without over loading
the number of packages contemporary subjected to vibration	3	2
h_1 -numeric value correlation with numeric value of packages height expressed in cm		
G -gross weight (mass) of package, kg.		

3.1.5. The resistance of transport packages to shakes and horizontal shocks

Every single one package should be resistant to shakes and horizontal shocks performed in accordance with Table 9 in 30 min. time

Table 9

Length of dolly way mm	150
Number of shockes in 1 min	125
Distance of moving wall of dolly case from package, mm	50

3.1.6. The resistance of transport packages to shocks during fall down and rolling

Every single one package of class I should be resistant to shocks during three full rotary of drum and package of class 3 during fifth full rotary of drum.

3.2. The resistance of transport packages against mechanical danger in case effect of hazards during distribution "multi test schedule".

3.2.1. The one way use packages foreseen to (for) intercountry turnover (group 1)

Should be resistant to hazards (tests) which are sequences and parameters, there are in Table 10

Table 10

Sequences of hazards	Kinds of hazards (tests)	Parameters				
		name	Unit of measure	Classes of package		
				1	2	3
1	Quasi stacking (compression resistance)	Loading	N	$F=1,25(\frac{300-h}{h}).G$		
		Max deviation	mm	15	15	15
		height	cm	70-G1	50-G1	90-G1
		min height	cm	20	20	30
		number of drops in cycle	-	4	4	5
		Number of cycle	-	1	1	1
2	Drop resistance	sequences performance of drops	The packages of variants 1 and 2			
			1-drop-on one of corner by bottom of package	as in classes 1 and 2 but plus		
			2-drop on longer edge of bottom or package	5 drop on the bottom of package		
			3-drop on shorter edge of bottom package			

		4-drop on edge of height of package The packages variant 3
	1-drop-on point 1 2-drop on point 4 3-drop on point 3 4-drop on point 2	as in classes 1 and 2 but plus 5-drop on generating line in place of joint of ride of package (container)

Sequences of hazards	Kinds of hazards tests)	Parameters				
		name	Unit of mesure	Classes of package		
				1	2	3
3	Vibration	Loading	N	$F=\left(\frac{220}{h_1}-3\right)G$		
		Number of vibration per 1 min	-	250		
		amplitude	mm	5		
		time of vibration	verti-cal	min 10		
			hori-zontal	min 10		
		lenght of dolly ways	m	1,5	1,0	2,0
		number of imp.cycle	-	4	4	4
		number of cycle(tests)	-	1	1	1
4	Inclined impact	Kinds of impact	The packages of variants 1 and 2 1.impact plane 5 2.impact plane 6 3.impact plane 2 4.impact plane 4 The packages of variants 3 1.impact-on generating line 1-2 2.impact on generating line 3-4 3.impact on generating line 5-6 4.impact on generating line 7-8			
5	Drum test turnover and rolling only variants I with top covered	number of drum turnover	1	-		2

h-height of package, cm
h1-numeric value in accordance with numeric value of package height expressed in cm
G-gross weight (mass) of package in kg.
G1-Coefficient expressed in centimeters, which numeric value is in accordance with numeric value of (mass) gross weight of testing package experssed in kg.

Table 11

Sequences of hazards (tests)	Kinds of hazards (tests)	Parameters				
		name	Unit of measuring	Classes of package		
				1	2	3
1	Quasistacking (compression resistance)	Loading	N	$F=1,5\left(\frac{400-h}{h}\right)G$		
		max deviation	mm	15	15	15
		height	cm	70-G1	50G1	90 G1
		min.height	cm	20	20	30
		number	-	4	4	5
		number of cycye	-	2	2	2
2	drop resistance	Sequence performence of drops	The packages of 1. drop on one of corner by bottom of package 2.drop on longer edge of bottom of package 3.drop on shorter edge of bottom of package 4.drop on edge of height of package		variant 1 and 2 as in classes 1 and 2 but plus 5-th drop on the bottom of package	

				The packages 1.drop on point 1 2.drop on point 4 3.drop on point 3 4.drop on point 2	variant 3 as in classes 1 and 2 but plus 5 th drop on generating line in place of joint of side of package (container)

Sequences of hazards (test)	kinds of hazards (tests)	parameters				
		name		Unit of measuring	Classes of package	
					1	2	3
3	Vibration loading			N	$F=\left(\frac{220}{h_1}-3\right)G$		
		number of vibration per minute		-	250		
		amplitude		mm	5		
		time of vibration	vertical	min	10		
			horizontal				
4	inclined impact	length of dolly ways		m	1,5	1,0	2,0
		number of impacts in cycle		-	4	4	4
		number of cycle		-	2	2	2

		kinds of impact		The packages of variants 1 and 2 1. impacts-plane 5 2. impacts-plane 5 3. impacts-plane 2 4. impacts-plane 4 The package of variants 3 1. impact on generating line 1-2 2. impact-on generating line 3-4 3. impact-on generating line 5-6 4. impact on generating line 7-8
5	Drum test turnover and rolling only variants 1 with top covered	number of drum turn-over		2 - 3

h-height of package

h1-numeric value in accordance with numeric value of package expressed in cm.

G-Gross Weight (mass) of package in kg.
G1-Coeffiencient expressed in centiemeters, which numeric value of gross weight (mass) of testing package, expressed

3.2.2- The reusable packages foreseen to (for) intercountry turnover (group 2. Should be resistant to double cycle (set) of hazards (tests) according to Table 10

Moreover between first and second cycle of hazards (tests) acc. Table 10 empty packages, ready to back ways, according to the practical custom by returnable transportation, should be resistant to turnover and rolling, being subjected to five (5) turnover in drum tester, in dependent of classes and variants of packages.

3.2.3- The packages designed for export products (group 3) **Should be resistant to hazards** (tests) which sequences and parameters, there are in Table 11.

4. Testing

4.1- Programme of testing

4.1.1- Individual test schedule. In order to examination of packages compatibility with the standard of packages in scope of resistance to mechanical damages in case of individual test schedule (3.1) should be conducted individual tests according to table 12.

The individual tests should be conducted in the folowing cases:

- Periodically in case when exist supposition about incompatibility between package and requirement of the standard.

- For campare different packages applying for the some product.

- In case the matter of controversy.

4.1.2- Multitest schedule

In order to examination compatibility with the standard of packages, in scope of resistance to mechanical damages in case of multi test schedule (3.2) should be conducted multi test, performance on every one package in the sample, the following tests successively:

a) Examining resistance to deformation by quasi stacking acc. PN.75/0-79163

b) Examining resistance to schock by free fall drop acc. PN-74/079160 (or ISO-2248)

c) Examining resistance to vibration acc. PN-75/079166 (or ISO 2247)

d) Examining resistance to inclined impact plane acc. PN-74/0-79162 (or ISO-2244)

e) Examining resistance to schocks by turnover and rolling acc. PN-70/0-79161

The multi test should be conducted in the following cases:

- By monitoring package, for which as well the country as international rules do not foresight to apply individual tests.

TABLE - 12

S.No.	Kinds of hazards (tests) for individual test performance	Method of testing according to	Variants of packages subjected to tests								
			1			2			3		
			classes of package								
			1	2	3	1	2	3	1	2	3
1	Shock by free fall drop (drop tests)	PN-74/0-79160 or (ISO-2248)	X	X	X	X	X	X	X	X	X
2	Shocks by turnover and rolling (Drum tests)	PN-70/0-79161 or (ISO-2876 ASTM D 782-82)	X	X			X		X	X	
3	Inclined impact (Inclined plane tests)	PN-74/0-79162 or ISO-2244	X	X	X	X	X	X	X	X	X
4	Quasi stacking (compression resistance) (compression tests)	PN-75/0-79163 or ISO-2872 ISO-2234	X	X	X	X	X	X	X	X	X
5	Shocks and horizantal shocks(impact) (horizontal impact and shockstest)	PN-70/0-79163	X			X			X		
6	Vibration (tests)	PN-75/0-79166 or ISO-2247	X	X	X	X	X	X	X	X	

- For compare different packages applying for the same product

- In case the matter of controversy.

4.2- Choose and preparation of samples acc. PN-74/O-79155

4.3- Assesments of the tests results.

4.3.1- The package is resistant to mechanical damage.

The tested package is resistant to mechanical damage, if after individual testing acc. 4.1.1 or multi testing acc. 4.1.2 is not tecnical destructed and product is not damage.

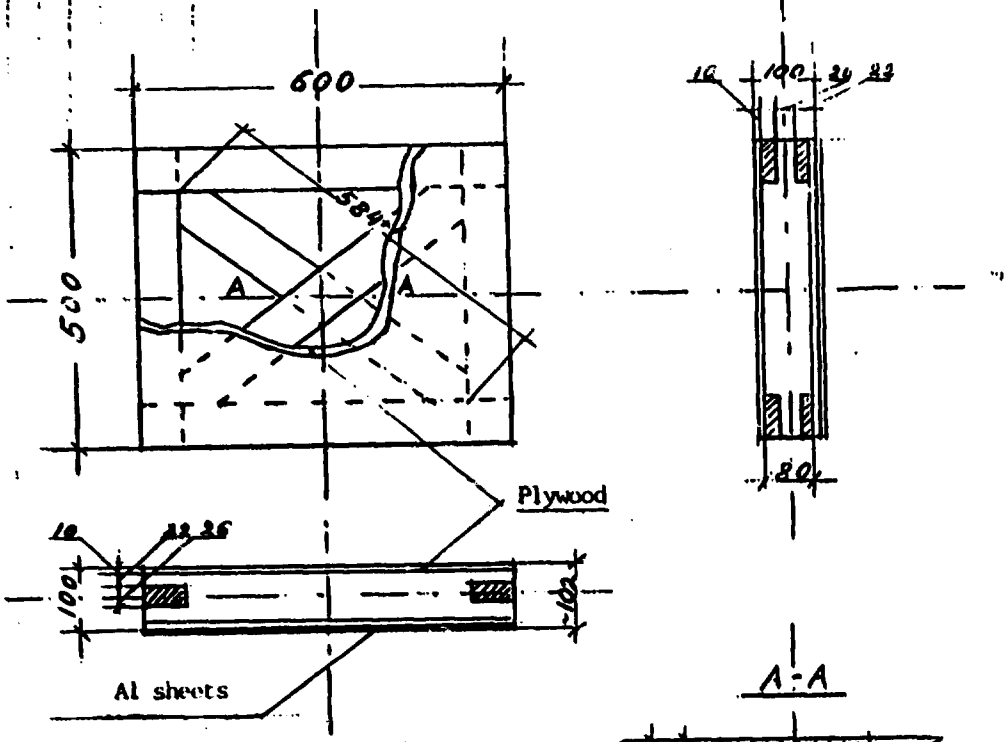
4.3.2- The package is not resistant to mechanical damage.

The tested package is not resistant to mechanical damage, if after individual testing acc. 4.1.1 or multi testing acc. 4.1.2 is technical destructed and product is damage.

4.3- Assesment of the group of package.

The group of package subjected to assesment should be recognizing as in accordance with requirement of the standard, if each one of package in the samples subjected to the tests is resistant to the mechanical damage.

Auxiliary wooden pallets for Compression Tester



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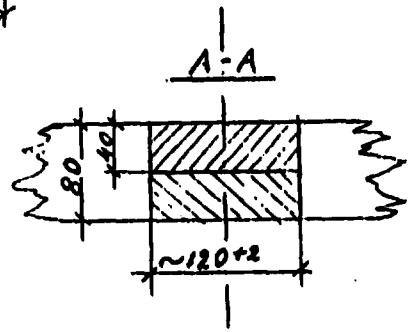

1:5

1. Materials for one pallet

1.1. 2 Beams 600 x 70 x 80 mm)
1.2. 2 Beams 500 x 70 x 80 mm) Hardwood, oak,
1.3. 2 Cross beams 584^{+1} x 70 x 80 mm) beech or other hard
(grain ⊥ to the plywood panel)) wood with density of above 700 kg/m^3

1.4. 2 Plywood panel 600 x 500 x 10 mm
1.5. 1 Aluminium sheet 600 x 500 x~2 mm
All wooden surface whittle

2. Materials for four pallets

2.1. 8 Beams 600 x 70 x 80 mm = 0.00336 m
2.2. 8 Beams 500 x 70 x 80 mm = 0.00280 m
2.3. 8 Cross beams 584^{+1} x 70 x80mm= 0.00299 m

0.00915 m^3

Total timber ~ 0.01 m^3

2.4. 8 Plywood panel 600 x 500 x 10 mm = 2.4 m^2

Total Plywood ~ 2.8 m^2

2.5. Aluminium sheets 600 x 500 x 2 mm = 1.2 m^2

Annex 13

List of additional equipment and indispensable testing and calibration accessories

Sl.No.	Name of Equipment	Specifications	Suggested Suppliers
1	2	3	4
1	Electromagnetic drop table with peak-G-meter	To study the properties of cushioning materials in dynamic conditions with guide vertical drop dynamic testing mechanism	1.Tetronix Inc. P.O.Box 500 Baverton Oregon 97005 USA
		a-Adjustable cross head and release mechanism	2.Karl Frank GmbH 694 Weikeum/
		b-Drop head platen	Bergester
		c-Box for lead shot	FRG
	Auxiliary equipment for p.1 /above/ as well as for field study of hazards and calibration of other testing equipment	a-Amplifier type 2626	
		b-Two channel microphone power supply type 2807	
		c-Two channel Amplifier type 2634;two pieces	Brüel and Kjäer DK-2850
		d-Bumb recorder type 2503	Naerum Denmark
		or	td /02/80-05-00
		Tape recorder type 7003	
		e-Vibration exciters type 4810	
		f-Vibration transducers /accelerometers/	
		type 4370-S+2 heads	
		type 4731-S+2 heads	
		type 4321-three pieces	
		type UA-0322;type 8305-S	
		type 8306+type ZR-0024	National
		g-Portable Oscilloscope	Matsushita Japan

1	2	3	4
3	Impactograph or PIRA drop recorder	For field and laboratory surveys of mechanical hazards	1. Impact-O-Graph firm USA 2. PIRA Leatherhead United Kingdom
4	Thermophil with accessories	For quick measures of temp. of air and surfaces of materials samples or packages -type 4444 in carrying case temp. range 60°C to 250°C with semiconductor probe	Ultrakust Gerätebau GMBH HA-375 Ruhmansfelden FRG
5	Hygrophil with accessories	For quick measures of relative humidity Type 4451-3 with sensors and extension cable type 4414/4 and carrying case	
6	Strapping devices	Suitable for metalic straps, non-metalic straps, wire tying -semi automatic; 8mm to 25 mm strap width	Signode Corp. Deptt. 446 PMC 2600 W. Western Av.Chicago Illionois 60647 USA
7	Stitching devices	Stitching machine for paper, fibre board, jute	1. Beckchards Machine Church Road King of Prusta PO 19406 USA
8	Stapling devices	For stapling hardboard, corrugated and solid fibreboard	2. Spotnoils Juc 1100 Hick Road Rolling Meadows Illionois 6000 - USA

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Annex 15

VISITING INDUSTRY - SUMMARY

Visit to: Soyuytce Sirketler Grubu
Ankara - Esenboga

Date: 86.10.07

Visited by: Mr Zdzisław KOSTRO - UNIDO Expert
The Packaging Centre TSE

Person seen: Mr Raivan TOSYA - Head of Production Department

Modern plant of medical accessories-production on a basis of licence of American Corp. Jonson and Jonson. Raw materials are imported. Production so far is supplied for indegenous market. They faced some problems with liquids which are packed firstly in individual polyetnylene container of capacity about 4,5 l, then in corrugated fibre boxes.

The boxes with products are stored in warehouse in seven layers. Customers complain from time to time for leakage of containers in boxes.

Findings

Because immediate observation did not indicate any inadequation in performance of package, it was decided to send samples to the Packaging Centre for testing by static test and compression test.

The boxes with products are now under stacking test. Quasi stacking test on compression testernas been just implemented.

Visit to: Ardem Pisirici ve Isitici
Bolu

Date: 86.10.15

Visited by: Mr Zdzisław KOSTRO - UNIDO expert
Mr Recep DEVECI Mech.Eng. /Msc/
The Packaging Centre TSE

Person seen: Mr Veysel Sever - Dep.Dir.Production Manager
Mr Ergin Derkunt - Dep.Dir.Technical
Mr Bilgin Ergun - Head of Quality Control Dep.

A very big modern factory on the area of 30000 m^2 and 27000 m^2 under production buildings. They manufacture mainly electrical and gas kitchens and accessories for domestic market and for abroad. One day efficiency about 12.000 kitchens. They faced with many problems of packages but particular concerned with exports to France.

General costs of package are 2.5 % of costs of production. They are exporting also to Algeria and Egipt. The kitchens are packed individually in wooden batten and boards, corrugated fibre board and polyuretane foam /styropor/ pads. They use a lot a individual as well as multi unit packages.

Findings

The visitors found a lot of defects in packaging materials as well as in packages performance.

The following suggestions were made:

- to apply other ways of fixing bottom of the kitchens to wooden frame
- to eliminate multi unit boxes for gas kitchens and accessories but to apply only externalwrappings and polypropylene straps,
- to change place of applying metal straps to electrical kitchens package,
- in the big multi unit packages for export corner joint of crates should be changed for "three way corner" joint and smaller general volume of crates should be made in order to save costs of freight,
- some practical advices were made concerned with proper nailing as well as with selecting of wooden packaging materials.

Visit to: Demantas Demircioglu Entegre Ambalaj San. ve Tic. A.S. Hendek / ADAPAZARI

Date: 86.10.14

Visited by: Mr Zdzisław KOSTRO - UNIDO Expert

Mr Recep DEVECI

Person seen: Mr Sabri Kalaycioglu - Plant Manager

Modern plant constructed three years ago in order to produce wirebound boxes and pallets. The plant employs 200 peoples including 6 engineers. The area of production building is about 2.500 m^2.
The equipment of the plant is modern, mostly from West Germany, some from the U.S.A. and Italy.

Findings

The production process is carried on in proper ways with exception of moisture of wood and kind of nails used for nailing pallets.
The proper advices in this matter were made.

Visit to: AEG Eti Elektrik Endustiri San. A.S.
Gebze /Kocaeli

Date: 86.10.15

Visited by: Mr Zdzisław KOSTRO - UNIDO Expert
Mr Recep DEVECI -Mech.En$_{g}$./Msc/ -
The Packaging Centre - TSE

Person seen: Mr Selami SUBASI - Production Manager

A very big modern factory of A.E.G. The factory produces mainly transformers, electrical switch board and accessories and electrical engines for mechanical vehicles.
They manufacture for domestic demand and for export.
Most of products are packed in wooden crates and cases, some of products do not sensative on mechanical and climatic hazards are shipped to the customer on wooden pallets only.

Findings

The substantial parts of wooden materials are of very low quality and construction. Cases and crates are made not in proper ways, moisture of wood on reasonable - air dried level.
Some products are overpacked and some crates are too big in comparison with equipment inside.
The suggestions were made to send some technical specifications to the Packaging Centre in order to re-elaborate in proper ways. x/

x/ The technical specifications have arrived and are now under elaboration. The particular advice by Expert has been made.

Visit to: Turkiye Sise ve Cam Sanayi Fabrikalari A.S.
Cam Isletme Tesisi
Gebze/KOCAELI

Date: 86.10.15

Visited by: Mr Zdzisław KOSTRO - UNIDO Expert
Mr Recep DEVECI - Mech.Eng. /Msc/ -
The Packaging Centre - TSE

Person seen: Mr Taner HALECI - Deputy Director

The modern big plant manufacturing dressing glass mainly for industrial purposes as: sun protected window glass, mirror glass and windscreen.
The plant is equipped with very modern automatic and semiautomatic production machines made in West Germany.
The production ispacked in traditional for glass sheets triangular racks as well as in wooden crates and cases. The costs of packages do not overcome 5 % of costs of the product.

Findings

The plant has good organization of packaging department. The timber is dried and of good quality.
The construction of packages is also proper.
Some problems with window glasses are occuring eventually by packing window glasses into partially empty cases as well as by unproper fixing packages on vehicle or careless unloading.
The problems were discussed with plant representatives.

Visit to: Ozeler Plastik ve Ambalaj San. A.S. Istanbul

Date: 86.10.16

Visited by: Mr Zdzisław KOSTRO - UNIDO Expert
Mr Recep DEVECI Mech.Eng. /Msc/ - The Packaging Centre - TSE

Person seen: Mr Okan ESIN - Main Engineer

The plant under extension, manufacturing plastic containers and bottles of high and low density polyethylene, cups made of polystyrene.
The containers are manufactured on a basis of blow moulding and cups - injection moulding techniques.

The machines were imported from West Germany /Bakum and others/, some auxiliary equipment was made in Turkey.

Findings

They do not face with problems of packages but they are interested in packaging / main production/ testing and elaboration of packaging standards as soon as possible.
They promised to be in contact with the Packaging Centre, in particular with transport testing laboratory.

Visit to: Tarim ve Orman Bakamligi
Orman Urünleri Genel Müdürlügü
Ahsap Ambala Fabrikasi
Antalya

Date: 86.10.30

Visited by: Mr Zdzisław KOSTRO - UNIDO Expert
Mr Recep DEVECI - Mech.Eng. /Msc/ -
The Packaging Centre - TSE

Person seen: Mr Naci Tüysüz - Dep. Director

The big wood production factory owned by government situated on 8 hectars. They manufacture different types of wooden boxes and pallets from own wooden raw materials / logs/, mainly pine. The factory is equipped with West German machinery, the auxiliary equipment is made in Turkey. The raw materials are stored directly on the ground, logs are not protected against solar radiation. A lot of cracks and other defects can be observed there. The cutting edges and sawing bands are not always sharp. The thickness of cleats on small boxes seems to be too big in comparison with the purpose - for fruits and vegetables mostly. The costs of raw materials amounted 55 % of overall costs.

Findings

The factory should pay more attention to logs yards and sharpening of edges of production machines.
The construction of wooden boxes is proper.
The factory faces problems connected with selling wirebound boxes, which are stored in warehouse about two years and any customer wants to buy these boxes because of the price, but this is more marketing problem than technical. The technical discussions with directors were conducted.

Annex 16

ITINERARY OF THE MISSION

From 17-th September to 28-th November 1986

Sept. 17	Arrival in Ankara about 19:00
Sept. 18-19	Meetings with the UNDP and TSE officials in order to get acquainted with the scope of work, laboratory equipment and other facilities.
Sept.22-23	Adjustment of Job Description the real possibility of implementation and preparation with the Counterpart Director actual work plan.
Sept.24-26	Elaboration of specification of indispensable apparatus and auxiliary facilities in order to enable full working capacity of transport package testing laboratory. Meetings with representatives of supplying firms as: Brüel and Kjäer, Packard, Loyds and others.
Sept. 29-30	Conducting with counterpart trial tests on compression tester with corrugated fibre boxes. Meetings with delegates of UNDP/UNIDO Mr Barucha and Mr F.E. Madi and discussions on the subject of tripartite review of the project.

Oct. 1-3 Discussing with counterparts on the subject of indispensable work to be done in connection with enabling of tests performance on main testing equipment as incline tester, compression tester and vibration table.
Preparation of specifications and sketch of auxiliary facilities - see Annex 12.

Oct. 6-8 Visiting timber market in Ankara in order to buy proper wood for laboratory auxiliary facilities.
Visiting medical auxiliary facilities manufacturing in factory at Esenboga 27 km from Ankara.
Discussing in workshop principles of performance of auxiliary facilities for transport testing laboratory.

Oct.9-10 Elaboration of materials for technical session with the Packaging Centre staff. Implementation of technical session on the subject: "Transit Packages - the purpose and conditions of performance" - see Annex 6.

Oct.13-17 Visits to factories in Bolu, Hendek, Gebze, Istanbul - see Annex 15

Oct.20-21 Elaboration of materials on a basis of factory visits. Acquaintance with Turkish standards concerning wooden materials and derivates. Preparation of materials for the second technical session with the staff of the Packaging Centre.

Oct. 22-24 Implementation of the technical session on the subject - " The purpose of testing" - see Annex 7.
Conducting technical discussions with counterpart staff on packaging subject.

Oct. 27-29 Preparation of technical materials for visiting factories.
Discussions with counterpart Director.
Sinopsis of the paper for the seminar on the subject of wooden packages.

Oct. 30-31 Visiting factory at Antalys - see Annex 15.

Nov. 3 - 5 Elaboration of findings from visiting factories.
Selection of materials for seminar.
Discussion with counterpart on preparatory steps for conducting stacking tests for Esenboga Medical Factory.

Nov. 6 - 7 Elaboration of materials for semiar on the subject: "Designing, performance and testing of wooden cases".

Nov.10-12 Selection of technical slides /60 pieces/ to support discussion during semiar.
Finishing elaboration of materials for seminar.
Elaboration of guidelines on the subject of stacking tests - see Annex 8.

Nov.13-14 Elaboration of guidelines on the subject of quasi stacking tests - compression test - see Annex 9.
Carrying out stacking tests with counterpart staff in laboratory conditioning room.

Nov. 17-19 Elaboration of general technical guidelines for transport package method of testing - see Annex 11.
Preparation to the seminar.

Nov. 20 Delivery of the lecture on seminar on the subject:"Designing, performance and testing of wooden cases".

Nov. 21 Starting preparations of "Technical report".

Nov.24-26 Implementation of elaboration of "Technical report". Conducting technical discussions with counterpart concerning assessment of AEG factory technical specifications.

Nov. 27 Meetings with the UNDP and TSE officials and summing up discussions on the subject of the mission.

Nov. 28 Departure from the Esenboga Airport.