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Optimization of distrubution packaging for the new warehouse of pharmaceutical products in Pliva

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OPTIMIZATION OF DISTRIBUTION PACKAGING FOR THE NEW WAREHOUSE OF PHARMACEUTICAL PRODUCTS IN PLIVA

by

Viktorija Tica

A Thesis

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To my Parents

(Mojim Roditeljima)

Department of Packaging Science
of Rochester Institute of Technology
Rochester, New York

CERTIFICATE OF APPROVAL

M.S. Degree

The M.S. Degree thesis of Viktorija Tica
has been examined and approved
by the thesis committee as satisfactory
for the thesis requirements for the
Master of Science Degree

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Optimization of Distribution Packaging for the New Warehouse of Pharmaceutical Products in PLIVA

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ABSTRACT

Optimization of the Distribution Packaging is one of the several most advisable studies to work on when a new warehouse project is initiated.

The study reviews the current Distribution packaging status and proceeds with evaluation of the improved transport boxes with a better Area and Cube Pallet efficiency. Data collection and recognition of the used 100 different types of folding cartons and bundles is followed by evaluation of their packaging into new proposed transport boxes, according to the specified packaging demands.

Therefore, the basic evaluation tool of this study was the computer program that matches unit pack dimensions and their arrangement inside box together with transport box dimensions and their stacking pattern on the pallet.

After computer analyzes, most acceptable solutions were selected according to the specified demands, and in line with selected solutions a group of new transport boxes for optimization was singled out.

Finally the results of the Area and Cube Pallet efficiency for current transport boxes were compared with that for new transport boxes to highlight the improvement achieved with distribution packaging optimization.

CONTENTS

1. INTRODUCTION

One of the very important things when we talk about successful packaging process is providing appropriate distribution packaging system for the products. Distribution Packaging describes technical packaging functions that provide product protection, which results in safe and cost-effective product distribution. (1) It is an integrated approach, which embraces protective, handling, manufacturing, functional, identification, and shipping considerations of a product. In other words, distribution packaging includes considerations of transportation, warehousing and material handling factors with primary emphasis on performance and economy. In that way package engineering is also employed in decisions involving the distribution of the product. These decisions concern basic protective requirements in warehousing and transit, as well as functional requirements of arrangement, size, weight, quantity, handling, disposal, re-use, etc. (2)

When talking about Dimensions for Maximum Efficiency of distribution packaging there comes a term "arrangement", the way of orienting a number of primary packages in shipping case. Each potential arrangement needs a different size of shipping container and furthermore, each shipping box size will have various possible palletizing patterns. Even small adjustments to primary container dimensions can have major impact on total shipping efficiency and costs through better cube utilization. (3)

Since Warehouse floor space is rented by area while cube utilization begins with the design of the primary package, we come to one important factor named Unit Load Efficiency. Among other things, primary dimensions should be considered in terms of possible packaging orientations in the shipping container, impact on palleting pattern and space utilization. Traditionally, the problem was solved through intuition, experience and a few nominal calculations. However, small cartons packed 24 to a shipper box, may have over a thousand possible orientation and palleting options. Therefore, currently available computer "arrangement" programs, that can calculate all the implications of pack size, are very useful and helping tool for designing and determining dimensions for maximum efficiency. (4)

2. THEORY

There are some facts one should consider with respect to Distribution Packaging and packaging optimization.

2.1. Box dimensions

The inside dimensions (ID) of the box are critical for proper fit around the product. Therefore the box manufacturing is based on this fit. At the same time, outside dimensions (OD) must be considered for proper palletization and distribution and therefore are used in carrier *Classifications*. Dimensions are always given in the sequence of length, width and height. Length is always the larger of two dimensions of the open face box as it is set up for filling. Width is the smaller dimension of the open face. Height is the distance perpendicular to the length and width. (5)

2.2. Regular slotted container (RSC)

Slotted box styles (International Box Code: 02) are generally made from one piece of corrugated or solid fibreboard. The blank is scored and slotted top permit folding. (6) Regular slotted container (RSC) is in more general use than any other box style, because it is the most economic of box styles (Figure 2.2.). All flaps are the same length and while the outer flaps meet at the center of the box, the inner flaps do not. The space between the inner flaps varies depending on the box length versus width. (7)

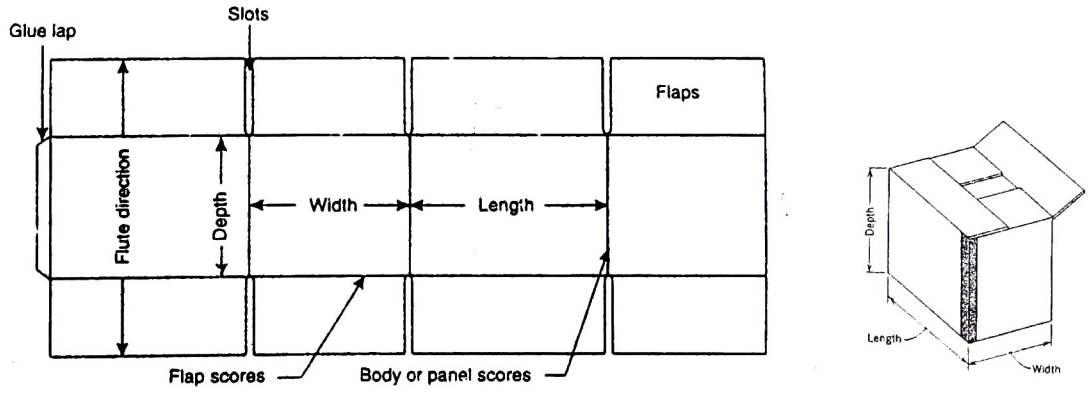


Figure 2.2. Regular slotted container (International Box Code: 0201)

2.3. Palletizing

The placement of boxes on pallets and stabilization and handling the pallet loads must follow a careful plan. Improper palletizing can reduce the stacking strength of each box by 55% or more, and be the direct cause of box failure. Instability of the load or improper handling can lead to spills, product damage and risk to the workers.

Two-thirds of the potential compression strength of a box reside in the four vertical corners. So all four corners must be fully supported. The most common violation of this practice is pallet overhang. If one side of the panel overhangs, the load must be borne by two corners of the box and the three remaining side panels. For example, an overhang of 2,54 cm (1 inch) can result in the loss of 32% of the top-to-bottom compression resistance of the box. And if the corner box on the pallet overhangs in two directions, the loss is even more serious. Than just one corner and the two side panels must bear the load. That is why the pallet fit should be discussed with the box manufacturer, and use of the available computer programs that match box dimensions and stacking patterns to pallet sizes, will be very helpful.

Concerning the stacking pattern on pallet, from the standpoint of box compression strength, the best solution is vertical columns. They are most effective if the boxes are properly aligned. But, in the three-high stack, a 1,27 cm (1/2 inch) misalignment of the middle layer will result in a 29% loss of compression strength.

Interlock stacking patterns are popular because they are more stable than vertical patterns. However, here the corners are not aligned; in fact, three or all four corners rest on the side panels of the box below. The result is a loss of 45% to 55% of the compressive strength. (8)

2.4. Good Distribution Practice (GDP)

Distribution packaging problems have been the subject of many studies that give us useful recommendations and suggestions for such problems as container dimensions, pallets and other factors of distribution packaging.

2.4.1. Container Dimensions

The recommended maximum and minimum dimensions for shipping containers are

Minimum container dimension	102 mm (4 in.)
Maximum width	610 mm (24 in.)
Maximum height	457 mm (18 in.)
Maximum length	762 mm (30 in.)
Maximum length: heavy products	610 mm (24 in.)
Maximum weight	20,5 kg (45 lb.)

There is also recommendation that containers should not be perfect square in any two dimensions. (9) Although, the DIN standard 55 520 offers among the other dimension sizes, also the square combination of the dimensions, and some dimension combinations that are above the maximum recommended case dimensions. (10) However, these recommendations should be considered from the point of different needs of individual producers.

2.5. Pharmaceutical Packaging

Because pharmaceutical factories usually manufacture and package in the same facility, packaging of drugs is consistent with standards of the pharmaceutical industry. Those factories usually have large number of different types of products (tablets, capsules, oral liquids, ointments, creams, suppositories, injections and others). Therefore, pharmaceutical manufactures use relatively high number of dissimilar materials and packages, while packaging operations form an intrinsic part of pharmaceutical manufacturing. First a drug is packed in its primary packaging (the packaging that is in direct contact with drug), usually the primary package is placed together with the insert (leaflet) into the folding carton. The term secondary packaging describes the packaging components that are not in direct contact with the drug products (folding cartons, paperboard sleeves, leaflets, labels etc.). (11)

2.6. Folding cartons

A folding carton is defined as a closed container made of bending grades paperboard, plain or printed, cut or creased, in variety of sizes and shapes, folded and delivered flat, or glued and collapsed by the maker, and to be set up, filled and closed by the user. Despite the many varieties of folding carton constrictions available, all cartons can be classified in one of three main groups: Tray-type constriction, Tube-type constriction (Reverse tuck, for example), and Special constrictions. (12)

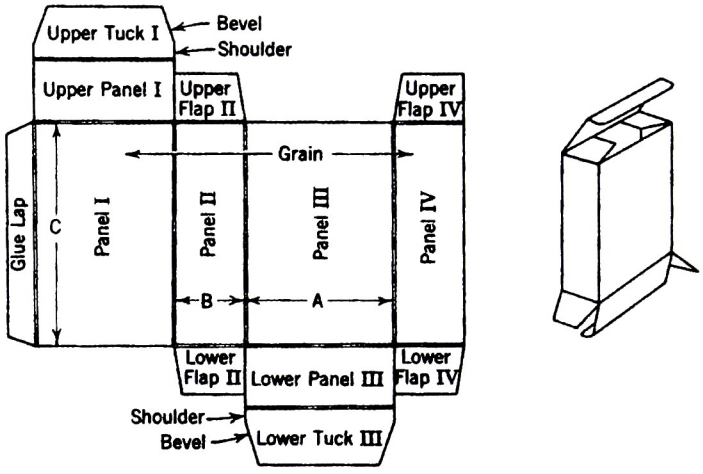


Figure 2.6. Reverse Tuck – one of the most popular types of the Folding cartons

3. OBJECTIVE

This study addresses the question of possible optimization of distribution packaging for pharmaceutical products that are packed in the large number of different size cartons, and have different demands of orientation in the transport box. Some of the cartons come in bindles, and some of them are single units. This large number of different drug packages requires a variety of shipping cases (transport boxes).

Now that the construction of the new warehouse for finished pharmaceutical products has started, it is a good time to examine relevant distribution packaging issues and find solutions to improve packaging area and volume efficiency.

HYPOTHESIS:

The existing distribution packaging can be improved.

To test this hypothesis the existing situation was examined by using the available computer program that calculates the efficiency of actual palletization of the products. This was followed by computer calculations with the objective of finding solutions for a better arrangement of existing products in the transport boxes that would provide better palletization results.

4. METODOLOGY

Prior to calculations related to distribution packaging optimization, a wide range of data was collected and the resultant input parameters were prepared and sorted. The CAPEPACK'99 computer software for packaging design and pallet loading optimization was used. The software consists of a group of programs (Pallet Group, Arrange Group, Design Group, Casefill Group and others) designed for solving most of the packaging problems. Each program in CAPEPACK'99 has its special purpose, and offers solutions for defined types of packaging problems.

4.1. Pallet Group

If you have a fixed size object, which you want to load onto a pallet or into a truck, you can run this program to see how to load the object based on restrictions you enter. The programs in the Pallet Group are designed to help you find the best way of loading your product. This program makes it possible to determine the current status of distribution packaging by calculating the pallet load efficiency for presently used transport boxes (shipping cases).

4.2. Arrange Group

This program helps when you have a product or primary package you need to arrange, to find a new case size and then palletize it for the shipping. You should specify the shape and size of the primary package enter the number of primary packages you want to put in a case, and (if required) define the bundle of the product. The program will calculate the case size, which it will then palletize. This program is designed to arrange the largest possible number of primary packages on the pallet based on loading restriction that you specify.

4.3. Design Group

If you have a product or primary package you need to re-size and arrange in case, and then palletize that case for shipping, you can run this program. Design Group calculates a new primary package size and arrangement as well as a new case size to fit it. You specify the shape and size of the primary package, how much the size can vary, and how many primary packages you want in a case, and (if needed) how the primary packages should be arranged in bundles. The program will then calculate new primary pack sizes, a variety of pack arrangements and new case size, which will then be palletized. The program is designed to calculate the optimal primary pack size in order to fit the maximum number of primary packages on the pallet.

4.4. Casefill Group

When you need to arrange a product or primary package within an existing case than this program group will best serve your purpose. After entering the data for case or tray sizes available in the warehouse, you should specify the size and shape of primary packages as well as cases you wish to load. The program will then select the best way to place primary packages into the case.

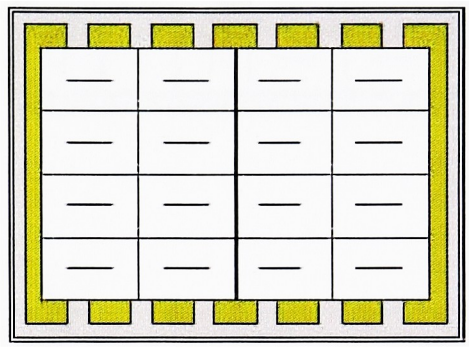
The Casefill Group program does not palletize the case, because it assumes that the palletization for these cases in your database is acceptable to you.

This program is useful in consolidating the number of existing case sizes that some company uses. Even the largest companies will be looking to maintain relatively few standard case sizes, which could ultimately hold a majority of their products. Typically the rule 80/20 (80% of the revenue generated by the 20% of the product range) governs which case sizes are likely to be retained. Those cases, in addition to the industry-standard modular case sizes, will probably form the initial database entries, but each company may have different needs. (13)

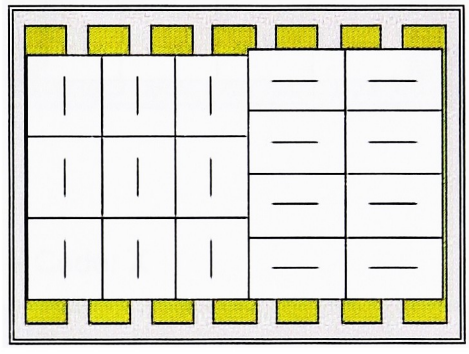
4.5. Cape's Pallet Patterns

This program offers six basic pattern styles, each style with many different pattern layouts. The following are the Cape's six standard pattern types:

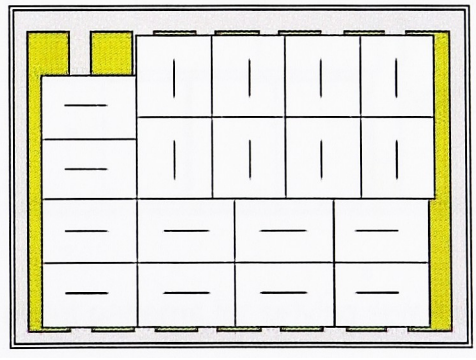
COLUMN pattern – Code: C



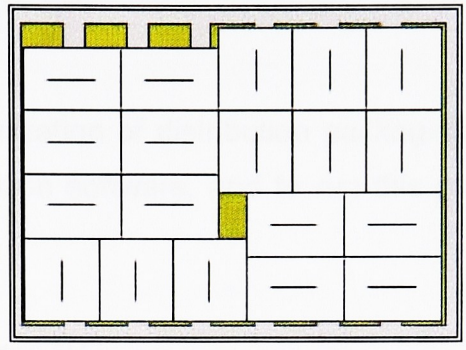
INTERLOCK pattern – Code: I



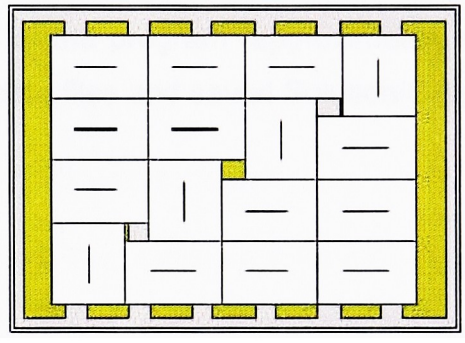
TRILOCK pattern – Code: T



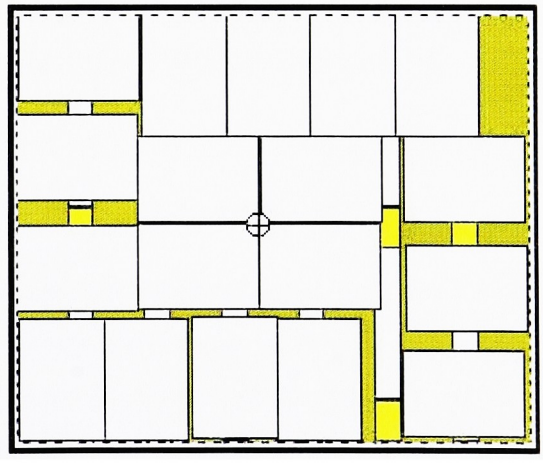
SPIRAL pattern – Code: S



DIAGONAL pattern – Code: D



EXPANDED SPIRAL pattern – Code: X



CAPE program groups use these pallet patterns for solving some packaging problems. (14)

5. EQUIPMENT

The calculation for the optimization of distribution packaging were obtained by using the CAPEPACK'99 millenium edition software, and to run this program the following was needed:

- A Pentium processor
- Windows 95/98 or Windows NT
- Computer must have color graphics capability (minimum of 640 x 480)
- Graphics capable printer
- Minimum of 32 Mbytes of RAM
- Hard Disc for installation of the program (approximately 60 MB of space on HD) and additional space for data files and saved Solution/Graphics files.

6. INPUT DATA PREPARATION

For the purpose of calculating optimization of the distribution packaging, we first had to collect and review all data on currently used cartons (for primary drug packages and pertaining leaflets) and transport boxes (shipping cases). Also, the planned warehouse related data relevant for the palletization input parameters had to be collected. After a detailed review of data about all products and their packaging, by help of SAP-system and current documentation, and after consulting Packaging and Warehousing departments, the necessary calculation inputs were prepared.

To evaluate the results of optimization calculation, besides calculation inputs the restricted demands had to be set up. All results of the Cape'99 software calculations were evaluated against these set values.

6.1. Setting up the optimization limits

Concerning the arrangement of the primary packages in the transport box, and the palletization of the transport boxes the following limits were set up for the results obtained by the Capepack'99 analysis:

A) Pallet Area Efficiency: 90 –100 %

B) Pallet Cube Efficiency: 90 – 100 %

C) Transport Box Cube Efficiency: 80 – 100 %

All the results were compared and evaluated against these limits.

6.2. Palletization of currently used transport boxes

Besides the fact that currently used transport boxes vary in size, there are two types of corrugated boxes in use: plain corrugated boxes and boxes coated with wax for better water resistance. The transport boxes are Regular Slotted Containers, which means that added material thickness for this type of box is 2, 2, 4 for length, width and height, respectively. 5m thick double wall corrugated cardboard was used.

Warehouse demands for palletization are following:

- Maximum pallet height: 1450 mm
- Maximum pallet weight: 600 kg
- Used pallet: EURO pallet (1200 x 800 x 150 mm; 25 kg)

Currently used transport boxes and their dimensions were listed and used for calculations in Pallet Group program (Table 6.2.).

Table 6.2. Database of the used transport boxes for Pallet Group analysis

Transport Box			Inside Dimensions			Material	Outside Dimensions		
No.	Code	Name	L/mm	W/mm	H/mm	Thick./mm	OL/mm	OW/mm	OH/mm
1	732791	KUT. T-1/A	580	255	160	5	590	265	180
2	733006	KUT. T-1/S	345	255	215	5	355	265	235
3	733237	KUT. T-10	410	325	230	5	420	335	250
4	733478	KUT. T-103/A	430	295	280	5	440	305	300
5	732959	KUT. T-104	380	370	250	5	390	380	270
6	732973	KUT. T-108	390	330	165	5	400	340	185
7	732980	KUT. T-111	360	360	115	5	370	370	135
8	732994	KUT. T-120	425	320	230	5	435	330	250
9	732997	KUT. T-122	410	345	115	5	420	355	135
10	733128	KUT. T-127	365	365	355	5	375	375	375
11	733472	KUT. T-129	350	235	140	5	360	245	160
12	733473	KUT. T-130	430	260	330	5	440	270	350
13	733479	KUT. T-131	590	250	200	5	600	260	220
14	733482	KUT. T-132	390	295	240	5	400	305	260
15	720325	KUT. T-132/A	365	310	230	5	375	320	250
16	733489	KUT. T-138	370	370	155	5	380	380	175
17	733496	KUT. T-141	430	310	110	5	440	320	130
18	733499	KUT. T-147	385	385	210	5	395	395	230
19	733501	KUT. T-148	570	350	210	5	580	360	230
20	733240	KUT. T-15	590	250	280	5	600	260	300
21	733001	KUT. T-151	315	215	270	5	325	225	290
22	733241	KUT. T-16	770	355	275	5	780	365	295
23	733243	KUT. T-18	410	325	290	5	420	335	310
24	733245	KUT. T-20	590	355	320	5	600	365	340
25	732866	KUT. T-24/A	385	290	345	5	395	300	365

No.	Code	Name	L/mm	W/mm	H/mm	Thick./mm	OL/mm	OW/mm	OH/mm
26	733258	KUT. T-28	510	215	235	5	520	225	255
27	732906	KUT. T-34/A	440	280	335	5	450	290	355
28	732886	KUT. T-49	585	235	115	5	595	245	135
29	732892	KUT. T-51	350	250	245	5	360	260	265
30	732871	KUT. T-60	510	250	300	5	520	260	320
31	732926	KUT. T-60/A	590	390	210	5	600	400	230
32	732705	KUT. T-63	560	355	230	5	570	365	250
33	732706	KUT. T-64	585	250	120	5	595	260	140
34	732930	KUT. T-66/A	550	185	275	5	560	195	295
35	732704	KUT. T-67	355	355	165	5	365	365	185
36	732933	KUT. T-68/A	585	345	140	5	595	355	160
37	732934	KUT. T-69/A	360	360	250	5	370	370	270
38	733161	KUT. T-7	440	290	240	5	450	300	260
39	732757	KUT. T-75	535	365	205	5	545	375	225
40	732938	KUT. T-75/A	570	370	205	5	580	380	225
41	732759	KUT. T-76	360	290	105	5	370	300	125
42	732761	KUT. T-78	345	290	270	5	355	300	290
43	732945	KUT. T-79/A	555	350	175	5	565	360	195
44	732946	KUT. T-80/A	425	315	235	5	435	325	255
45	732769	KUT. T-83	560	240	260	5	570	250	280
46	732770	KUT. T-84	320	190	270	5	330	200	290
47	OH 732777	KUT. T-91	395	395	165	5	405	405	185
48	no OH	KUT. T-91	390	390	165	5	400	400	185
49	732779	KUT. T-93	530	245	330	5	540	255	350
50	732941/1	KUT. T-96/A	505	210	215	5	515	220	235
51	732941/2	KUT. T-96/A	505	210	215	5	515	220	235
52	733293	KUT. T-neutr.	334	166	120	5	344	176	140
53	732718	KUT. VOT-10	390	240	205	5	400	250	225
54	732754	KUT. VOT-13	545	345	180	5	555	355	200
55	732750	KUT. VOT-15	425	330	380	5	435	340	400
56	732753	KUT. VOT-17	590	370	215	5	600	380	235
57	732758	KUT. VOT-18	620	370	300	5	630	380	320
58	732822	KUT. VOT-2	510	340	345	5	520	350	365

No.	Code	Name	L/mm	W/mm	H/mm	Thick./mm	OL/mm	OW/mm	OH/mm
59	732763	KUT. VOT-20	540	335	290	5	550	345	310
60	732765	KUT. VOT-21	535	425	165	5	545	435	185
61	732780	KUT. VOT-22	540	230	275	5	550	240	295
62	722388	KUT. VOT-24	320	245	190	5	330	255	210
63	732795	KUT. VOT-28	580	255	180	5	590	265	200
64	732823	KUT. VOT-3	465	350	325	5	475	360	345
65	732912	KUT. VOT-32	565	310	210	5	575	320	230
66	732925	KUT. VOT-33	370	370	320	5	380	380	340
67	732947	KUT. VOT-36	410	340	170	5	420	350	190
68	732948	KUT. VOT-37	565	375	300	5	575	385	320
69	732953	KUT. VOT-40	415	340	235	5	425	350	255
70	732954	KUT. VOT-41	540	385	215	5	550	395	235
71	732955	KUT. VOT-42	420	330	300	5	430	340	320
72	732957	KUT. VOT-43	570	350	215	5	580	360	235
73	732966	KUT. VOT-46	520	220	305	5	530	230	325
74	732971	KUT. VOT-48	365	365	435	5	375	375	455
75	733475	KUT. VOT-50	575	335	170	5	585	345	190
76	733477	KUT. VOT-51	390	255	245	5	400	265	265
77	733483	KUT. VOT-53	530	350	365	5	540	360	385
78	733387	KUT. VOT-54	380	280	180	5	390	290	200
79	733490	KUT. VOT-56	400	340	140	5	410	350	160
80	733494	KUT. VOT-57	525	310	115	5	535	320	135
81	726024	KUT. VOT-59	505	195	275	5	515	205	295
82	732832	KUT. VOT-6	595	295	280	5	605	305	300
83	726027	KUT. VOT-61	440	270	335	5	450	280	355
84	726029	KUT. VOT-62	570	365	140	5	580	375	160
85	726046	KUT. VOT-63	580	365	230	5	590	375	250
86	732794	KUT. VOT-69	415	315	225	5	425	325	245
87	732701	KUT. VOT-7	500	305	350	5	510	315	370
88	732747	KUT. VOT-71	685	280	185	5	695	290	205
89	732836	KUT. VOT-72	581	362	148	5	591	372	168
90	720306	KUT. VOT-73	390	295	240	5	400	305	260
91	728541	KUT. VOT-74	385	385	210	5	395	395	230

No.	Code	Name	L/mm	W/mm	H/mm	Thick./mm	OL/mm	OW/mm	OH/mm
92	70000241	KUT. VOT-75	365	310	230	5	375	320	250
93	732712	KUT. VOT-8	425	330	335	5	435	340	355
94	725062	KUT. VOT-neutr. 1	695	335	290	5	705	345	310
95	OH 722608	KUT. VOT-neutr. 2	655	400	430	5	665	410	450
96	no OH	KUT. VOT-neutr. 2	655	390	430	5	665	400	450
97	733194	KUT. VOT-neutr. 3	535	345	145	5	545	355	165
98	OH 732832	KUT. VOT-6	595	295	280	5	605	305	300
99	no OH	KUT. VOT-6	590	290	280	5	600	300	300

Key:

No. - type of transport box that is been used

Inside Dimensions:

L/mm - length of the transport box (mm)

W/mm - width of the transport box (mm)

H/mm - height of the transport box (mm)

Thick./mm - corrugated thickness (mm)

Outside Dimensions:

OL/mm - outside length of the transport box (mm)

OW/mm - outside width of the transport box (mm)

OH/mm - outside height of the transport box (mm)

OH / no OH - overhanging of the transport box

Input data for 99 Pallet group analyses are given in this table, and it presents 95 different transport boxes, and 4 variations of 4 transport boxes. Three variations are given due to overhanging (boxes no. 47/48, 95/96, 98/99) and one on account of two different types of box arrangement on the pallet (box no. 50 and its variation no. 51).

6.3. Data for Casefill Group analysis

For the purpose of this analysis it was necessary to compile all the data on cartons for placing primary packaging and leaflets of all products. The cartons were grouped by Cartoning machine and size. The result of this huge effort was the table comprising carton types, dimensions, weight, data on forming of bundles (if applicable), and the possible vertical dimensions for each carton type (Table 6.3.1.).

The large number of data on all types of unit product packages presented in the table was used as an input for each Casefill Group analysis. One should stress that each type covers a number of different pharmaceutical products packed in a defined folding carton. This means that these 100 types of boxes cover hundreds of folding cartons used for specific products.

The folding cartons are grouped according to the cartoning machine and by packed drug form (for example: tablets, capsules, syrups, dry syrups, ointments, injections, dry injections, drops, dry drops and so on). Therefore, these Groups offer useful information for the application of the obtained results by this Cape analysis.

Next to the Group column in the Table 6.3.1. there are columns for outside dimensions of the used folding cartons (length, width and height). You will notice that the Table shows two identical folding carton dimensions (No. 91 and 99, marked blue). Although the dimensions are identical, these types have different shapes of bundles, they are used for packaging different types of drugs on different cartoning machines, and have different demands for dimensions allowed being vertical. Therefore, this two unit product packaging types should be considered separately.

The following columns show dimension multipliers for defining the bundle (ZbA, ZbB, ZbC). Cases with all three multipliers 1 show that the type has no bundle. Dimensions of bundle, or unit package (where the bundle is not used) are presented in the following columns. Those dimensions are maximum dimensions of each bundle or unit package and they are used in Casefill Group analysis. Most of these dimensions can be computed using the following equation:

$$\text{Maximum Dim. (mm)} = [\ \text{Folding Carton Dim.(mm)} + 1\text{mm}\ ] \times \text{Bundle Multiplier}$$

Some dimensions have slightly larger maximum dimensions for Casefill Group analysis then calculated by this formula. The main reason is difference between bundling materials that are used. Most of the bundles are formed using the PP-foils, or PE-foils, but for some paper is used as wrapping material.

Table 6.3.1. Database of unit product packaging used for the Casefill Group analysis

No.	Group	L/mm	W/mm	H/mm	ZbA	ZbB	ZbC	A/mm	B/mm	C/mm	Vert	Net/g	Gross/g	# per B
1	A&C	34	16	83	6	3	1	210	51	84	all	360	370	18
2	A&C	34	20	83	6	3	1	210	63	84	all	360	370	18
3	B	37	16	83	2	5	1	76	85	84	all	170	180	10
4	B	37	25	83	2	5	1	76	130	84	all	210	220	10
5	B	42	16	103	2	5	1	86	85	104	all	220	230	10
6	B	123	83	68	1	1	1	124	84	69	all	170	180	1
7	Bx	165	100	83	1	1	1	166	101	84	all	190	200	1
8	C	34	30	83	6	2	1	210	62	84	all	252	262	12
9	Cd	34	50	83	5	2	1	175	102	84	all	575	585	10
10	Cx	42	33	102	1	1	1	43	34	103	all	23	33	1
11	D	43	16	99	5	4	1	220	68	100	all	323	333	20
12	D	43	20	99	5	4	1	220	84	100	all	466	476	20
13	D	43	25	99	5	4	1	220	104	100	all	520	530	20
14	D	43	30	99	5	2	1	220	62	100	all	321	331	10
15	D	43	50	99	5	2	1	220	102	100	all	583	593	10
16	D	56	21,5	91	5	4	1	285	90	92	all	454	464	20
17	D	56	29,5	91	5	2	1	285	61	92	all	323	333	10
18	D	56	38	91	5	2	1	285	78	92	all	414	424	10
19	D	56	50	91	5	2	1	285	102	92	all	505	515	10
20	D	91	72	56	1	1	1	92	73	57	all	24	34	1
21	D&L	45	30	103	5	2	1	230	62	104	all	446	456	10
22	E	35	15	83	1	10	1	36	160	84	all	100	110	10
23	E	42	15	99	1	10	1	43	160	100	all	110	120	10
24	Ed	55	15	91	1	10	1	56	160	92	all	220	230	10
25	Ed	55	22	91	1	10	1	56	230	92	all	230	240	10
26	Ed	55	31	91	1	10	1	56	320	92	all	323	333	10
27	Ed	62	15	65	1	10	1	63	160	66	all	105	115	10
28	Ed	62	20	65	1	10	1	63	210	66	all	180	190	10
29	Ed	65	15	130	1	10	1	66	160	131	all	170	180	10
30	Ed	65	18	130	1	10	1	66	190	131	all	210	220	10
31	F	40	15	101	2	5	1	82	80	102	all	200	210	10

No.	Group	L/mm	W/mm	H/mm	ZbA	ZbB	ZbC	A/mm	B/mm	C/mm	Vert	Net/g	Gross/g	# per B
32	F	77	20	108	2	5	1	156	105	109	all	250	260	10
33	Fd	40	20	101	2	5	1	82	105	102	all	250	260	10
34	Fd	40	33	101	2	5	1	82	170	102	all	250	260	10
35	Fd	50	15	130	2	5	1	102	80	131	all	250	260	10
36	Fd	50	25	130	2	5	1	102	130	131	all	250	260	10
37	Fd	50	43	130	2	5	1	102	220	131	all	250	260	10
38	Fd	52	15	99	2	5	1	106	80	100	all	250	260	10
39	Fd	52	30	99	2	5	1	106	155	100	all	250	260	10
40	Fd	52	35	99	2	5	1	106	180	100	all	250	260	10
41	Fd	52	54	99	2	5	1	106	275	100	all	250	260	10
42	Fd	66	52	99	2	5	1	134	265	100	all	250	260	10
43	G	81	22	78	1	1	1	82	23	79	all	25	26	1
44	G	81	33	73	1	1	1	82	34	74	all	45	46	1
45	G	81	71	154	1	1	1	82	72	155	all	210	220	1
46	H&N	73	22	81	2	5	1	148	115	82	all	250	260	10
47	H&N	73	33	81	2	5	1	148	170	82	all	450	460	10
48	I	99	90	178	1	1	1	100	91	179	all	510	520	1
49	I	195	115	110	1	1	1	196	116	111	all	910	920	1
50	I&N	84	22	99	2	5	1	170	115	100	all	400	410	10
51	I&N	84	40	99	2	5	1	170	205	100	all	900	910	10
52	J	56,5	45,5	108,5	5	2	1	288	93	110	110	1059	1069	10
53	J	59,5	56,5	108,5	5	2	1	303	115	112	112	1465	1475	10
54	K	37	37	94	10	2	1	380	76	95	all	1245	1255	20
55	L	38	38	122	5	2	1	195	78	123	123	750	760	10
56	L	58	21,5	91	5	3	1	295	68	92	all	403	413	15
57	L	61	18	105	5	4	1	310	76	106	all	340	350	20
58	L	72	25	103	1	1	1	73	26	104	all	21	31	1
59	M	32,5	32,5	66,5	5	2	1	168	67	68	68	250	260	10
60	M	38	38	69	5	2	1	195	78	70	70	650	660	10
61	O	40,5	40,5	62	1	1	1	42	42	63	63	40	41	1
62	O	48	48	100	5	2	1	245	98	101	101	1150	1160	10
63	O	48	48	75	1	1	1	49	49	76	76	90	100	1

No.	Group	L/mm	W/mm	H/mm	ZbA	ZbB	ZbC	A/mm	B/mm	C/mm	Vert	Net/g	Gross/g	# per B
64	O	56	56	100	5	2	1	285	114	101	101	1250	1260	10
65	O	71	20	143	1	10	1	72	210	144	all	280	290	10
66	O	120	85	55	1	1	1	121	86	56	all	35	45	1
67	O	160	105	65	1	1	1	161	106	66	all	150	160	1
68	Od	124	57	115	1	1	1	125	58	116	116	400	410	1
69	P	56	56	131	5	2	1	285	114	132	132	2490	2500	10
70	P	63	63	153	5	2	1	320	128	154	154	3880	3890	10
71	R	20	20	90	5	4	1	105	84	91	all	180	190	20
72	R	33	22	111	5	4	1	170	92	112	all	520	530	20
73	R	33	22	133	5	4	1	170	92	134	all	620	630	20
74	R	42	28	133	5	4	1	215	116	134	all	890	900	20
75	R	43	32	160	5	2	1	220	66	161	all	800	810	10
76	Ra	52	20	100	2	12	1	106	252	101	all	600	610	24
77	R	42	33	157	5	2	1	215	68	158	all	800	810	10
78	S	165	65	64	1	1	1	166	66	65	65	350	360	1
79	S	168	37,5	65	1	1	1	169	39	66	66	180	190	1
80	S	212	92	88	1	1	1	213	93	89	89	875	885	1
81	Ti	35	35	66,5	5	2	1	175	73	68	68	250	260	10
82	Ti	114	24	53	1	1	1	115	25	54	54	120	130	1
83	Ti	140	31	65	1	1	1	141	32	66	66	180	190	1
84	Ti	160	35	65	1	1	1	161	36	66	66	180	190	1
85	Ti	168	37,5	65	1	1	1	169	39	66	66	190	200	1
86	Tk	51	32	107	1	10	1	52	330	110	110	500	510	10
87	Tk	62	36	119	1	10	1	63	360	120	120	750	760	10
88	Tkaps	40,5	40,5	73,5	5	2	1	198	80	75	75	700	710	10
89	Tkaps	45	45	72,5	5	2	1	230	90	75	75	900	910	10
90	Tkaps	58,5	58,5	110	1	1	1	60	60	111	111	190	200	1
91	Tkaps	61	20	66	2	10	1	124	220	68	68	500	510	20
92	Tl	56	56	128	1	1	1	57	57	129	129	230	240	1
93	Tl	63	56	135	1	1	1	64	57	136	136	240	250	1
94	U	40	40	107	1	1	1	41	41	108	108	90	100	1
95	U	40	40	150	1	1	1	41	41	151	151	110	120	1

No.	Group	L/mm	W/mm	H/mm	ZbA	ZbB	ZbC	A/mm	B/mm	C/mm	Vert	Net/g	Gross/g	# per B
96	U	110	110	20	1	1	1	111	111	21	all	50	60	1
97	V-kapi	33	33	78	5	2	1	170	68	79	79	500	510	10
98	Z	159	60	53	1	1	1	160	61	54	54	340	350	1
99	X	61	20	66	4	5	1	248	105	67	all	500	510	20
100	X	82	81	60	1	1	1	83	82	61	all	190	200	1

Key:

No. - type of the used folding carton

Group - groups of folding cartons according to the used cartooning machinery and packed form of drug

L/mm - length of the folding carton (mm)

W/mm - width of the folding carton (mm)

H/mm - height of the folding carton (mm)

ZbA - multiplier for the length of folding cartons

ZbB - multiplier for the width of folding cartons

ZbC - multiplier for the height of folding cartons

A/mm - bundle length (mm)

B/mm - bundle width (mm)

C/mm - bundle height (mm)

Vert - dimensions allowed to be vertical

Net /g - net mass of the bundle (g)

Gross/g - gross mass of the bundle (g)

 # per B - number of the unit packs per bundle

Besides with these data, it was necessary to plan the database of the acceptable transport boxes for packaging those unit cartons or bundles. Because the available transport boxes are many and their palletizing efficiency is very variable, the standard DIN 55 520 was used as a reference for creating the transport box database. (15)

The DIN 55 520 offers 20 different box sizes for pallet size 1200 x 800 mm. Considering the fact that warehouse employees prefer such palletization that allows all the boxes to be seen (there are no middle columns of boxes inside the pallet), 5 different types

of the 20 offered box sizes were selected while additional type was added as a variation of the already used combination. The attention was also paid to the dimensions of the offered size combinations. Because in this case the large boxes are not preferable, chosen solutions were under the recommended GDP maximum dimensions. Since square boxes (two of equal dimensions) already in use present no problem, this DIN solution was added to the list of possible transport box dimensions.

The DIN standard gave the dimensions for the outside length and width of the box, possible box heights remained to be determined. From the data about maximum height of the pallet load (1450 mm), and the height of the used EURO pallet (150 mm) it was easy to calculate the maximum height of the box layers on the pallet that is 1300 mm. This simple equation gives us the maximum height of the box layers on the pallet:

Max. Height of the box layers = 1450 mm – 150 mm = 1300 mm

According to this height, and the given thickness of corrugated cardboard for transport boxes made as regular slotted container (RSC), and the height of the unit drug cartons or bundles, the calculation of possible transport box heights produced four different box heights (165mm, 195mm, 240mm and 305mm – inside dimensions).

By combining the dimension sizes of length and width with the possible heights of the boxes, and after calculating their palletization efficiency by CAPE'99 Pallet Group program, the list of the possible transport boxes was made (Table 6.3.2.). It is also important to pay attention to the maximum weight of the transport box, considering the new warehouse limit of 600 kg for the maximum pallet load.

Table 6.3.2. Database of the transport boxes prepared for the Casefill Group analysis

No.	Case	Length/mm	Width/mm	Height/mm	# Per Load	Area eff./%	Cube eff./%	Max.m/kg
1	TK-1A	585	255	165	42	98,5	98,2	13,69
2	TK-1B	585	255	195	36	98,5	97,8	15,97
3	TK-1C	585	255	240	30	98,5	98,5	19,17
4	TK-2A	550	230	165	49	98,0	97,6	11,73
5	TK-2B	550	230	195	42	98,0	97,2	13,69
6	TK-2C	550	230	240	35	98,0	98,0	16,43
7	TK-3A	385	385	165	42	97,5	97,1	13,69
8	TK-3B	385	385	195	36	97,5	96,8	15,97
9	TK-3C	385	385	240	30	97,5	97,5	19,17
10	TK-3D	385	385	305	24	97,5	97,5	23,96
11	TK-4B	390	255	195	54	99,4	98,6	10,65
12	TK-4C	390	255	240	45	99,4	99,4	12,78
13	TK-4D	390	255	305	36	99,4	99,4	15,97
14	TK-5C	385	225	240	50	96,7	96,7	11,50
15	V-6A	590	385	165	28	98,8	98,4	20,54
16	V-6B	590	385	195	24	98,8	98,0	23,96
17	V-6C	590	385	240	20	98,8	98,8	28,75

Key:

Length, Width, and Height - inside dimensions of the transport box (mm)

Per Load - Number of cases per pallet load

Area eff. /% - Pallet Area Efficiency for transport box (%)

Cube eff./% - Pallet Cube Efficiency for transport box (%)

Max.m/kg - Maximum weight of the transport box

(Calculated considering the number of transport boxes on the pallet (# Per Load), maximum pallet weight defined for the warehouse (600 kg), and weight of the EURO pallet (25 kg)

Equation: Max.m/kg = (600-25) kg / (# Per Load)

It is important to remember that the recommended maximum weight according to the Good Distribution Practice is 20,5 kg (45 lb.) and therefore all values above this limit shall be reduced to 20,5 kg.

This database of the 17 transport boxes was used in the Casefill Group analysis for all the 100 types of unit pack cartons or bundles, to get results of the "1st circle" optimization calculations.

After the "1st circle" of the optimization calculation there were still 18 carton types that did not give satisfactory results, so an added database of transport boxes was made for the "2nd circle" of Casefill Group analysis. This second database had another 11 variations of the transport boxes created as a combination of existing transport boxes with good palletizing results and some of the variations of the transport boxes from the first database. The Arrange Group program and Design Group program were also used to define some of the dimensions of added transport boxes (Table 6.3.3.).

Table 6.3.3. Database of the transport boxes for added Casefill Group analysis

No.	Case	Length/mm	Width/mm	Height/mm	# Per Load	Area eff./%	Cube eff./%	Max.m/kg
1	TK-1E	585	255	140	48	98,5	97,0	11,98
2	TK-2E	550	230	220	35	98,0	90,5	16,43
3	TK-8A	505	270	305	24	90,1	90,1	23,96
4	TK-9A	385	290	305	32	98,8	98,8	17,97
5	TK-10A	305	240	240	55	90,2	90,2	10,45
6	TK-11A	565	375	140	32	92,2	90,8	17,97
7	TK-28A	385	225	190	60	96,7	93,7	9,58
8	Tx-15	585	250	290	24	96,7	92,2	23,96
9	VOT-37	565	375	300	16	92,2	90,8	35,94
10	VOT-40	415	340	235	30	93,0	91,2	19,17
11	VOT-42	420	330	300	24	91,4	90,0	23,96

(For this table the key is same as for the Table 6.3.2.)

Those data were used for calculating the optimization of the distribution packaging. It is important to point out that the dimensions of the unit pack cartons and bundles for this calculation were constant, because of the machines currently used for the packaging process.

7. PROCEDURE

The Capepack'99 calculations were carried out in this sequence:

(1) Calculation of the pallet efficiency for existing transport boxes, by using the Pallet Group program.

(2) Calculation of the pallet efficiency for potential transport boxes, based on the DIN 55 520 standard and planned maximum height of the pallet load

(3) Calculation of arrangement and cube efficiency of packaging the unit drug cartons and bundles into the prepared transport boxes, by using the Casefill Group program.

(4) Evaluation of results of the Casefill Group analysis and finding out the possible transport boxes for unit drug cartons and bundles whose cube efficiency was under the set limit of 80% in the "1st circle" of Casefill Group analysis. For additional database some existing transport boxes with good palletization efficiency were selected, as well as new boxes designed by Arrange Group analysis and Design Group analysis.

(5) Calculation of arrangement and cube efficiency of packaging the unit drug cartons and bundles from the step (4) into the prepared transport boxes, by using the Casefill Group program.

(6) Review of all results of Capepack'99 analysis and selection of the most suitable optimization results.

(7) Comparison of existing situation with the one proposed from the optimization results.

8. DATA ANALYSIS

8.1. Pallet Group analysis of the existing transport boxes

The Pallet Group analysis of the existing transport boxes gave various results for pallet load efficiency (Table 8.1.). It is important to emphasize that in the conditions of new warehouse, the efficiency of some boxes proved solid or even good results, but there were also boxes whose palletization efficiency was poor, as demonstrated in the Table 8.1.

As already mentioned in the theoretical segment of this thesis, overhanging is one of the biggest problems in palletization, as it may cause significant damages of products during distribution. In the Table 8.1. three cases of overhanging (T-91, VOT-neutr.2 and VOT-6, marked red) are presented, together with their palletization results, as well as results of palletization without overhanging.

Beside, the table also shows one case of palletizing the same transport box in two pallet pattern types (box T-96/A, marked blue) that are used for two different products.

Inside dimensions of the boxes are shown in the table, since all transport boxes are ordered on the basis of inside dimensions and corrugated cardboard thickness (5 mm). All boxes are Regular Slotted Containers (RSC), meaning that Material Thickness Added in Each Dimension (L, W, H) of box type is 2, 2, 4 for length, width and height respectively. Outside dimensions are easily calculated by Cape program.

For example:

The box T-1/A is RSC- box with inside dimensions 580x255x160 mm

Outside dimensions are: 580 mm + 2 x 5 mm = 590 mm
255 mm + 2 x 5 mm = 265 mm
160 mm + 4 x 5 mm = 180 mm.

Inside dimensions: 580x255x160 mm

Outside dimensions: 590x265x180 mm.

Together with the results of area and cube efficiency, the table shows the number of box layers on the pallet, the number of boxes in a layer and the number of boxes on the pallet. Attention should be paid to the box weight, bearing in mind the maximum pallet weight (600 kg) and the maximum box weight (20,5 kg).

(This calculation is explained in the section 6.3. Data for Casefill Group analysis.)

Table 8.1. Database of the Pallet Group analysis for the existing transport boxes

No.	Code	Name	L/mm	W/mm	H/mm	A eff./%	C eff./%	L	# per L	# per P	Max.m/kg
1	732791	KUT. T-1/A	580	255	160	97,7	94,7	7	6	42	13,69
2	733006	KUT. T-1/S	345	255	215	88,2	79,7	5	9	45	12,78
3	733237	KUT. T-10	410	325	230	87,9	84,6	5	6	30	19,17
4	733478	KUT. T-103/A	430	295	280	83,9	77,4	4	6	24	23,96
5	732959	KUT. T-104	380	370	250	92,6	76,9	4	6	24	23,96
6	732973	KUT. T-108	390	330	165	85,0	84,7	7	6	42	13,69
7	732980	KUT. T-111	360	360	115	85,6	80,0	9	6	54	10,65
8	732994	KUT. T-120	425	320	230	89,7	86,3	5	6	30	19,17
9	732997	KUT. T-122	410	345	115	93,2	87,1	9	6	54	10,65
10	733128	KUT. T-127	365	365	355	87,9	76,1	3	6	18	31,94
11	733472	KUT. T-129	350	235	140	82,7	81,4	8	9	72	7,99
12	733473	KUT. T-130	430	260	330	74,3	60,0	3	6	18	31,94
13	733479	KUT. T-131	590	250	200	97,5	82,5	5	6	30	19,17
14	733482	KUT. T-132	390	295	240	76,3	76,3	5	6	30	19,17
15	720325	KUT. T-132/A	365	310	230	75,0	72,1	5	6	30	19,17
16	733489	KUT. T-138	370	370	155	90,3	85,0	7	6	42	13,69
17	733496	KUT. T-141	430	310	110	88,0	88,0	10	6	60	9,58
18	733499	KUT. T-147	385	385	210	97,5	86,3	5	6	30	19,17
19	733501	KUT. T-148	570	350	210	87,0	77,0	5	4	20	28,75
20	733240	KUT. T-15	590	250	280	97,5	90,0	4	6	24	23,96
21	733001	KUT. T-151	315	215	270	91,4	81,6	4	12	48	11,98
22	733241	KUT. T-16	770	355	275	89,0	80,8	4	3	12	47,92
23	733243	KUT. T-18	410	325	290	87,9	83,9	4	6	24	23,96
24	733245	KUT. T-20	590	355	320	91,3	71,6	3	4	12	47,92
25	732866	KUT. T-24/A	385	290	345	98,8	83,2	3	8	24	23,96
26	733258	KUT. T-28	510	215	235	85,3	83,7	5	7	35	16,43

No.	Code	Name	L/mm	W/mm	H/mm	A eff./%	C eff./%	L	# per L	# per P	Max.m/kg
27	732906	KUT. T-34/A	440	280	335	81,6	66,8	3	6	18	31,94
28	732886	KUT. T-49	585	235	115	91,1	85,2	9	6	54	10,65
29	732892	KUT. T-51	350	250	245	87,8	71,6	4	9	36	15,97
30	732871	KUT. T-60	510	250	300	84,5	83,2	4	6	24	23,96
31	732926	KUT. T-60/A	590	390	210	100,0	88,5	5	4	20	28,75
32	732705	KUT. T-63	560	355	230	86,7	83,4	5	4	20	28,75
33	732706	KUT. T-64	585	250	120	96,7	83,3	8	6	48	11,98
34	732930	KUT. T-66/A	550	185	275	91,0	82,6	4	8	32	17,97
35	732704	KUT. T-67	355	355	165	83,3	82,9	7	6	42	13,69
36	732933	KUT. T-68/A	585	345	140	88,0	86,7	8	4	32	17,97
37	732934	KUT. T-69/A	360	360	250	85,6	71,1	4	6	24	23,96
38	733161	KUT. T-7	440	290	240	84,4	84,4	4	6	24	23,96
39	732757	KUT. T-75	535	365	205	85,2	73,7	5	4	20	28,75
40	732938	KUT. T-75/A	570	370	205	91,8	79,5	5	4	20	28,75
41	732759	KUT. T-76	360	290	105	92,5	88,9	10	8	80	7,19
42	732761	KUT. T-78	345	290	270	88,8	79,2	4	8	32	17,97
43	732945	KUT. T-79/A	555	350	175	84,8	76,3	6	4	24	23,96
44	732946	KUT. T-80/A	425	315	235	88,4	86,7	5	6	30	19,17
45	732769	KUT. T-83	560	240	260	89,1	76,7	4	6	24	23,96
46	732770	KUT. T-84	320	190	270	96,3	85,9	4	14	56	10,27
47	OH 732777	KUT. T-91	395	395	165	34,2	34,0	7	6	42	13,69
48	no OH	KUT. T-91	390	390	165	100,0	99,6	7	6	42	13,69
49	732779	KUT. T-93	530	245	330	86,1	69,5	3	6	18	31,94
50	732941/1	KUT. T-96/A	505	210	215	70,8	64,0	5	6	30	19,17
51	732941/2	KUT. T-96/A	505	210	215	82,6	74,1	5	7	35	16,43
52	733293	KUT. T-neutr.	334	166	120	75,7	73,4	9	12	108	5,32
53	732718	KUT. VOT-10	390	240	205	93,8	81,1	5	9	45	12,78

No.	Code	Name	L/mm	W/mm	H/mm	A eff./%	C eff./%	L	# per L	# per P	Max.m/kg
54	732754	KUT. VOT-13	545	345	180	82,1	75,8	6	4	24	23,96
55	732750	KUT. VOT-15	425	330	380	77,0	71,1	3	5	15	38,33
56	732753	KUT. VOT-17	590	370	215	95,0	85,9	5	4	20	28,75
57	732758	KUT. VOT-18	620	370	300	74,8	73,7	4	3	12	47,92
58	732822	KUT. VOT-2	510	340	345	75,8	63,9	3	4	12	47,92
59	732763	KUT. VOT-20	540	335	290	79,1	75,4	4	4	16	35,94
60	732765	KUT. VOT-21	535	425	165	49,4	49,2	7	2	14	41,07
61	732780	KUT. VOT-22	540	230	275	96,3	87,4	4	7	28	20,54
62	722388	KUT. VOT-24	320	245	190	87,7	85,0	6	10	60	9,58
63	732795	KUT. VOT-28	580	255	180	97,9	90,2	6	6	36	15,97
64	732823	KUT. VOT-3	465	350	325	71,3	56,7	3	4	12	47,92
65	732912	KUT. VOT-32	565	310	210	76,7	67,8	5	4	20	28,75
66	732925	KUT. VOT-33	370	370	320	90,3	70,8	3	6	18	31,94
67	732947	KUT. VOT-36	410	340	170	91,9	80,6	6	6	36	15,97
68	732948	KUT. VOT-37	565	375	300	92,2	90,8	4	4	16	35,94
69	732953	KUT. VOT-40	415	340	235	93,0	91,2	5	6	30	19,17
70	732954	KUT. VOT-41	540	385	215	90,5	81,8	5	4	20	28,75
71	732955	KUT. VOT-42	420	330	300	91,4	90,0	4	6	24	23,96
72	732957	KUT. VOT-43	570	350	215	87,0	78,6	5	4	20	28,75
73	732966	KUT. VOT-46	520	220	305	88,9	88,9	4	7	28	20,54
74	732971	KUT. VOT-48	365	365	435	87,9	61,5	2	6	12	47,92
75	733475	KUT. VOT-50	575	335	170	84,1	73,7	6	4	24	23,96
76	733477	KUT. VOT-51	390	255	245	99,4	81,0	4	9	36	15,97
77	733483	KUT. VOT-53	530	350	365	81,0	72,0	3	4	12	47,92
78	733387	KUT. VOT-54	380	280	180	94,3	87,0	6	8	48	11,98
79	733490	KUT. VOT-56	400	340	140	89,7	88,3	8	6	48	11,98
80	733494	KUT. VOT-57	525	310	115	71,3	51,9	7	4	28	20,54

No.	Code	Name	L/mm	W/mm	H/mm	A eff./%	C eff./%	L	# per L	# per P	Max.m/kg
81	726024	KUT. VOT-59	505	195	275	77,0	69,9	4	7	28	20,54
82	732832	KUT. VOT-6	595	295	280	57,7	53,2	4	3	12	47,92
83	726027	KUT. VOT-61	440	270	335	78,8	64,5	3	6	18	31,94
84	726029	KUT. VOT-62	570	365	140	90,6	89,2	8	4	32	17,97
85	726046	KUT. VOT-63	580	365	230	92,2	88,6	5	4	20	28,75
86	732794	KUT. VOT-69	415	315	225	86,3	81,3	5	6	30	19,17
87	732701	KUT. VOT-7	500	305	350	66,9	57,2	3	4	12	47,92
88	732747	KUT. VOT-71	685	280	185	84,0	79,5	6	4	24	23,96
89	732836	KUT. VOT-72	581	362	148	91,6	82,9	7	4	28	20,54
90	720306	KUT. VOT-73	390	295	240	76,3	76,3	5	6	30	19,17
91	728541	KUT. VOT-74	385	385	210	97,5	86,3	5	6	30	19,17
92	70000241	KUT. VOT-75	365	310	230	75,0	72,1	5	6	30	19,17
93	732712	KUT. VOT-8	425	330	335	77,0	63,1	3	5	15	38,33
94	725062	KUT. VOT-neutr. 1	695	335	290	76,0	72,5	4	3	12	47,92
95	OH 722608	KUT. VOT-neutr. 2	655	400	430	56,8	39,3	2	2	4	143,75
96	no OH	KUT. VOT-neutr. 2	655	390	430	83,1	57,5	2	3	6	95,83
97	733194	KUT. VOT-neutr. 3	535	345	145	80,6	71,6	7	4	28	20,54
98	OH 732832	KUT. VOT-6	595	295	280	57,7	53,2	4	3	12	47,92
99	no OH	KUT. VOT-6	590	290	280	75,0	69,2	4	4	16	35,94
				Mean Value:		**84,8**	**77,0**				

Key:

Inside dimensions of the transport box:

L/mm - length (mm),

W/mm - width (mm),

H/mm - height (mm)

A eff./% - Pallet Area Efficiency for transport box (%)

C eff./% - Pallet Cube Efficiency for transport box (%)

L - number of the box layers on the Pallet

per L - number of the transport boxes per layer

per P - number of the transport boxes per pallet

Max.m/kg - maximum weight of the transport box
(Weight calculated considering the number of transport boxes on the pallet (# per P), maximum pallet weight defined for the warehouse (600 kg), and weight of the EURO pallet (25 kg)

Equation:	Max.m/kg = (600-25) kg / (# per P)

It is important to remember that the recommended maximum weight according to the Good Distribution Practice is 20,5 kg (45 lb.) and therefore all values above this limit shall be reduced to 20,5 kg.

Please note the calculated mean values of the Pallet Area efficiency and Pallet Cube efficiency given at the end of the table. Those numbers will be good basis for comparison of the current and proposed packaging situation.

8.2. Casefill Group analysis

The results of the Casefill Group analysis are shown in the Table 8.2.1. The table lists only the results of the cube transport box efficiency above 80%.

These cube efficiencies for arrangement of bundles or unit packs in proposed transport boxes should be considered as possible solutions. These solutions entail different number of unit packs per pallet and per box, and different type of the transport box arrangements. Therefore, cube efficiency is one of the many things that should be considered in the assortment of the Casefill analysis results.

Besides of the cube efficiency, the arrangement of unit packs or bundles in the box is also important. Important are also the number of the units per load, the weight of the transport box with the product inside, and the group of the folding carton type in order to minimize number of different transport boxes used per cartonong machine.

Table 8.2.1. Database of the results for Casefill Group analysis

No.	TK-1A	TK-1B	TK-1C	TK-2A	TK-2B	TK-2C	TK-3A	TK-3B	TK-3C	TK-3D	TK-4B	TK-4C	TK-4D	TK-5C	V-6A	V-6B	V-6C
1			**85,4**				88,3		80,9			86,7			86,4		80,9
2			**83,8**					92,3	81,2			83,8				90,3	85,6
3											83,9	81,8	**85,9**				
4	80,9		83,5		80,7	82,0	81,4		84,0	88,1		93,9	**98,5**		84,1		
5								84,2		80,7						**82,4**	
6	81,8		84,3							82,7		81,3	**85,3**		80,5		83,1
7											79,9		**83,6**			79,5	
8			**85,5**		79,8	82,9		90,8	79,9		84,6	82,5				88,9	84,3
9		82,5						83,0		79,6	**85,0**					84,6	
10		80,8	**91,3**			90,3		83,4	94,8	93,3	81,5	92,7	86,9	91,3		84,3	92,8
11									84,1								**85,1**
12			87,7						83,1			85,2	91,4				**88,1**
13																	
14			87,8		82,9	85,4			80,5			80,0	80,9	85,3			**85,1**
15																	
16								81,6		83,5						**85,2**	
17		88,0						83,0		88,4			84,4			**86,7**	
18		84,4					83,6		86,2				87,7		87,3	83,1	**90,0**
19																	
20	80,9	89,5	85,5	80,7	90,0	85,7	81,4	87,4	90,4	88,9	86,9	83,4	85,8	88,4	83,8	89,9	**92,7**
21			91,1		90,2	92,8			87,5			87,0		85,6			**89,8**
22	**94,4**	83,2		92,7			95,0	80,4			79,8						
23	86,7			92,3			90,0						**88,5**		91,8		
24	87,1		82,9	86,9	86,9		87,6	91,3		87,5		82,9	81,5		**90,2**	85,6	
25		81,5	86,1		86,5	85,9			86,6			84,4		91,2			**89,1**
26								79,9								**81,9**	
27	94,6	82,3			**89,0**		89,8	82,9		82,4					94,1	85,6	
28			80,5		**85,0**							80,5					80,1
29				79,5											**81,2**		

No.	TK-1A	TK-1B	TK-1C	TK-2A	TK-2B	TK-2C	TK-3A	TK-3B	TK-3C	TK-3D	TK-4B	TK-4C	TK-4D	TK-5C	V-6A	V-6B	V-6C
30					79,9											**81,6**	
31	87,0		**89,7**				87,5		90,3			92,5			89,3		
32				**85,5**					80,3								
33				84,2								**80,9**					
34				81,7			81,4				80,7				**83,5**		
35			80,6	81,9		84,5			81,1						79,9		**82,4**
36																	
37																	
38			80,5	81,3		83,8				**90,0**			83,9				
39			82,6							**87,2**							
40									85,8								**84,0**
41																	
42																	
43	96,9	86,0	97,4	94,2	79,7	94,2	93,8		93,0		81,4	95,5		90,3	97,0	82,1	**96,7**
44	93,9		89,9	94,9	80,3	90,4	94,5	79,9	87,0	91,3	79,8	90,8	92,5	83,4	96,9	82,0	**92,7**
45	89,2			87,7			89,8								**92,8**		
46	85,1			80,2		82,7	79,9			80,3		81,9	82,8		89,4		**87,0**
47	83,8												**81,6**				
48								90,2		**86,5**						88,3	
49						83,1											**83,3**
50									87,9								**86,1**
51										**92,5**							
52									82,8								**86,5**
53																	
54							89,7	94,9	**92,5**	91,0	84,9		81,4		87,8	86,7	M
55																	
56										**85,7**			85,2			83,3	81,2
57		85,9	**83,7**		81,0							83,7					
58	86,6	85,5	89,3	85,1	84,0	87,8	87,2	86,0	89,9	86,5	85,5	89,3	85,9	94,0	91,6	90,5	**94,5**
59										**81,3**							

No.	TK-1A	TK-1B	TK-1C	TK-2A	TK-2B	TK-2C	TK-3A	TK-3B	TK-3C	TK-3D	TK-4B	TK-4C	TK-4D	TK-5C	V-6A	V-6B	V-6C
60			80,3							M		80,3	**84,2**				M
61		89,4			87,9			93,4		79,6	92,8					**94,8**	
62																	
63	81,5		84,1							M		80,3	**84,2**		81,8		M
64																	
65																	79,9
66		80,1			80,3				85,2	83,8						82,9	**89,8**
67	86,9			86,3		81,6	92,1			79,7					**93,2**		
68			**94,0**						85,1			84,6					M
69																	
70															**84,2**		
71		82,8	80,7					88,9		**85,2**	82,8	80,7				90,6	82,4
72					**85,2**												
73																**80,4**	
74			84,0			88,1			84,5			84,0					**85,8**
75				**89,6**		84,7				82,7					81,1		
76													**80,1**				
77				**88,5**		83,7				81,8					80,1		84,7
78		80,8						88,7								**86,8**	
79													**80,3**				
80																	
81			80,1										**80,2**				
82	94,6	80,1		**98,2**	83,1	M	93,3		M	M	81,7	88,5		83,6	M	M	M
83																	
84										**81,2**							
85													**80,3**				
86									84,9								**83,1**
87									91,8			91,2					**89,9**
88			79,6						**80,1**								M
89				89,3		**92,0**				M			81,9				M

No.	TK-1A	TK-1B	TK-1C	TK-2A	TK-2B	TK-2C	TK-3A	TK-3B	TK-3C	TK-3D	TK-4B	TK-4C	TK-4D	TK-5C	V-6A	V-6B	V-6C
90			80,4						**80,9**			80,4					
91														**80,3**			
92																	
93																	
94			**85,2**						82,7			82,1					M
95	86,6						84,1			91,0			**90,4**		85,3		
96		80,1	89,6			88,6			88,7			88,9		89,6			**90,2**
97	81,6		84,2			81,2	89,6		92,4			80,4			**87,7**		M
98	83,5			90,9		83,3	**90,5**					79,5		81,1			M
99																	
100	**94,5**	89,9		95,5	80,8		88,3				81,4		82,1		93,0		

Key:

No. - marks the type of the folding carton described in the chapter 6.3. Data for the Casefill Group analysis, Table 6.3.1.

M - negative results because of the problem with the weight limit for the transport box

The table lists only acceptable cube efficiency results obtained by the Casefill analysis of 100 unit pack types, each analyzed through 17 different transport boxes described in the chapter 6.3. Data for Casefill Group analysis (Table 6.3.2.). Also presented are marginal results that are close to the limit (between the 79,5 – 80,0) and M stands for results that had the problem with the weight limit of the transport box.

There are 18 folding carton types whose results were under the limit of the 80,0% of the cube efficiency and they are marked as blue lines in the table. Those folding carton types needed further Cape analysis in order to get the satisfactory result. Other 82 folding carton types were successfully packed in proposed 17 transport boxes and their positive results are presented in the table. For majority of the folding carton types there is more than one positive solution so the comparison was made and the most appropriate solution for each type is marked **bold** in the table.

After the most appropriate solutions were pointed out, the use of the transport boxes was analyzed. Results from the Table 8.2.1. were analyzed from the aspect of the proposed transport boxes use. The table 8.2.2. presents the summary of this analysis.

Table 8.2.2. Analysis of the use of proposed transport boxes from Casefull group analysis

No.	Case	# positive sol.	# selected sol.	Usage / %	Total Usage
1	TK-1A	21	2	2,4	51,2
2	TK-1B	18	0	0,0	0,0
3	TK-1C	31	8	9,8	302,4
4	TK-2A	21	4	4,9	102,4
5	TK-2B	16	3	3,7	58,5
6	TK-2C	22	1	1,2	26,8
7	TK-3A	21	1	1,2	25,6
8	TK-3B	17	0	0,0	0,0
9	TK-3C	31	3	3,7	113,4
10	TK-3D	26	8	9,8	253,7
11	TK-4B	13	1	1,2	15,9
12	TK-4C	32	1	1,2	39,0
13	TK-4D	28	13	15,9	443,9
14	TK-5C	12	1	1,2	14,6
15	V-6A	25	7	8,5	213,4
16	V-6B	24	8	9,8	234,1
17	V-6C	30	21	25,6	768,3
	Sum	388	82	100	

Key:

 # positive sol. - number of all positive solutions for the transport box

 # selected sol. - number of selected positive solutions that are the most appropriate for a folding carton type

Usage / % - percentage of the transport box use as a ratio of selected solution compared to the total number of selected solutions

Equation: Usage (%) = 100% x (# selected sol.) / 82

Total Usage - relative value from the number of positive solutions multiplied with the usage percent

Equation:	Total Usage = Usage (%) x (# positive sol.)

Numbers from the Table 8.2.2. show that the boxes have different level of usage. All the boxes have positive solutions but there are two boxes without any selected solution (TK-1B and TK-3B). This means that use of boxes TK-1B and TK-3B is not obligatory and that they may be used just as a possible substitution. For the box TK-5C there is a minimum number of positive solutions and just one selected solution (for type 91, marked red in the Table 8.2.1.). Therefore, for this box the number of Total usage is minimal (marked red), except of course, the zero values for TK-1B and TK-3B. This requires checking the possibility of replacing this transport box with some other box that will be used for added Casefil Group analysis of relevant 18 types of folding cartons with poor cube efficiency found in "1st circle" of the Casefill Group analysis.

8.3. Arrange Group and Design Group analysis

Beside using available transport boxes and their variations, it was also necessary to use Arrange Group and Design Group analysis to get some acceptable solutions.

The folding carton type 53 needed those additional analyses for finding appropriate transport box for it. After analysing the current palletizing status (Figure 8.3.1.) and packaging of this product (Figure 8.3.2.) the Arrange Group and Design Group analysis were performed.

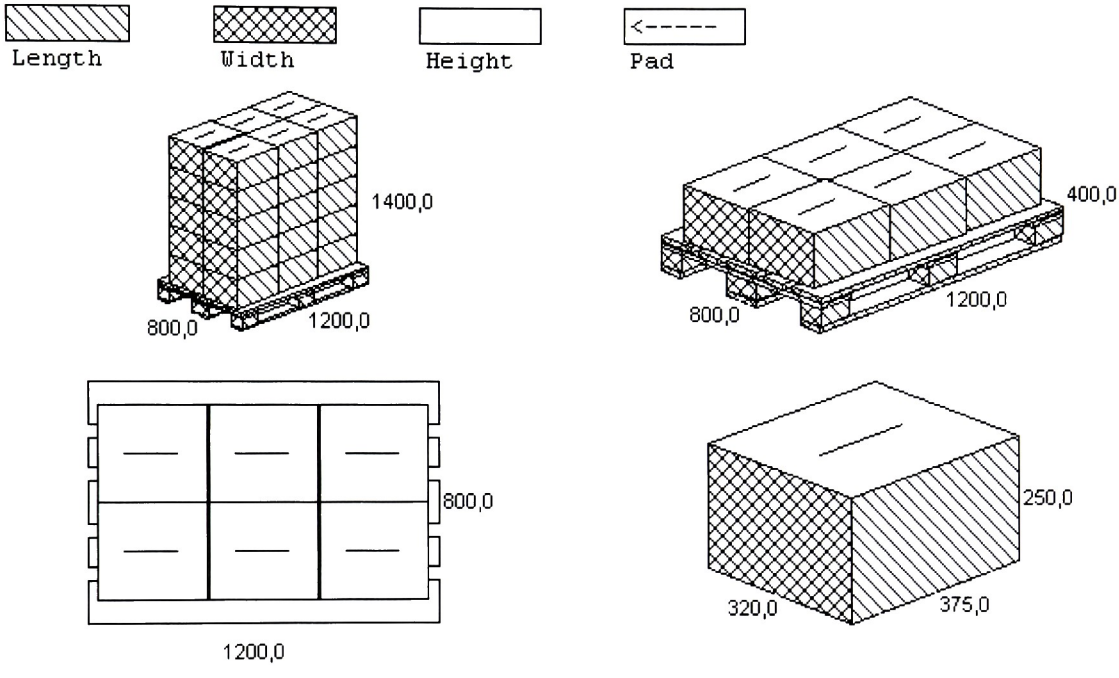
In Arrange Group analyses, the basics input consisted of data on unit package and bundle. Taking into consideration palletizing demands, the program calculated all possible solutions and the most acceptable solution was selected (Figure 8.3.3.)

To see possible small variations of the existing dimensions and find better palletizing solutions the Design Group analysis was used and the most appropriate solution was selected (Figure 8.3.4.).

Product Name T-132/A
Product Code 720325
Datafile Name kutija t-132a (05.02.00)
Solution Ref. 1 C
Cube Used 72,1 %
Area Used 75,0 %
Pallet type Euro

6 Transport box / Layer
5 Layer / Load
30 Transport box / Load

	Outside Dimension			Weight		
	Length	Width	Height	Net	Gross	Cube
Transpor	375,0	320,0	250,0 mm	8,800	9,300 Kg	30000 cm^3
Load	1200,0	800,0	1400,0 mm	264,000	304,000 Kg	1,34 m^3



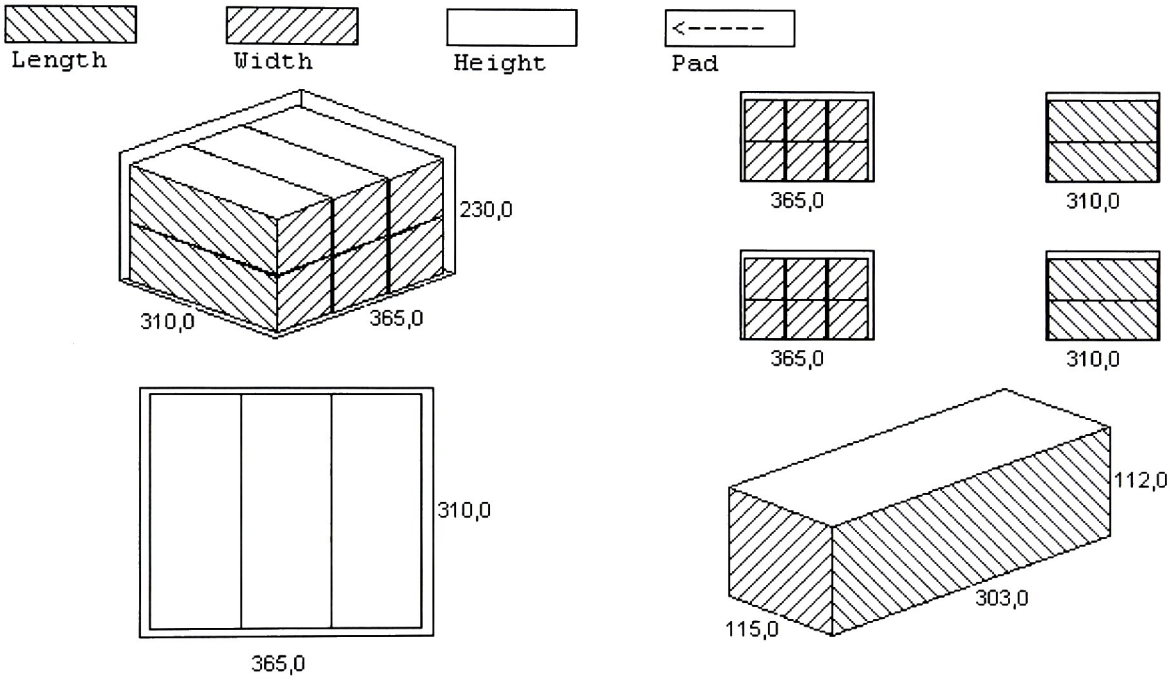
Pallet Group Analysis of existing transport boxes.
Max. Height of the load is 1450 mm.
Max. Weight of the load is 600 kg.
Euro-pallet (1200x800x150 mm, 25kg).

Figure 8.3.1. Report of the Pallet Group analysis for the existing palletization for the folding carton named “Tip 53”

Product Name J, Tip 53
Product Code 59,5x56,5x108,5
Cube Used 90,0 %
Area Used 92,4 %

10	ITEMS / Zbirno p
6	Zbirno p / T-132/A
60	ITEMS / T-132/A
30	T-132/A / Load
1800	ITEMS / Load

	Outside Dimension				Weight		
	Length	Width	Height		Net	Gross	Cube
Zbirno p	303,0	115,0	112,0	mm	1,465	1,475 Kg	3902 cm^3
FILL DIMS.	345,0	303,0	224,0	mm	8,790	8,850 Kg	23415 cm^3
T-132/A	365,0	310,0	230,0	mm	8,850	9,350 Kg	26024 cm^3
T-132/A	375,0	320,0	250,0	mm	8,850	9,350 Kg	30000 cm^3



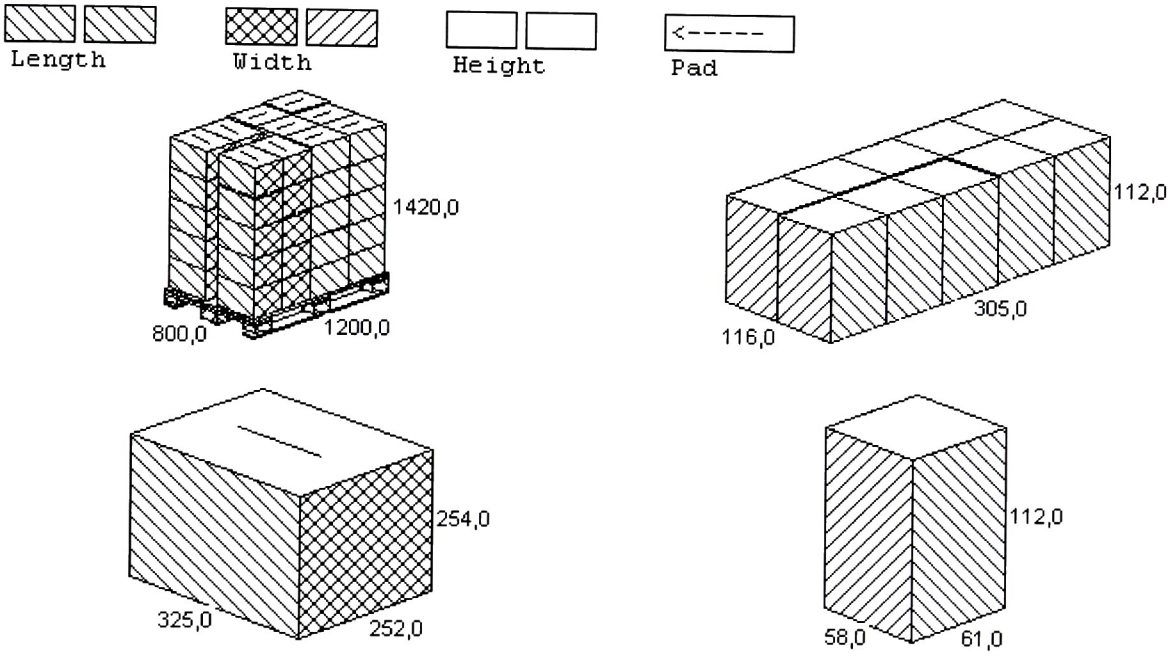
Casefill Group Analysis of existing transport box for Tip 53.
Max. Height of the load is 1450 mm.
Max. Weight of the load is 600 kg.
Euro-pallet (1200x800x150 mm, 25kg).

Figure 8.3.2. Report of the Casefill Group analysis for the “Tip 53” in the box T-132/A

Product Name	Tip 53
Product Code	59,5x56,5x108,5
Datafile Name	tip 53 (11.02.00)
Solution Ref.	2 I
Cube Used	83,3 %
Area Used	85,3 %
Pallet type	Euro

40	Type 53 / Transp
2000	Type 53 / Load
10	Transp. box / Layer
5	Layer / Load
50	Transp. box / Load
10	Type 53 / Zbirno
200	Zbirno pak. / Load
4	Zbirno pak. / Transp

	Outside Dimension				Weight		
	Length	Width	Height	Net	Gross		Cube
Type 53	61,0	58,0	112,0 mm	0,146	0,147	Kg	396 cm^3
Zbirno p	305,0	116,0	112,0 mm	1,460	1,470	Kg	3962 cm^3
Transp.	325,0	252,0	254,0 mm	5,880	6,270	Kg	20802 cm^3
Load	1200,0	800,0	1420,0 mm	294,000	338,505	Kg	1,36 m^3

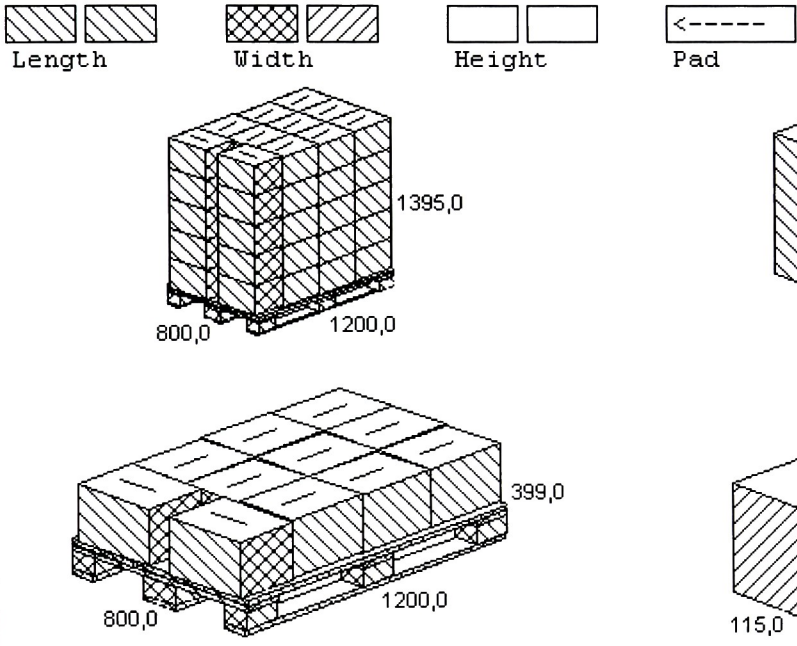


Arrange Group analysis for folding carton Tip 53.
Max. Height of the load is 1450mm.
Max. Weight of the load is 600 kg.
Euro-pallet (1200x800x150 mm, 25 kg)

Figure 8.3.3. Report of the Arrange Group analysis for the “Tip 53”– selected solution

Product Name	Tip 53		
Product Code	59,5x56,5x108,5		
Datafile Name	tip 53 suma 1200 (14.02.00)		
Solution Ref.	3 I	4	Carton / Case
Cube Used	85,5 %	220	Carton / Load
Area Used	89,3 %	11	Case / Layer
Pallet type	Euro	5	Layer / Load
		55	Case / Load

	Outside Dimension				Weight			
	Length	Width	Height		Net	Gross		Cube
Carton	303,0	115,0	112,0	mm	1,460	1,470	Kg	3902 cm^3
Case	318,0	245,0	249,0	mm	5,880	6,252	Kg	19399 cm^3
Load	1200,0	800,0	1395,0	mm	323,400	368,838	Kg	1,34 m^3



Design Group analysis for the folding carton Tip 53.
Max. Height of the load is 1450 mm.
Max. Weight of the load is 600 kg.
Euro-pallet (1200x800x150 mm, 25 kg).

Figure 8.3.4. Report of the Design Group analysis for the “Tip 53” – selected solution

Based on information from these reports, the solution for the transport box was found.

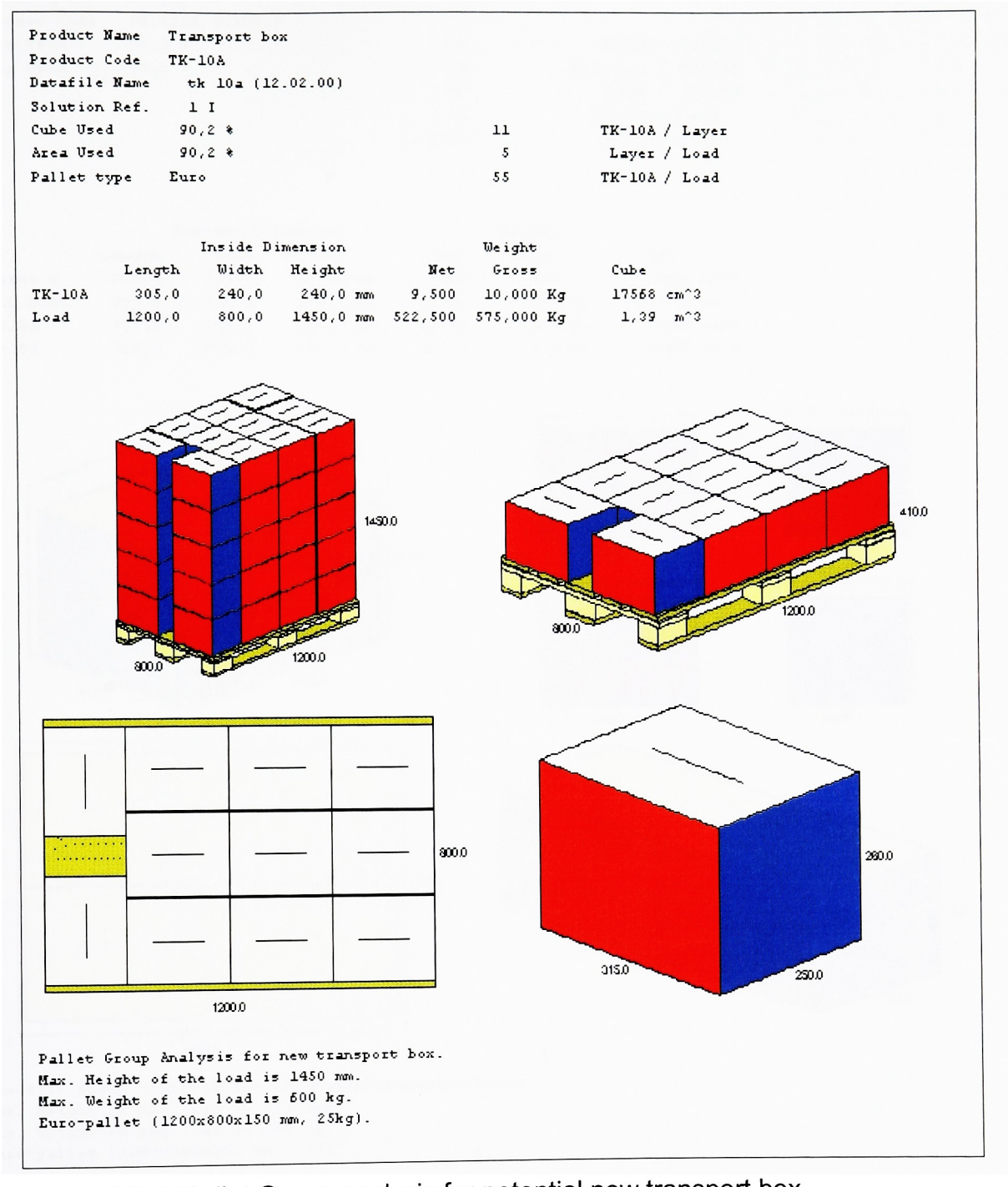


Figure 8.3.5. Pallet Group analysis for potential new transport box

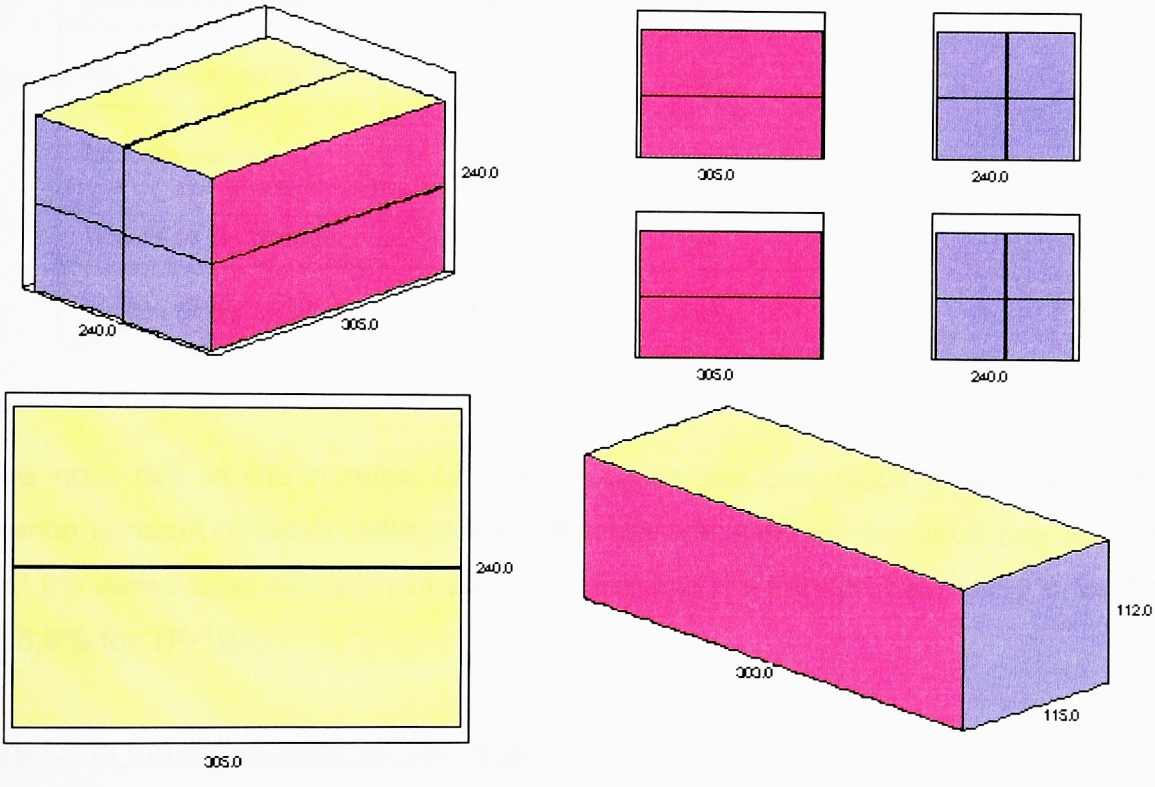
Palletization efficiency of this transport box is above the set limit (90,2% Cube and Area used), implying that the box is a potential solution for packaging of folding carton named "Tip 53" (Figure 8.3.5.).

There is an analysis of packaging bundles for the folding carton “Tip 53” in the box TK-10A.

Product Name J, Tip 53
Product Code 59,5x56,5x108,5
Cube Used 88,9 %
Area Used 95,2 %

10	ITEMS / Zbirno p
4	Zbirno p / TK-10A
40	ITEMS / TK-10A
55	TK-10A / Load
2200	ITEMS / Load

	Outside Dimension				Weight		
	Length	Width	Height	Net	Gross	Cube
Zbirno p	303,0	115,0	112,0 mm	1,465	1,475 Kg	3902 cm^3
FILL DIMS.	303,0	230,0	224,0 mm	5,860	5,900 Kg	15610 cm^3
TK-10A	305,0	240,0	240,0 mm	5,900	6,400 Kg	17568 cm^3
TK-10A	315,0	250,0	250,0 mm	5,900	6,400 Kg	20475 cm^3



Casefill Group Analysis for potential transport boxes.
Max. Height of the load is 1450 mm.
Max. Weight of the load is 600 kg.
Euro-pallet (1200x800x150 mm, 25kg).

Figure 8.3.6. Casefill Group analysis for packaging “Tip 53” in the potential new transport box

The result for the Cube used in the box TK-10A (88,9%) is above the set limit and this means that the box T-10A is appropriate for packaging the folding cartons “Tip 53”.

The data from those six reports are compared in the Table 8.3.1.

Table 8.3.1. Comparison of the results for the folding carton "Tip 53"

Parameter	Current situation	Proposed situation
Transport box	T-132/A	TK-10A
Pallet Area used	75,00%	90,20%
Pallet Cube used	72,10%	90,20%
Box Cube used	90,20%	88,90%
No.boxes per pallet	30	55
No.units per pallet	1800	2200
No.units per box	60	40
Weight of the box / kg	9,35	6,4
Weight of the pallet / kg	305,5	377

Please note rise in the number of unit packages per one pallet load. This significant difference is result of better palletization efficiency with the new transport box TK-10A and almost the same cube efficiency of the packaging into the transport box (90,2% for T-132/A and 88,9% for TK-10A).

Difference in the palletization efficiency is:

Area used: 90,2% - 75,0% = 15,2% (**15,2% better** for TK-10A)

Cube used: 90,2% - 72,1% = 18,1% (**18,1% better** for TK-10A)

Difference in numbers of unit packages per one pallet load is:

2200 – 1800 = 400 units

(400 / 1800) · 100% = 22,2% (**22,2% better** for TK-10A than T-132/A)

8.4. Added Casefill Group analysis

The results of the Added Casefill Group analysis are shown in the Table 8.4.1. Besides those 18 folding carton types that have not gave good results in the "1st circle" of the Casefill Group analysis, there are also results for folding carton type 91. It had only one good result in the first Casefill Group analyses (marked red in the Table 8.2.2.) of the transport box TK-5C. To omit the use of TK-5C this folding carton type 91 was subjected to the added Casfill Group analyses. The table presents only the results of above 80% cube efficiency of the transport box.

Criteria of selecting the best result (**marked bold** in the Table 8.2.2.) of some analyses was the same as in the 1st cycle of the Casefill Group analysis.

Table 8.4.1. Database of the results for added Casefill Group analysis

No.	TK-1E	TK-2E	TK-8A	TK-9A	TK-10A	TK-11A	TK-28A	Tx-15	VOT-37	VOT-40	VOT-42
13		82,2								**82,8**	82,5
15		80,6								**81,2**	81,0
19									**84,2**		
36						**82,0**					
37		84,5								**88,7**	
41		83,8							**82,5**		84,1
42			**85,4**								
53					**88,9**						
55	**80,6**										
62			**87,5**								
64				**86,7**							
65								82,1	**89,1**	83,8	
69	**82,1**										
80							**85,7**				
83	85,6					**90,4**			M	80,8	M
92	**80,3**										
93	**92,6**							91,2	M		83,5
99	**83,5**					82,3		82,3			
Ad 91	**88,8**	80,0				87,6		87,5	81,7		

Key:

No. - type of the folding carton described in the chapter 6.3. Data for the Casefill Group analysis, Table 6.3.1.

M - negative results due to the problem with the weight limit

The most appropriate solutions were pointed out and the usage of the transport boxes was analyzed with respect to the usage of the proposed added transport boxes. The table 8.4.2. presents the summary of this analysis.

Table 8.4.2. Analysis of the use of transport boxes from added Casefill Group analysis

No.	Case	**# positiv sol.**	**# select. sol.**	**Usage / %**
1	TK-1E	7	6	31,6
2	TK-2E	5	0	0,0
3	TK-8A	2	2	10,5
4	TK-9A	1	1	5,3
5	TK-10A	1	1	5,3
6	TK-11A	4	2	10,5
7	TK-28A	1	1	5,3
8	Tx-15	4	0	0,0
9	VOT-37	4	3	15,8
10	VOT-40	5	3	15,8
11	VOT-42	4	0	0,0

Key:

 # positive sol. - number of all positive solutions for the transport box

 # selected sol. - number of selected positive solutions that are the most appropriate for a folding carton type

Usage / % - percentage of the transport box use as a ratio of selected solution compared to the total number of selected solutions

Equation: Usage (%) = 100% x (# selected sol.) / 19

Data from the Table 8.4.2. confirm that the boxes have different level of usage. Positive solutions were obtained for all boxes. However, for three boxes no solution was selected (TK-2E, Tx-15 and VOT-42). Therefore, the use of those three boxes is not obligatory and they can be used just as possible substitution. In other words, use of 8 transport boxes from the added database is obligatory under the defined efficiency limits.

It needs to be stressed that added analyses of the folding carton type 91 were more successful than in the 1st cycle of Casefill Group analysis. This means that use of the transport box TK-5C is also not obligatory, so from the first database of 17 transport boxes use of three is optional and of 14 is obligatory.

8.5. Obligatory transport boxes

Both cycles of the Casefill Group analysis resulted in identification of obligatory transport boxes for proposed optimization of the distribution packaging, as presented in the Table 8.5.1. In the 1st cycle of Casefill Group analyses solutions were not found for two boxes (TK-1B and TK-3B) plus the transport box TK-5C with one selected solution that was improved in the 2nd cycle of the Casefill Group analyses. This means that from 17 proposed boxes in 1st cycle 14 obligatory transport boxes were selected. In the 2nd cycle of the Casefill Group analyses solution was not found for three transport boxes , so from 11 proposed transport boxes in 2nd circle 8 of them are obligatory.

This means that 22 of 28 transport boxes used in Casefill Group analyses can be used for packaging all of the 100 types of the folding cartons considered.

Table 8.5.1. lists all the obligatory transport boxes and the basic data on those boxes. Please note the calculated mean values of the Pallet Area efficiency and Pallet Cube efficiency given at the end of the table. Those numbers are good basis for comparison of the current and proposed packaging situation.

Table 8.5.1. Obligatory transport boxes for proposed optimization

No.	Case	Length/mm	Width/mm	Height/mm	# Per Load	Area eff./%	Cube eff./%	Max.m/kg
1	TK-1A	585	255	165	42	98,5	98,2	13,69
2	TK-1C	585	255	240	30	98,5	98,5	19,17
3	TK-2A	550	230	165	49	98,0	97,6	11,73
4	TK-2B	550	230	195	42	98,0	97,2	13,69
5	TK-2C	550	230	240	35	98,0	98,0	16,43
6	TK-3A	385	385	165	42	97,5	97,1	13,69
7	TK-3C	385	385	240	30	97,5	97,5	19,17
8	TK-3D	385	385	305	24	97,5	97,5	23,96
9	TK-4B	390	255	195	54	99,4	98,6	10,65
10	TK-4C	390	255	240	45	99,4	99,4	12,78
11	TK-4D	390	255	305	36	99,4	99,4	15,97
12	V-6A	590	385	165	28	98,8	98,4	20,54
13	V-6B	590	385	195	24	98,8	98,0	23,96
14	V-6C	590	385	240	20	98,8	98,8	28,75
15	TK-1E	585	255	140	48	98,5	97,0	11,98
16	TK-8A	505	270	305	24	90,1	90,1	23,96
17	TK-9A	385	290	305	32	98,8	98,8	17,97
18	TK-10A	305	240	240	55	90,2	90,2	10,45
19	TK-11A	565	375	140	32	92,2	90,8	17,97
20	TK-28A	385	225	190	60	96,7	93,7	9,58
21	VOT-37	565	375	300	16	92,2	90,8	35,94
22	VOT-40	415	340	235	30	93,0	91,2	19,17
			Mean	**value:**	36	**96,8**	**96,2**	17,78

Key:

Length, Width, and Height - inside dimensions of the transport box (mm)

Per Load - Number of cases per pallet load

Area eff. /% - Pallet Area Efficiency for transport box (%)

Cube eff./% - Pallet Cube Efficiency for transport box (%)

Max.m/kg - Maximum weight of the transport box

(Calculated considering the number of transport boxes on the pallet (# Per Load), maximum pallet weight defined for the warehouse (600 kg), and weight of the EURO pallet (25 kg)

Equation:	Max.m/kg = (600-25) kg / (# Per Load)

It is important to remember that the recommended maximum weight according to the Good Distribution Practice is 20,5 kg (45 lb.) and therefore all values above this limit shall be reduced to 20,5 kg.

Significant numbers that summarize these data are mean values for the Area and Cube palletization efficiency. Comparison with similar results given in the table that shows the current situation with 95 different transport boxes in use (Table 8.1.), brings out numbers that mathematically represent improvements of distribution packaging elaborated in this thesis. Table 8.5.2. shows the results of comparison of summarized palletizing efficiency.

Table 8.5.2. Comparison of the Current and Proposed Palletization of products

Parameter	Current situation	Proposed situation	**Improvement**
Transport boxes in use	95	22	**factor 4,3**
Average Pallet Area used	84,8%	96,8%	**12,0%**
Average Pallet Cube used	77,0%	96,2%	**19,2%**

The table clearly demonstrates the Area and Cube efficiency improvement, and it points to the fact that the number of different dimensions of the transport boxes can be reduced 4,3 times.

9. CONCLUSION

The results of calculations and presented data show that for all folding carton types from the Table 6.3.1. the proposed 22 different transport boxes dimensions can be used instead of current 95 different transport boxes. Besides unification of the distribution packaging, the proposed transport boxes offer palletization improvement with 12,0% Area efficiency improvement and significant 19,2% Cube efficiency improvement

Important points that need to be emphasized are also saving of the warehouse space and cutting down on the price of transport boxes as a consequence of larger orders for smaller number of transport box types. There is also easier handling of all documentation related to ordering and Quality Control of transport boxes.

These results could be a good basis for production, purchasing and warehousing analyses for many cost analyses related to reduction in working hours, warehousing space, distribution costs and transport boxes prices.

FOOTNOTES

(1) Walter Soroka: "Fundamentals of Packaging technology", 2nd Ed. 1998, Institute of Packaging Professionals, Herndon, Virginia, pg. 397

(2) Walter F. Friedman and Jerome J. Kipnees: "Distribution Packaging"1st Ed. 1977, Krieger Publishing Company, Malabar, Florida, U.S.A. pg. 17-19, 31 - 32

(3) Walter Soroka: "Fundamentals of Packaging technology", 2nd Ed. 1998, Institute of Packaging Professionals, Herndon, Virginia, pg. 399 – 400

(4) Walter Soroka: "Fundamentals of Packaging technology", 2nd Ed. 1998, Institute of Packaging Professionals, Herndon, Virginia, pg. 408 – 409

(5) Fibre Box Handbook, 1997, Fibre Box Association, Rolling Maedows, IL 60008, U.S.A. pg. 12

(6) Fibre Box Handbook, 1997, Fibre Box Association, Rolling Maedows, IL 60008, U.S.A. pg. 17

(7) Walter F. Friedman and Jerome J. Kipnees: "Distribution Packaging"1st Ed. 1977, Krieger Publishing Company, Malabar, Florida, U.S.A. pg. 77 - 78

(8) Fibre Box Handbook, 1997, Fibre Box Association, Rolling Maedows, IL 60008, U.S.A. pg. 52 - 54

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(11) The Wiley Encyclopedia of Packaging Technology, John Wiley & Sons, 1986, pg. 506-509

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(13) Millennium Edition CAPEPACK'99, Volume One - Getting Started, By Cape Systems (2000)

(14) Millennium Edition CAPEPACK'99, Volume Two - Using The Wizards and Accessories, By Cape Systems (2000)

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(II) Walter F. Friedman and Jerome J. Kipnees: "Distribution Packaging"1st Ed. 1977, Krieger Publishing Company, Malabar, Florida, U.S.A.

(III) Fibre Box Handbook, 1997, Fibre Box Association, Rolling Maedows, IL 60008, U.S.A.

(IV) DIN-Taschenbuch 239 **Verpackung**, Terminologie, Prüfung, Maβordnung, Markierung, Kennzeichnung, Lieferbedingungen Normen, I. Auflage Stand der abgedruckten Normen; 1991, Beuth Verlag GmbH. Berlin-Köln, pg. 378-383

(V) The Wiley Encyclopedia of Packaging Technology, John Wiley & Sons, 1986, pg. 506-509

(VI) Millennium Edition CAPEPACK'99, Volume One - Getting Started, By Cape Systems (2000)

(VII) Millennium Edition CAPEPACK'99, Volume Two - Using The Wizards and Accessories, By Cape Systems (2000)

LIST OF TABLES

Page Number

10. APPENDIX

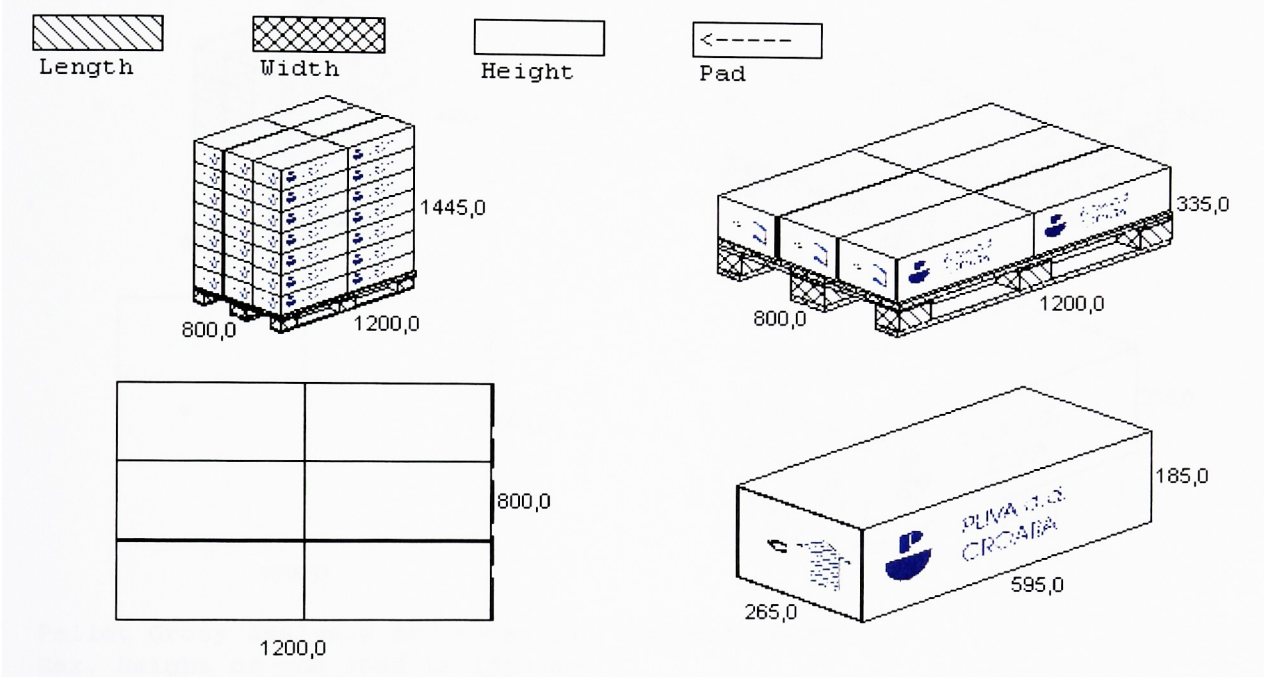
Palletization Cape reports of the proposed new transport boxes for optimization are listed in this sequence:

Page

Product Name	TK-1A
Product Code	
Datafile Name	tk 1a (24.01.00)
Solution Ref.	1 C
Cube Used	98,2 %
Area Used	98,5 %
Pallet type	Euro

6	Transport Box / Layer
7	Layer / Load
42	Transport Box / Load

	Outside Dimension Length	Width	Height		Weight Net	Gross		Cube	
Transpor	595,0	265,0	185,0	mm	13,000	13,500	Kg	29169	cm^3
Load	1200,0	800,0	1445,0	mm	546,000	592,000	Kg	1,39	m^3

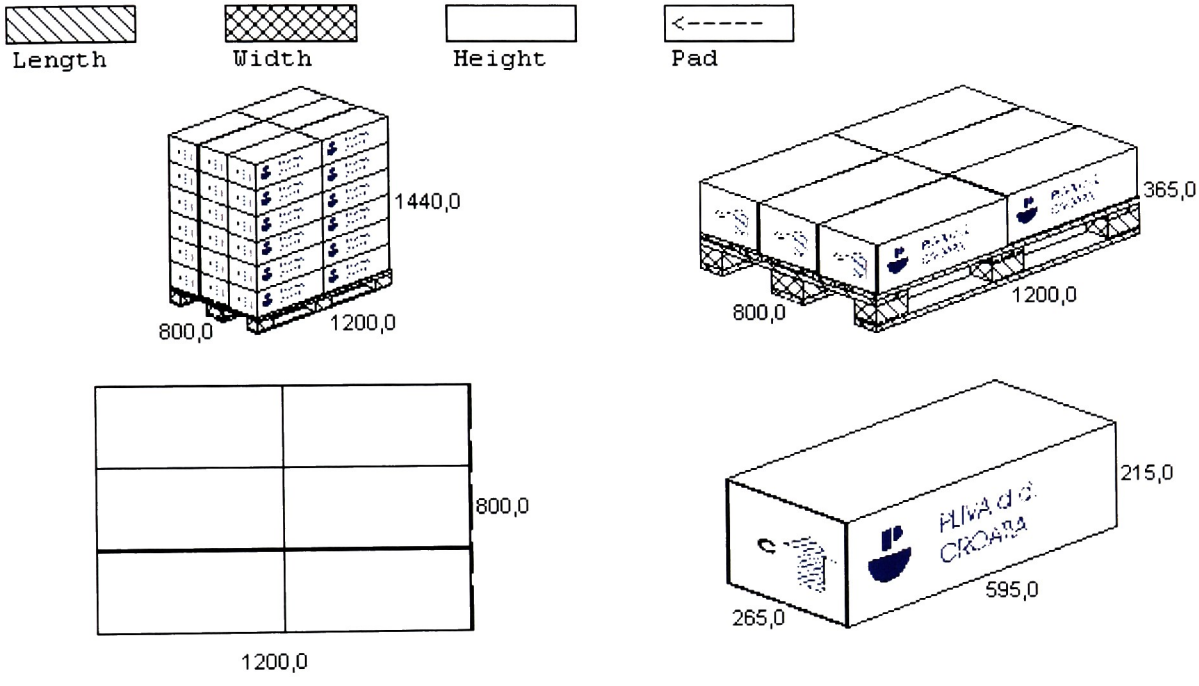


Pallet Group Analysis for potential transport boxes.
Max. Height of the load is 1450 mm.
Max. Weight of the load is 600 kg.
Euro-pallet (1200x800x150 mm, 25kg).

Figure 10.1. Cape Report of the Pallet Group analysis for the transport box TK-1A

```
Product Name    TK-1B
Product Code    2
Datafile Name             (24.01.00)
Solution Ref.     1 C
Cube Used        97,8 %                          6   Transport Box / Layer
Area Used        98,5 %                          6          Layer / Load
Pallet type      Euro                           36   Transport Box / Load
```

	Outside Dimension				Weight			
	Length	Width	Height		Net	Gross		Cube
Transpor	595,0	265,0	215,0	mm	15,000	15,500	Kg	33900 cm^3
Load	1200,0	800,0	1440,0	mm	540,000	583,000	Kg	1,38 m^3

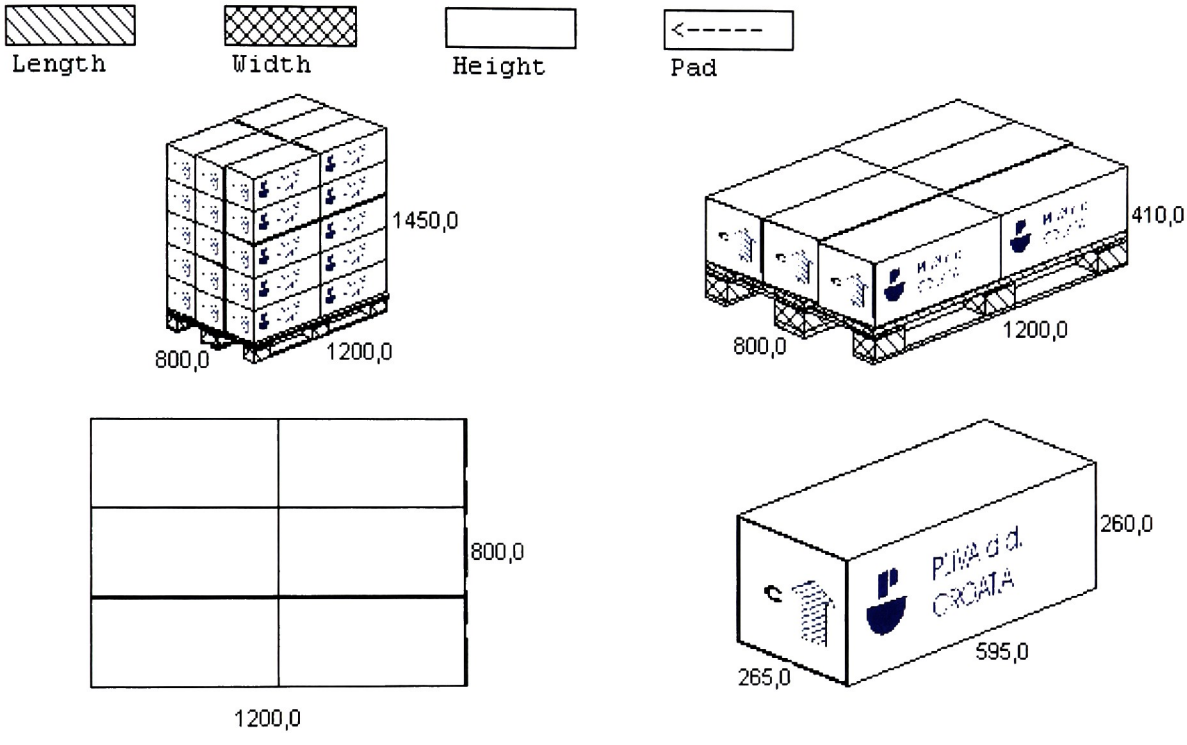



```
Pallet Group Analysis for potential transport boxes.
Max. Height of the load is 1450 mm.
Max. Weight of the load is 600 kg.
Euro-pallet (1200x800x150 mm, 25kg).
```

Figure 10.2. Cape Report of the Pallet Group analysis for the transport box TK-1B

Product Name	TK-1C		
Product Code	3		
Datafile Name	tk 1c (24.01.00)		
Solution Ref.	1 C		
Cube Used	98,5 %	6	Transport Box / Layer
Area Used	98,5 %	5	Layer / Load
Pallet type	Euro	30	Transport Box / Load

	Outside Dimension				Weight			
	Length	Width	Height		Net	Gross		Cube
Transpor	595,0	265,0	260,0	mm	18,600	19,100	Kg	40995 cm^3
Load	1200,0	800,0	1450,0	mm	558,000	598,000	Kg	1,39 m^3



Pallet Group Analysis for potential transport boxes.
Max. Height of the load is 1450 mm.
Max. Weight of the load is 600 kg.
Euro-pallet (1200x800x150 mm, 25kg).

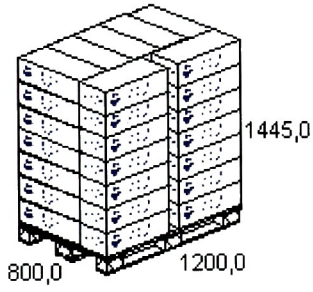
Figure 10.3. Cape Report of the Pallet Group analysis for the transport box TK-1C

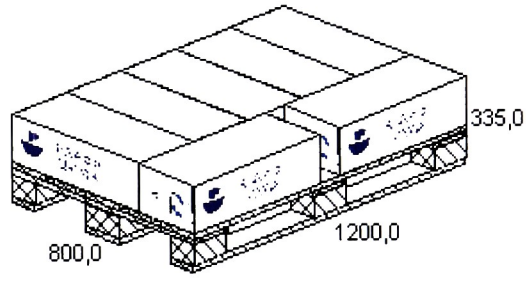
Product Name TK-2A
Product Code 4
Datafile Name tk 1a (24.01.00)
Solution Ref. 1 I
Cube Used 97,6 %
Area Used 98,0 %
Pallet type Euro
Custom Arrangement 2L x 2W x 2H

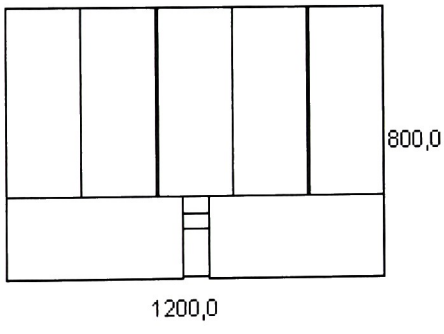
7	Transport Box / Layer	
7	Layer / Load	
49	Transport Box / Load	
8	Box / Transpor	
392	Box / Load	

	Outside Dimension				Weight			
	Length	Width	Height		Net	Gross		Cube
Transpor	560,0	240,0	185,0	mm	11,000	11,500	Kg	24864 cm^3
Load	1200,0	800,0	1445,0	mm	539,000	588,500	Kg	1,39 m^3

Length Width Height Pad





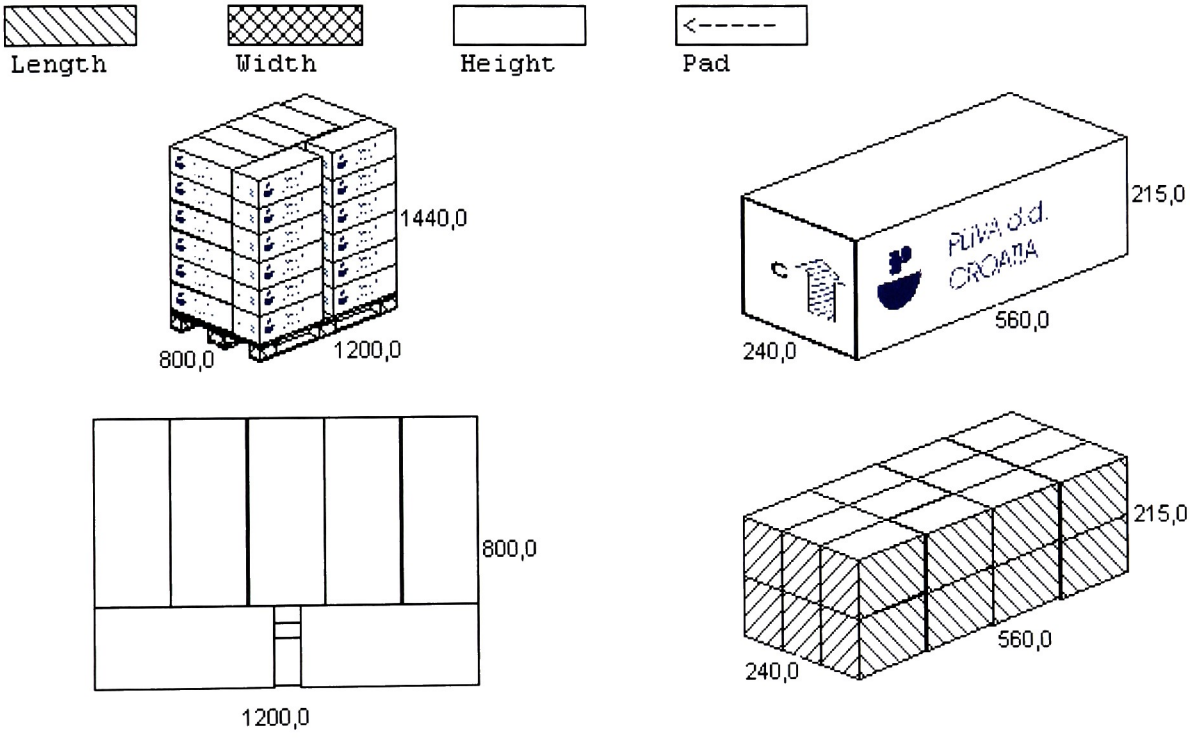


Pallet Group Analysis for potential transport boxes.
Max. Height of the load is 1450 mm.
Max. Weight of the load is 600 kg.
Euro-pallet (1200x800x150 mm, 25kg).

Figure 10.4. Cape Report of the Pallet Group analysis for the transport box TK-2A

Product Name	TK-2B for Tip 4		
Product Code	5		
Datafile Name	tk 2b (24.01.00)		
Solution Ref.	1 I		
Cube Used	97,2 %	7	Transport Box / Layer
Area Used	98,0 %	6	Layer / Load
Pallet type	Euro	42	Transport Box / Load
Custom Arrangement	4L x 3W x 2H		
		24	Box / Transpor
		1008	Box / Load

	Outside Dimension				Weight			
	Length	Width	Height		Net	Gross		Cube
Transpor	560,0	240,0	215,0	mm	13,100	13,600	Kg	28896 cm^3
Load	1200,0	800,0	1440,0	mm	550,200	596,200	Kg	1,38 m^3

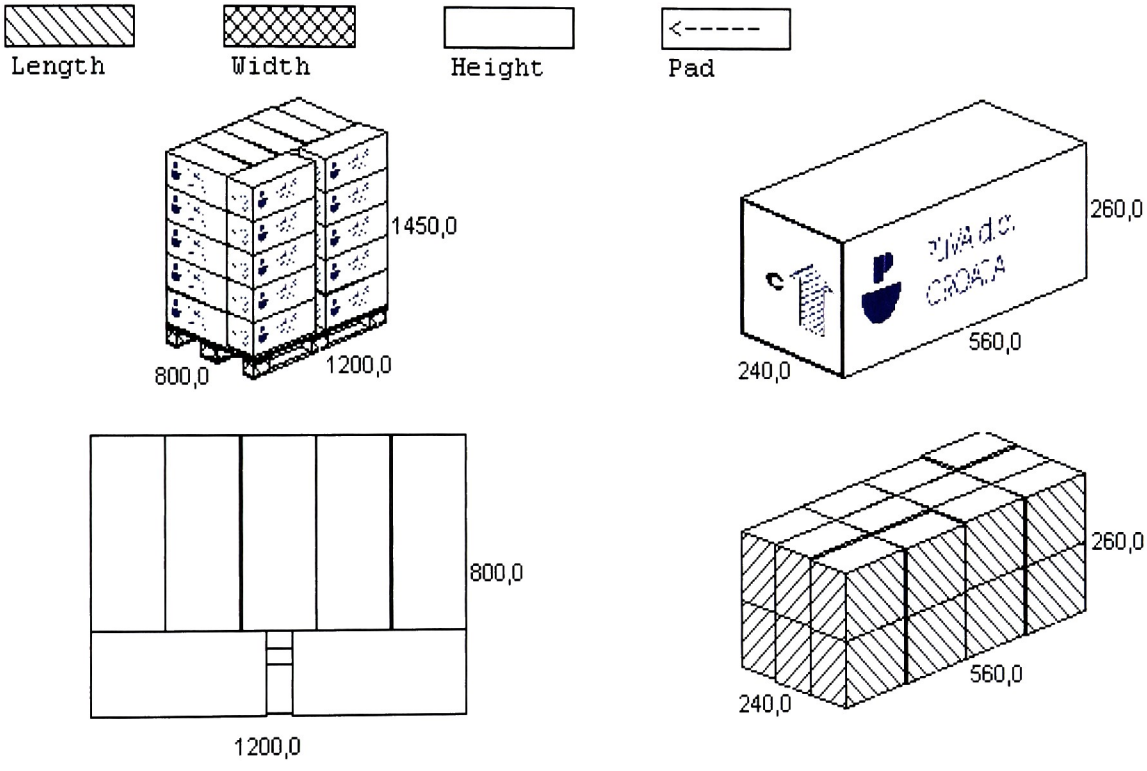


Pallet Group Analysis for potential transport boxes.
Max. Height of the load is 1450 mm.
Max. Weight of the load is 600 kg.
Euro-pallet (1200x800x150 mm, 25kg).

Figure 10.5. Cape Report of the Pallet Group analysis for the transport box TK-2B

```
Product Name    TK-2C
Product Code    6
Datafile Name      tk 2c (24.01.00)
Solution Ref.     1 I
Cube Used        98,0 %                    7   Transport Box / Layer
Area Used        98,0 %                    5         Layer / Load
Pallet type     Euro                      35   Transport Box / Load
Custom Arrangement    4L x  3W x  2H
                                          24         Box / Transpo
                                         840         Box / Load
```

	Outside Dimension				Weight			
	Length	Width	Height		Net	Gross		Cube
Transpor	560,0	240,0	260,0	mm	15,900	16,400	Kg	34944 cm^3
Load	1200,0	800,0	1450,0	mm	556,500	599,000	Kg	1,39 m^3

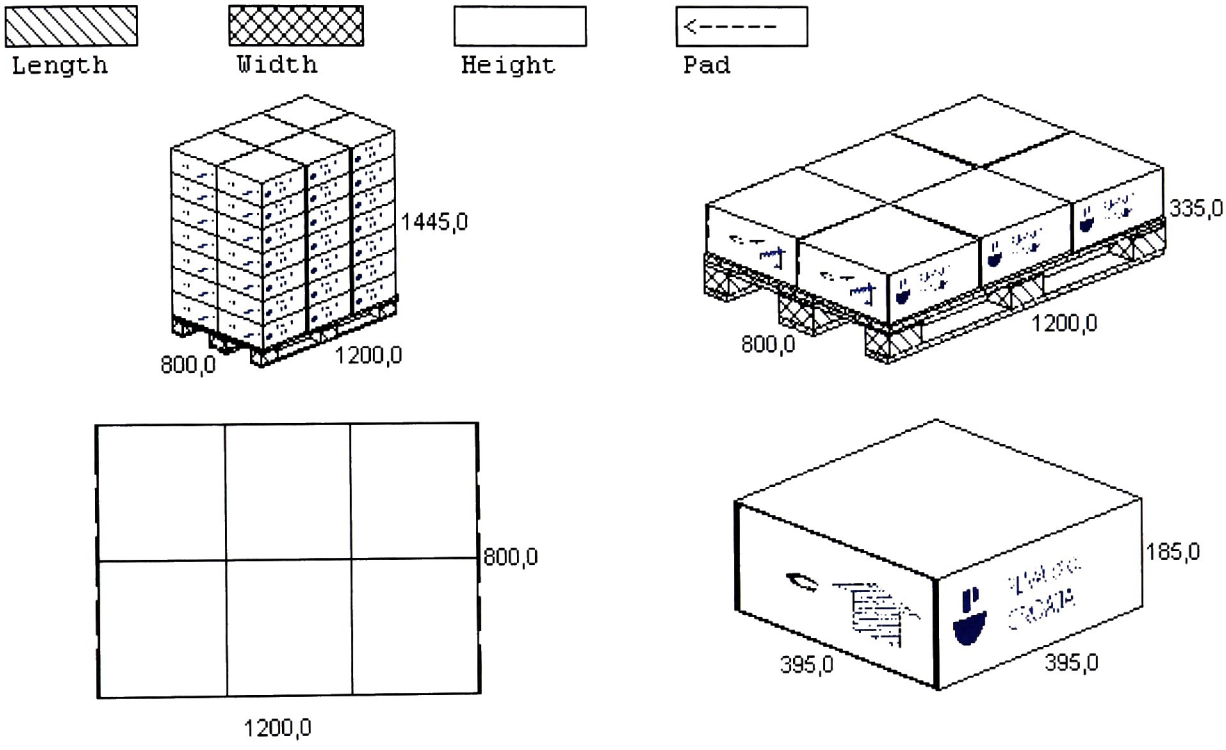



```
Pallet Group Analysis for potential transport boxes.
Max. Height of the load is 1450 mm.
Max. Weight of the load is 600 kg.
Euro-pallet (1200x800x150 mm, 25kg).
```

Figure 10.6. Cape Report of the Pallet Group analysis for the transport box TK-2C

```
Product Name    TK-3A
Product Code    7
Datafile Name      tk 3a (24.01.00)
Solution Ref.     1 C
Cube Used        97,1 %                    6   Transport Box / Layer
Area Used        97,5 %                    7          Layer / Load
Pallet type     Euro                      42   Transport Box / Load
```

	Outside Dimension			Weight		
	Length	Width	Height	Net	Gross	Cube
Transpor	395,0	395,0	185,0 mm	13,100	13,600 Kg	28864 cm^3
Load	1200,0	800,0	1445,0 mm	550,200	596,200 Kg	1,39 m^3

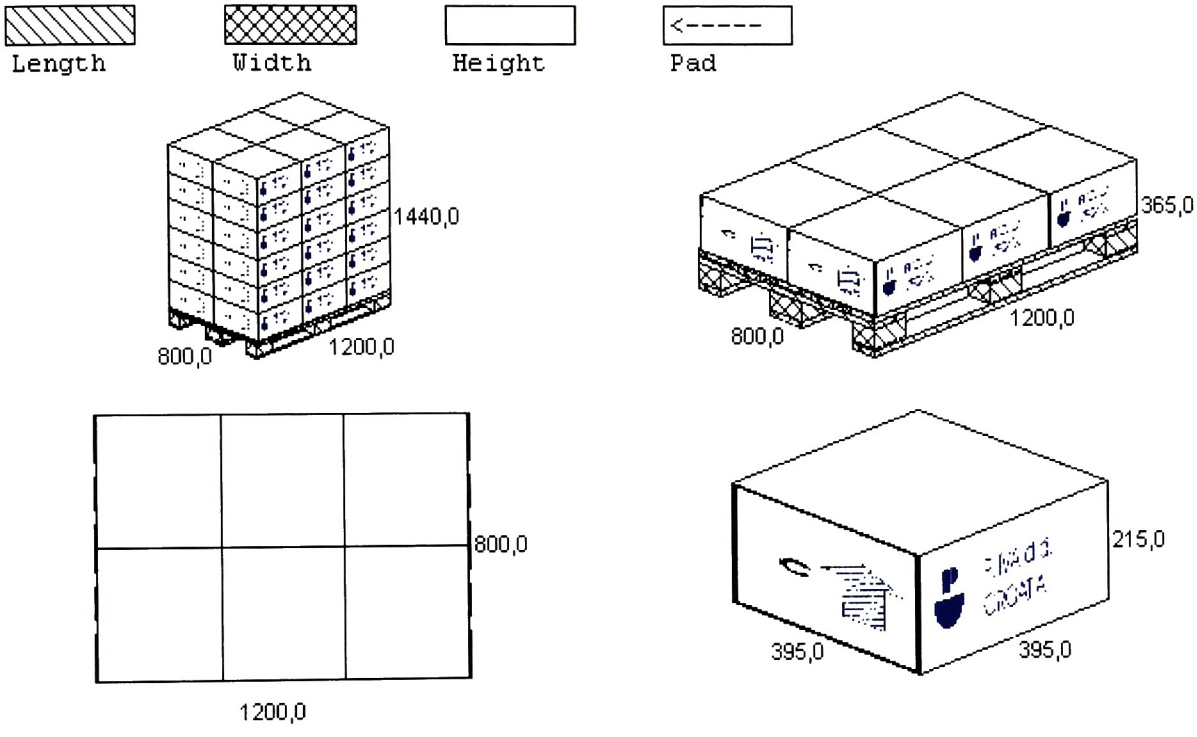



```
Pallet Group Analysis for potential transport boxes.
Max. Height of the load is 1450 mm.
Max. Weight of the load is 600 kg.
Euro-pallet (1200x800x150 mm, 25kg).
```

Figure 10.7. Cape Report of the Pallet Group analysis for the transport box TK-3A

```
Product Name    TK-3B
Product Code    8
Datafile Name      tk 3b (24.01.00)
Solution Ref.     1 C
Cube Used        96,8 %                    6   Transport Box / Layer
Area Used        97,5 %                    6          Layer / Load
Pallet type     Euro                      36   Transport Box / Load
```

	Outside Dimension				Weight			
	Length	Width	Height		Net	Gross		Cube
Transpor	395,0	395,0	215,0	mm	15,400	15,900	Kg	33545 cm^3
Load	1200,0	800,0	1440,0	mm	554,400	597,400	Kg	1,38 m^3

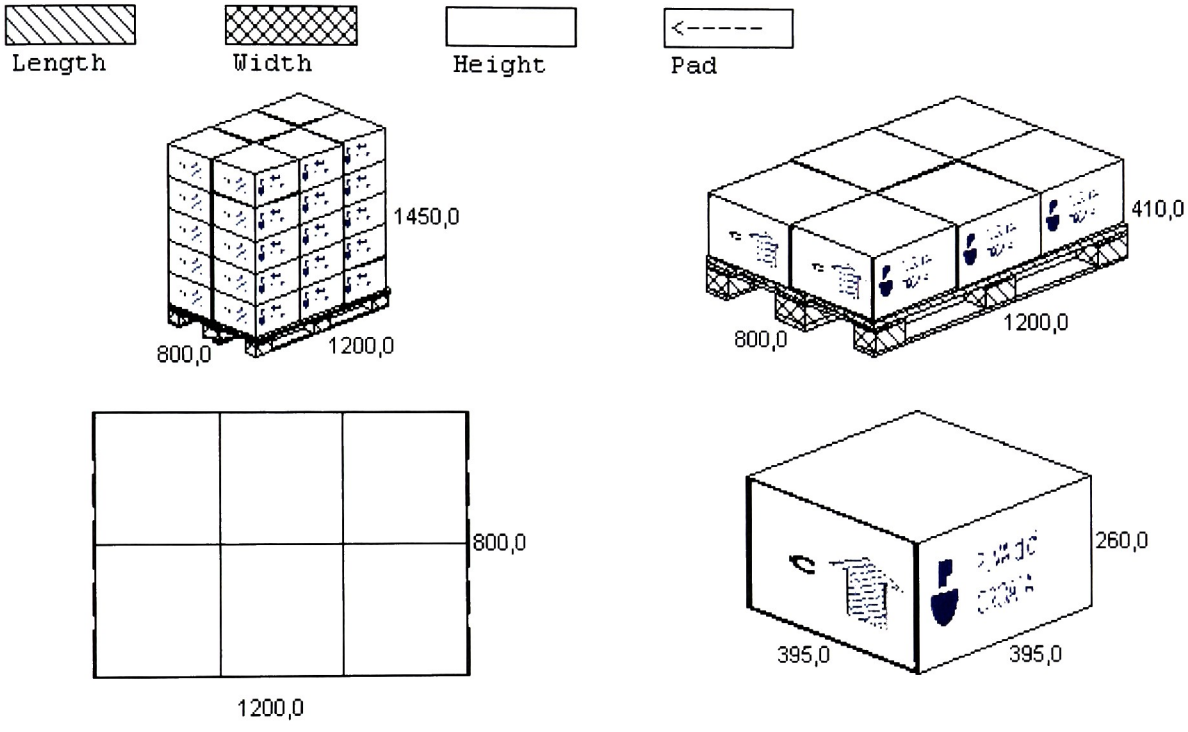



```
Pallet Group Analysis for potential transport boxes.
Max. Height of the load is 1450 mm.
Max. Weight of the load is 600 kg.
Euro-pallet (1200x800x150 mm, 25kg).
```

Figure 10.8. Cape Report of the Pallet Group analysis for the transport box TK-3B

Product Name	TK-3C		
Product Code	9		
Datafile Name	tk 3c (24.01.00)		
Solution Ref.	1 C		
Cube Used	97,5 %	6	Transport Box / Layer
Area Used	97,5 %	5	Layer / Load
Pallet type	Euro	30	Transport Box / Load

	Outside Dimension				Weight		
	Length	Width	Height	Net	Gross	Cube	
Transpor	395,0	395,0	260,0 mm	18,600	19,100 Kg	40566	cm^3
Load	1200,0	800,0	1450,0 mm	558,000	598,000 Kg	1,39	m^3



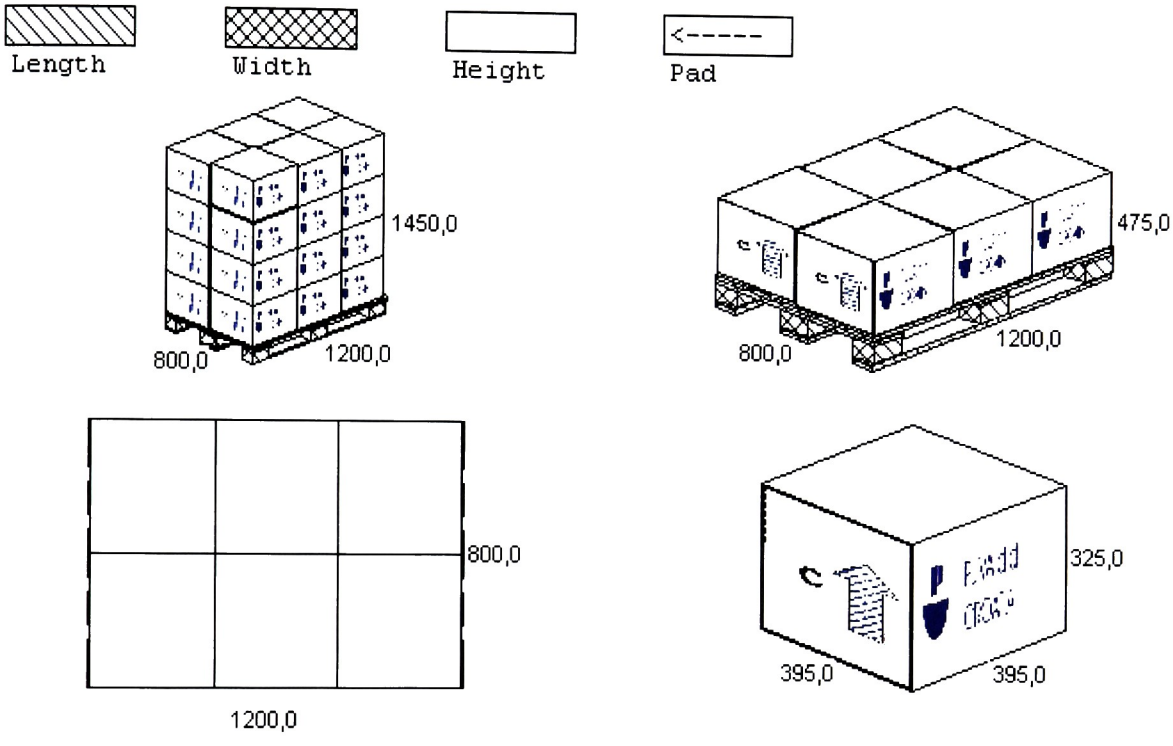
Pallet Group Analysis for potential transport boxes.
Max. Height of the load is 1450 mm.
Max. Weight of the load is 600 kg.
Euro-pallet (1200x800x150 mm, 25kg).

Figure 10.9. Cape Report of the Pallet Group analysis for the transport box TK-3C

Product Name	TK-3D
Product Code	10
Datafile Name	tk 3d (24.01.00)
Solution Ref.	1 C
Cube Used	97,5 %
Area Used	97,5 %
Pallet type	Euro

6	Transport Box / Layer
4	Layer / Load
24	Transport Box / Load

	Outside Dimension				Weight			
	Length	Width	Height		Net	Gross		Cube
Transpor	395,0	395,0	325,0	mm	19,500	20,000	Kg	50708 cm^3
Load	1200,0	800,0	1450,0	mm	468,000	505,000	Kg	1,39 m^3



Pallet Group Analysis for potential transport boxes.
Max. Height of the load is 1450 mm.
Max. Weight of the load is 600 kg.
Euro-pallet (1200x800x150 mm, 25kg).

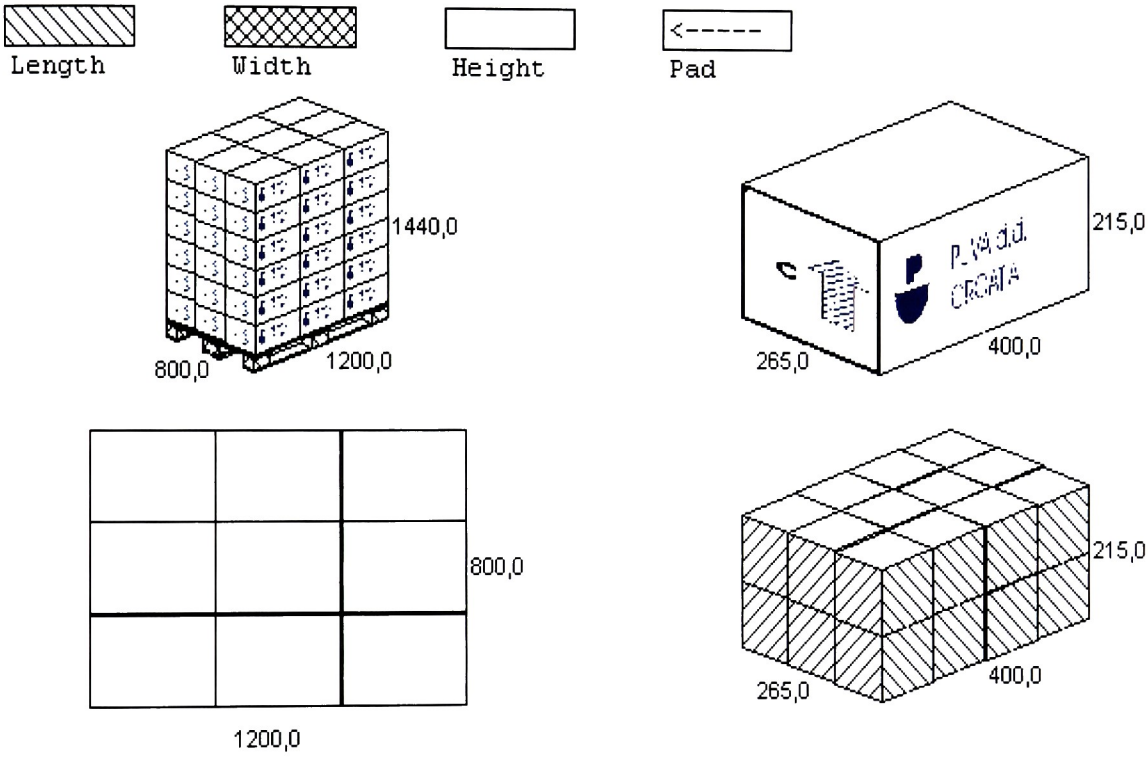
Figure 10.10. Cape Report of the Pallet Group analysis for the transport box TK-3D

```
Product Name    TK-4B   for Tip 3
Product Code    11
Datafile Name      tk 4b (24.01.00)
Solution Ref.     1 C
Cube Used        98,6 %
Area Used        99,4 %
Pallet type     Euro
Custom Arrangement    4L x  3W x 2H
```

```
    9   Transport Box / Layer
    6           Layer / Load
   54   Transport Box / Load

   24             Box / Transpor
 1296             Box / Load
```

	Outside Dimension				Weight			
	Length	Width	Height		Net	Gross	Cube	
Transpor	400,0	265,0	215,0	mm	10,100	10,600 Kg	22790	cm^3
Load	1200,0	800,0	1440,0	mm	545,400	597,400 Kg	1,38	m^3




```
Pallet Group Analysis for potential transport boxes.
Max. Height of the load is 1450 mm.
Max. Weight of the load is 600 kg.
Euro-pallet (1200x800x150 mm, 25kg).
```

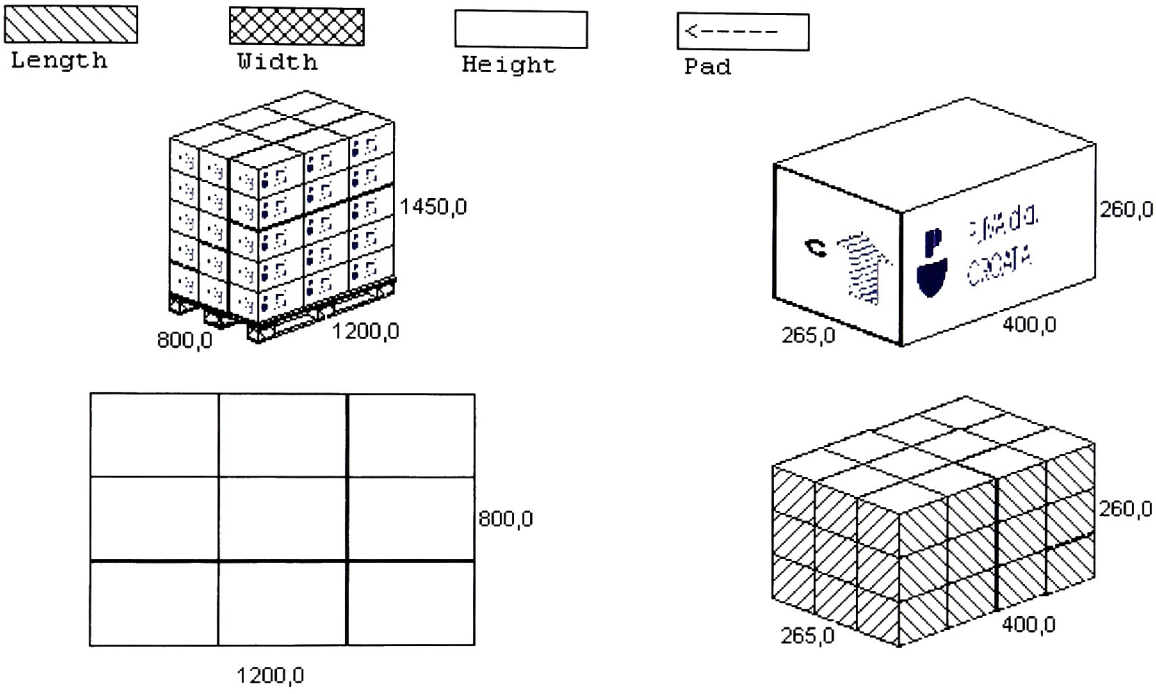
Figure 10.11. Cape Report of the Pallet Group analysis for the transport box TK-4B

```
Product Name    TK-4C   for Tip 3
Product Code    12
Datafile Name   tk 4c for tip 3 (24.01.00)
Solution Ref.     1 C
Cube Used        99,4 %
Area Used        99,4 %
Pallet type     Euro
Custom Arrangement    4L x  3W x  3H
```

```
    9   Transport Box / Layer
    5           Layer / Load
   45   Transport Box / Load

   36             Box / Transpor
 1620             Box / Load
```

	Outside Dimension			Weight		
	Length	Width	Height	Net	Gross	Cube
Transpor	400,0	265,0	260,0 mm	12,200	12,700 Kg	27560 cm^3
Load	1200,0	800,0	1450,0 mm	549,000	596,500 Kg	1,39 m^3

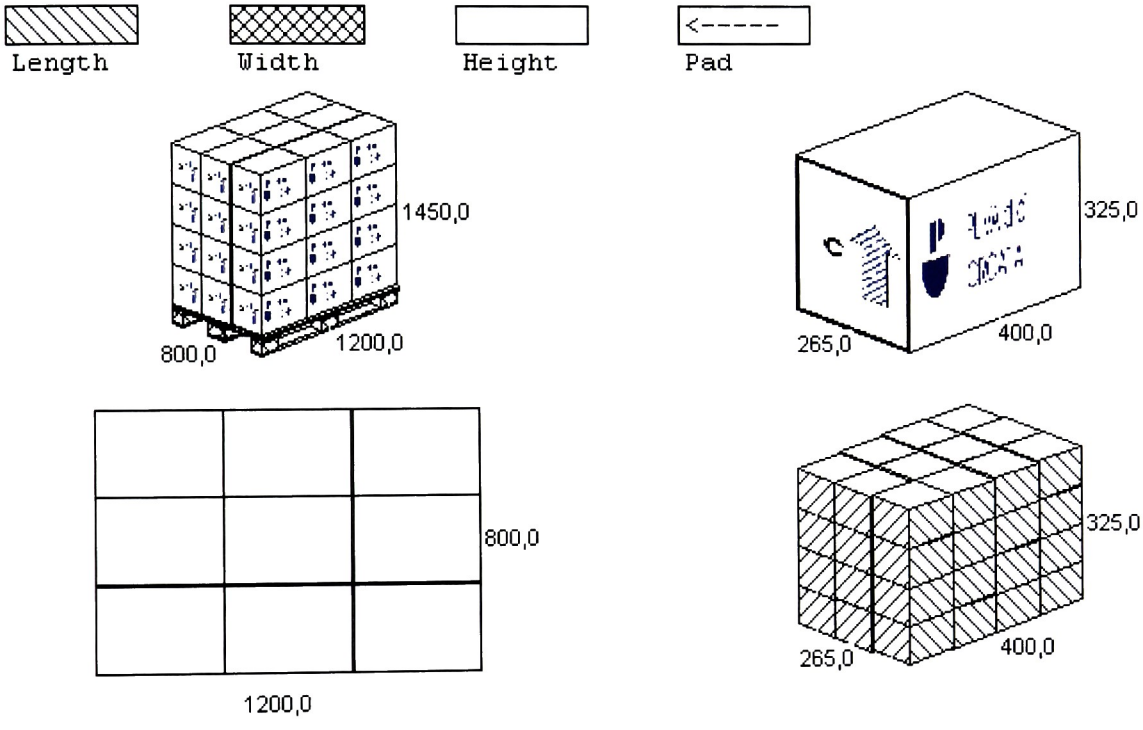



```
Pallet Group Analysis for potential transport boxes.
Max. Height of the load is 1450 mm.
Max. Weight of the load is 600 kg.
Euro-pallet (1200x800x150 mm, 25kg).
```

Figure 10.12. Cape Report of the Pallet Group analysis for the transport box TK-4C

```
Product Name    TK-4D   for Tip 3
Product Code    13
Datafile Name   tk 4d for tip 3 (24.01.00)
Solution Ref.     1 C
Cube Used        99,4 %                      9   Transport Box / Layer
Area Used        99,4 %                      4         Layer / Load
Pallet type     Euro                        36   Transport Box / Load
Custom Arrangement   4L x  3W x 4H
                                             48         Box / Transpor
                                           1728         Box / Load
```

	Outside Dimension				Weight			
	Length	Width	Height		Net	Gross		Cube
Transpor	400,0	265,0	325,0	mm	15,400	15,900	Kg	34450 cm^3
Load	1200,0	800,0	1450,0	mm	554,400	597,400	Kg	1,39 m^3

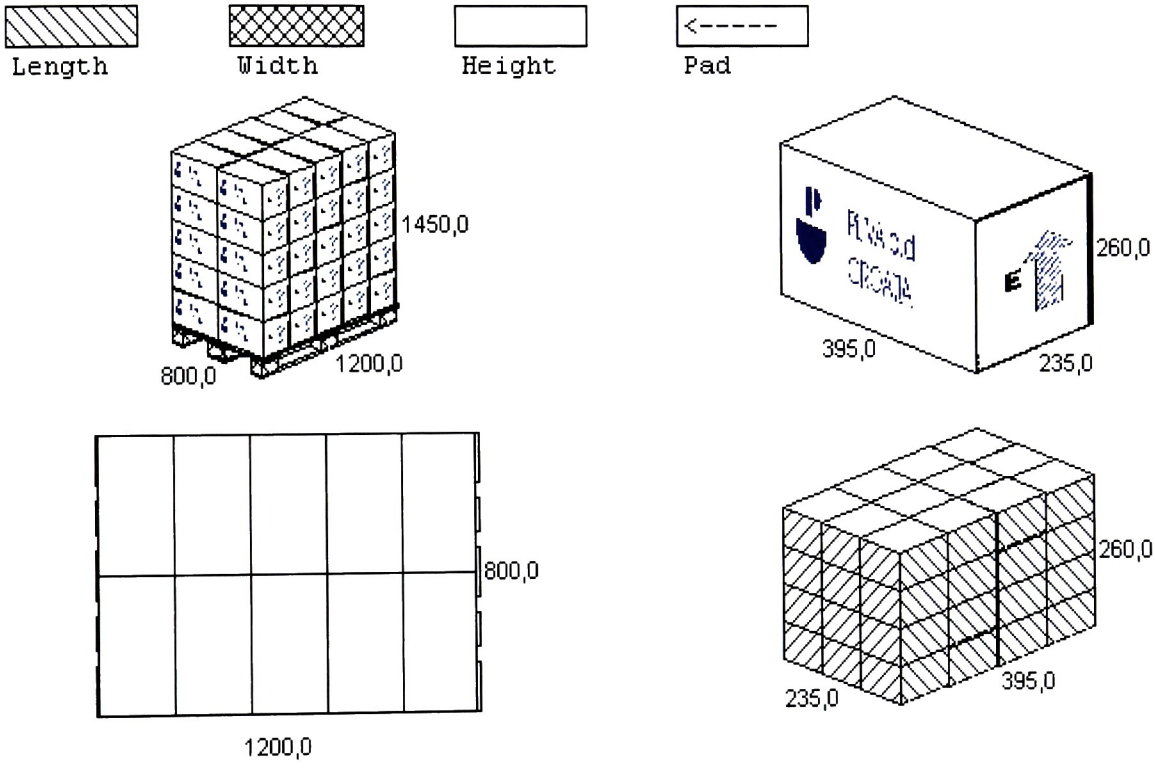



```
Pallet Group Analysis for potential transport boxes.
Max. Height of the load is 1450 mm.
Max. Weight of the load is 600 kg.
Euro-pallet (1200x800x150 mm, 25kg).
```

Figure 10.13. Cape Report of the Pallet Group analysis for the transport box TK-4D

```
Product Name    TK-5C   for Tip 20
Product Code    14
Datafile Name   tk 5c for tip 20 (24.01.00)
Solution Ref.     1 C
Cube Used        96,7 %                          10   Transport Box / Layer
Area Used        96,7 %                           5          Layer / Load
Pallet type     Euro                             50   Transport Box / Load
Custom Arrangement   4L x  3W x  4H
                                                 48            Box / Transpor
                                               2400            Box / Load
```

	Outside Dimension			Weight		
	Length	Width	Height	Net	Gross	Cube
Transpor	395,0	235,0	260,0 mm	11,000	11,500 Kg	24134 cm^3
Load	1200,0	800,0	1450,0 mm	550,000	600,000 Kg	1,39 m^3



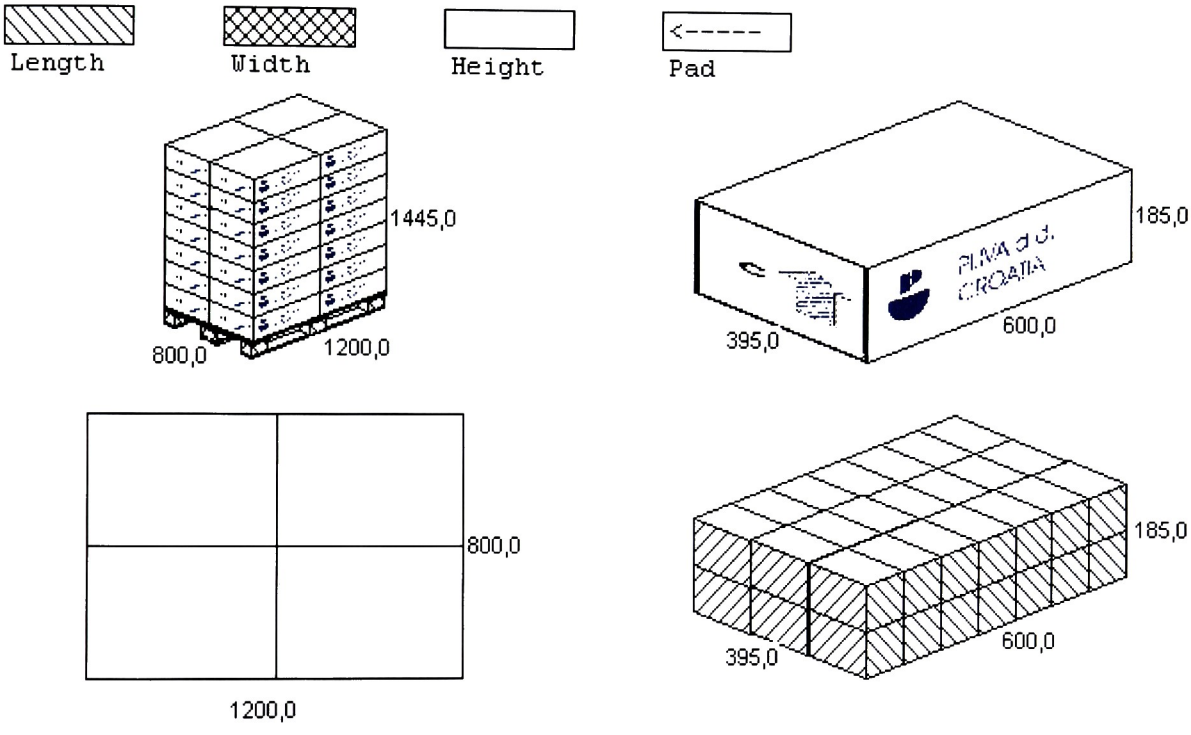

```
Pallet Group Analysis for potential transport boxes.
Max. Height of the load is 1450 mm.
Max. Weight of the load is 600 kg.
Euro-pallet (1200x800x150 mm, 25kg).
```

Figure 10.14. Cape Report of the Pallet Group analysis for the transport box TK-5C

Product Name V 6A for Tip 6
Product Code 15
Datafile Name v 6a for tip 6 (24.01.00)
Solution Ref. 1 C
Cube Used 98,4 %
Area Used 98,8 %
Pallet type Euro
Custom Arrangement 7L x 3W x 2H

4	Transport Box / Layer
7	Layer / Load
28	Transport Box / Load
42	Box / Transpor
1176	Box / Load

	Outside Dimension				Weight		
	Length	Width	Height	Net	Gross		Cube
Transpor	600,0	395,0	185,0 mm	19,500	20,000 Kg		43845 cm^3
Load	1200,0	800,0	1445,0 mm	546,000	585,000 Kg		1,39 m^3



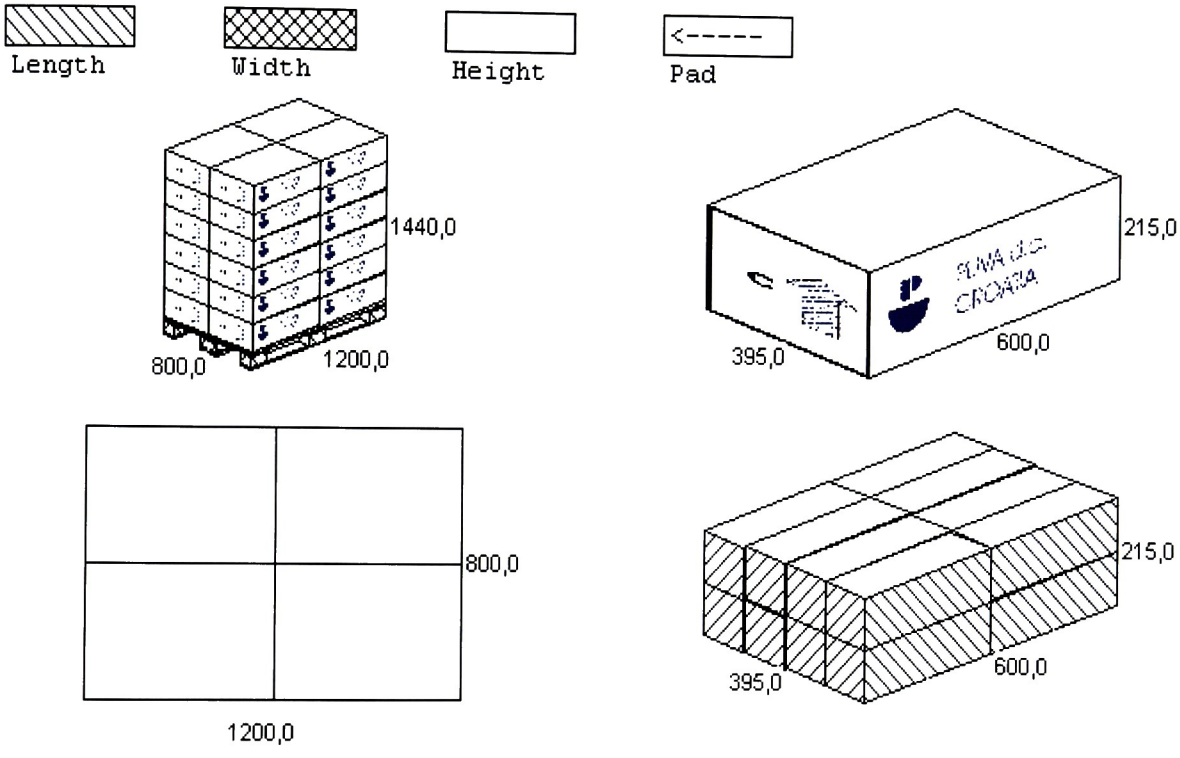
Pallet Group Analysis for potential transport boxes.
Max. Height of the load is 1450 mm.
Max. Weight of the load is 600 kg.
Euro-pallet (1200x800x150 mm, 25kg).

Figure 10.15. Cape Report of the Pallet Group analysis for the transport box V-6A

Product Name	V-6B for Tip 16
Product Code	16
Datafile Name	v 6b for tip 16 (24.01.00)
Solution Ref.	1 C
Cube Used	98,0 %
Area Used	98,8 %
Pallet type	Euro
Custom Arrangement	2L x 4W x 2H

4	Transport Box / Layer
6	Layer / Load
24	Transport Box / Load
16	Box / Transpor
384	Box / Load

	Outside Dimension				Weight		
	Length	Width	Height	Net	Gross	Cube	
Transpor	600,0	395,0	215,0 mm	19,500	20,000 Kg	50955	cm^3
Load	1200,0	800,0	1440,0 mm	468,000	505,000 Kg	1,38	m^3



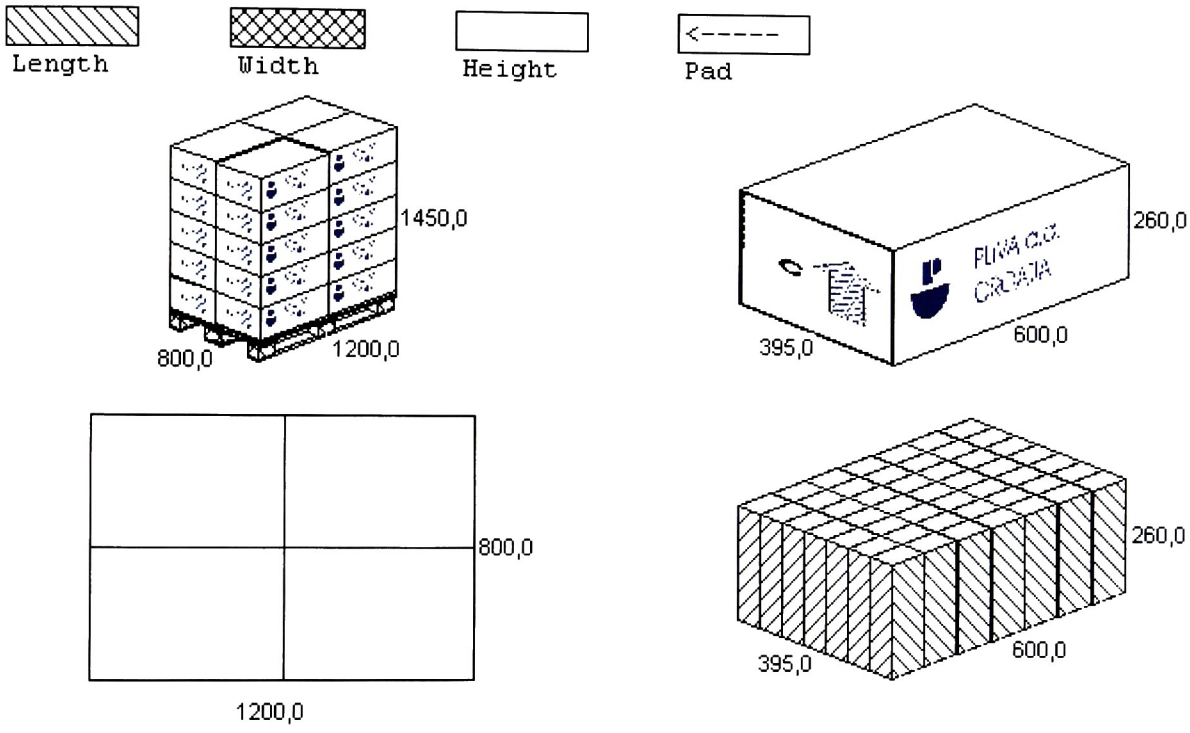
Pallet Group Analysis for potential transport boxes.
Max. Height of the load is 1450 mm.
Max. Weight of the load is 600 kg.
Euro-pallet (1200x800x150 mm, 25kg).

Figure 10.16. Cape Report of the Pallet Group analysis for the transport box V-6B

Product Name	TK-6C for Tip 1
Product Code	17
Datafile Name	v 6c for tip 1 (24.01.00)
Solution Ref.	1 C
Cube Used	98,8 %
Area Used	98,8 %
Pallet type	Euro
Custom Arrangement	7L x 7W x 1H

4	Transport Box / Layer
5	Layer / Load
20	Transport Box / Load
49	Box / Transpor
980	Box / Load

	Outside Dimension			Weight		
	Length	Width	Height	Net	Gross	Cube
Transpor	600,0	395,0	260,0 mm	19,500	20,000 Kg	61620 cm^3
Load	1200,0	800,0	1450,0 mm	390,000	425,000 Kg	1,39 m^3

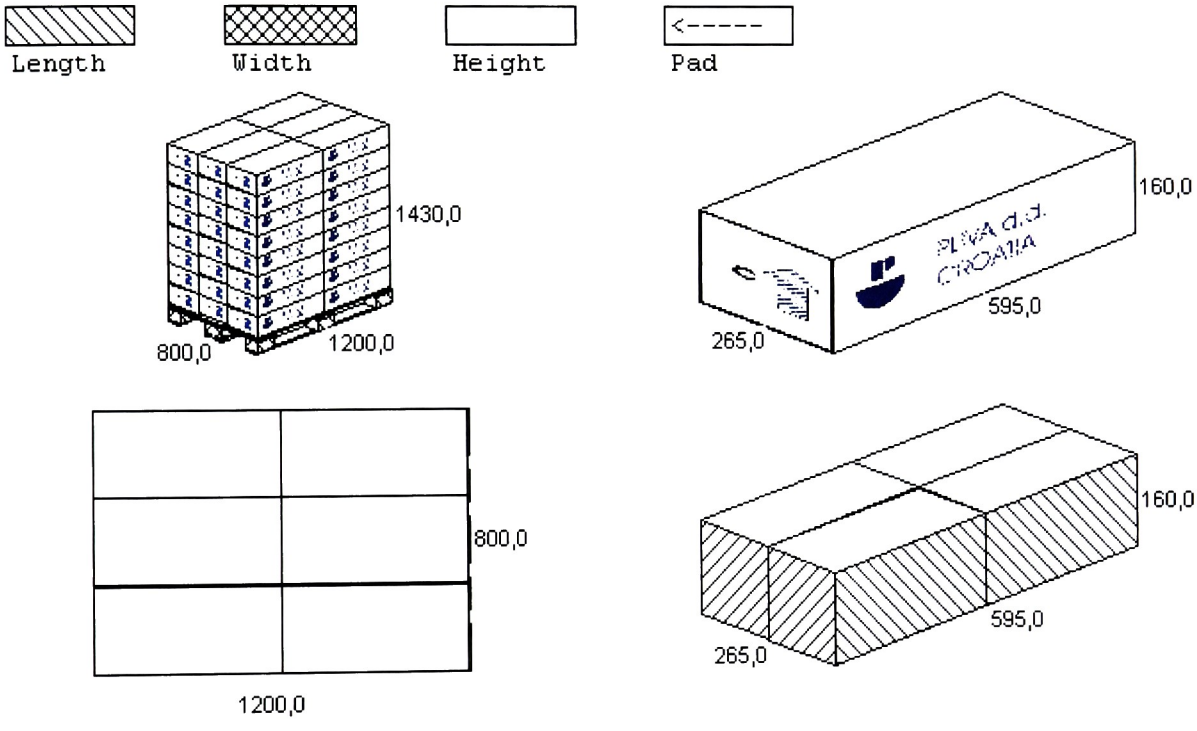


Pallet Group Analysis for potential transport boxes.
Max. Height of the load is 1450 mm.
Max. Weight of the load is 600 kg.
Euro-pallet (1200x800x150 mm, 25kg).

Figure 10.17. Cape Report of the Pallet Group analysis for the transport box V-6C

Product Name	TK-1E for Tip 69		
Product Code	Added 1		
Datafile Name	tk 1e for tip 69 (24.01.00)		
Solution Ref.	1 C		
Cube Used	97,0 %	6	Transport Box / Layer
Area Used	98,5 %	8	Layer / Load
Pallet type	Euro	48	Transport Box / Load
Custom Arrangement	2L x 2W x 1H		
		4	Box / Transpo
		192	Box / Load

	Outside Dimension				Weight		
	Length	Width	Height	Net	Gross	Cube	
Transpor	595,0	265,0	160,0 mm	11,400	11,900 Kg	25228	cm^3
Load	1200,0	800,0	1430,0 mm	547,200	596,200 Kg	1,37	m^3



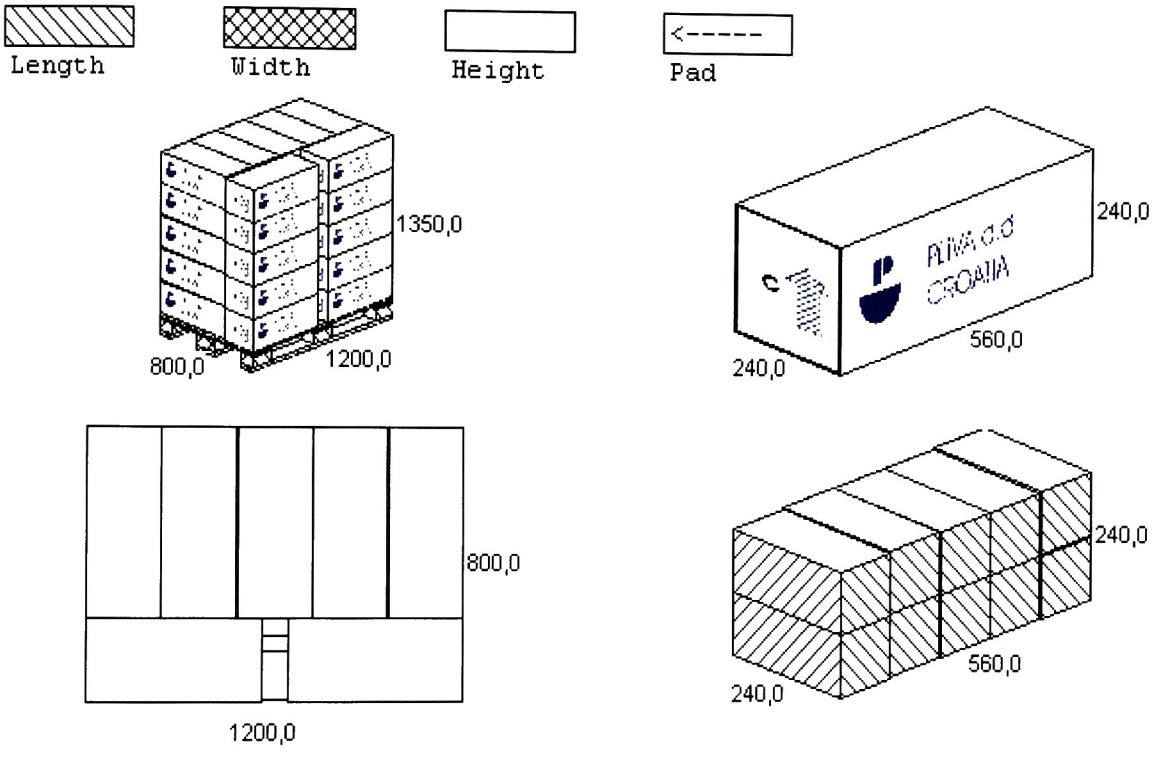
Pallet Group Analysis for potential transport boxes.
Max. Height of the load is 1450 mm.
Max. Weight of the load is 600 kg.
Euro-pallet (1200x800x150 mm, 25kg).

Figure 10.18. Cape Report of the Pallet Group analysis for the transport box TK-1E

Product Name	TK-2E for Tip 13
Product Code	Added 2
Datafile Name	tk 2e for tip 13 (24.01.00)
Solution Ref.	1 I
Cube Used	90,5 %
Area Used	98,0 %
Pallet type	Euro
Custom Arrangement	5L x 1W x 2H

7	Transport Box / Layer
5	Layer / Load
35	Transport Box / Load
10	Box / Transpor
350	Box / Load

	Outside Dimension			Weight			
	Length	Width	Height	Net	Gross		Cube
Transpor	560,0	240,0	240,0 mm	15,900	16,400	Kg	32256 cm^3
Load	1200,0	800,0	1350,0 mm	556,500	599,000	Kg	1,30 m^3



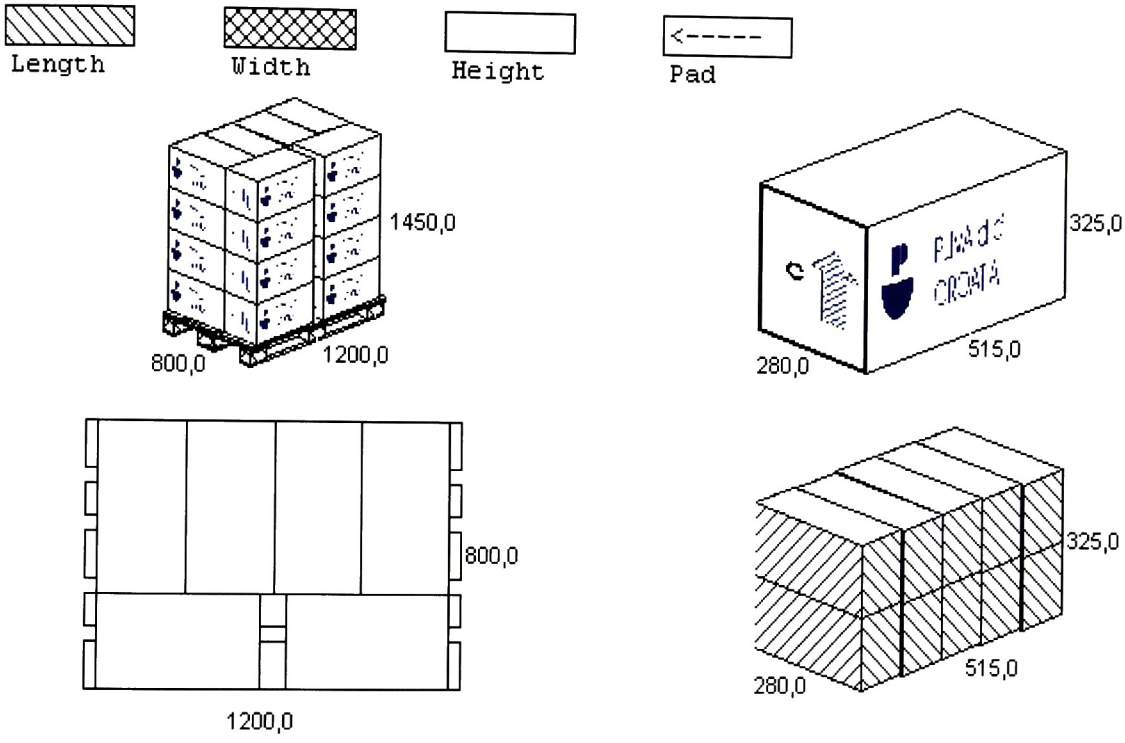
Pallet Group Analysis for potential transport boxes.
Max. Height of the load is 1450 mm.
Max. Weight of the load is 600 kg.
Euro-pallet (1200x800x150 mm, 25kg).

Figure 10.19. Cape Report of the Pallet Group analysis for the transport box TK-2E

Product Name	TK-8A for Tip 42
Product Code	Added 3
Datafile Name	tk 8a for tip 42 (24.01.00)
Solution Ref.	1 I
Cube Used	90,1 %
Area Used	90,1 %
Pallet type	Euro
Custom Arrangement	5L x 1W x 2H

6	Transport Box / Layer
4	Layer / Load
24	Transport Box / Load
10	Box / Transpor
240	Box / Load

	Outside Dimension				Weight		
	Length	Width	Height	Net	Gross	Cube	
Transpor	515,0	280,0	325,0 mm	19,500	20,000 Kg	46865	cm^3
Load	1200,0	800,0	1450,0 mm	468,000	505,000 Kg	1,39	m^3



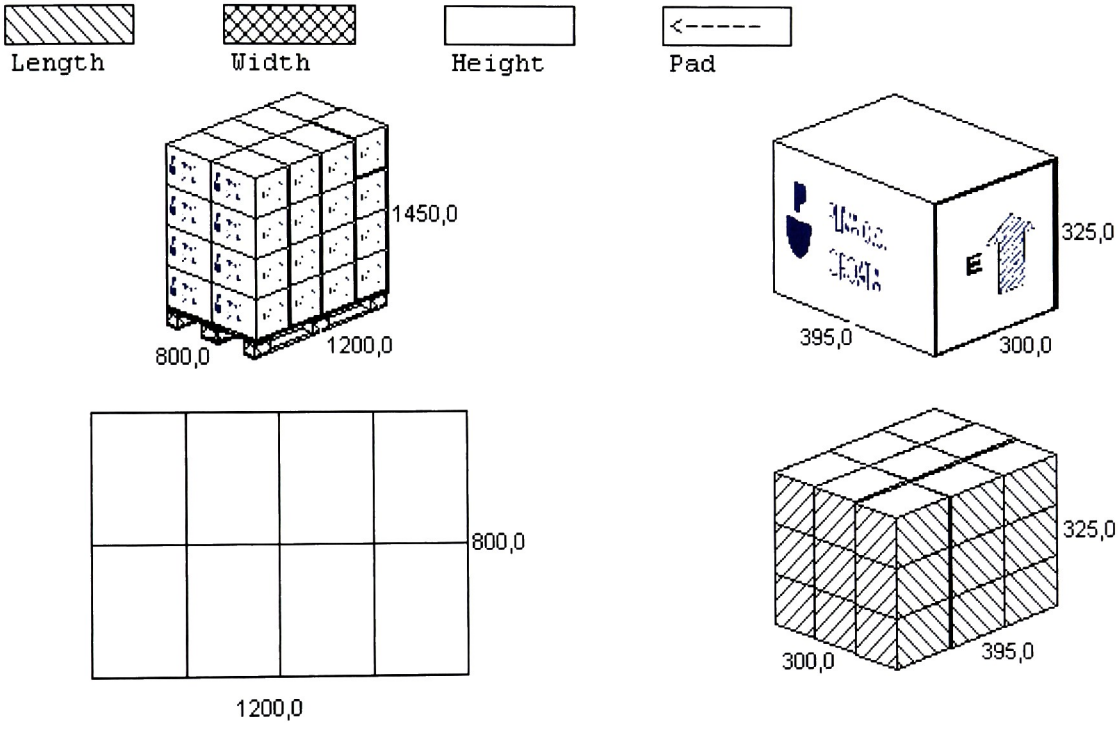
Pallet Group Analysis for potential transport boxes.
Max. Height of the load is 1450 mm.
Max. Weight of the load is 600 kg.
Euro-pallet (1200x800x150 mm, 25kg).

Figure 10.20. Cape Report of the Pallet Group analysis for the transport box TK-8A

Product Name	TK-9A for Tip 64
Product Code	Added 4
Datafile Name	tk 9a for tip 64 (24.01.00)
Solution Ref.	1 C
Cube Used	98,8 %
Area Used	98,8 %
Pallet type	Euro
Custom Arrangement	3L x 3W x 3H

8	Transport Box / Layer
4	Layer / Load
32	Transport Box / Load
27	Box / Transpo
864	Box / Load

	Outside Dimension			Weight		
	Length	Width	Height	Net	Gross	Cube
Transpor	395,0	300,0	325,0 mm	17,400	17,900 Kg	38512 cm^3
Load	1200,0	800,0	1450,0 mm	556,800	597,800 Kg	1,39 m^3



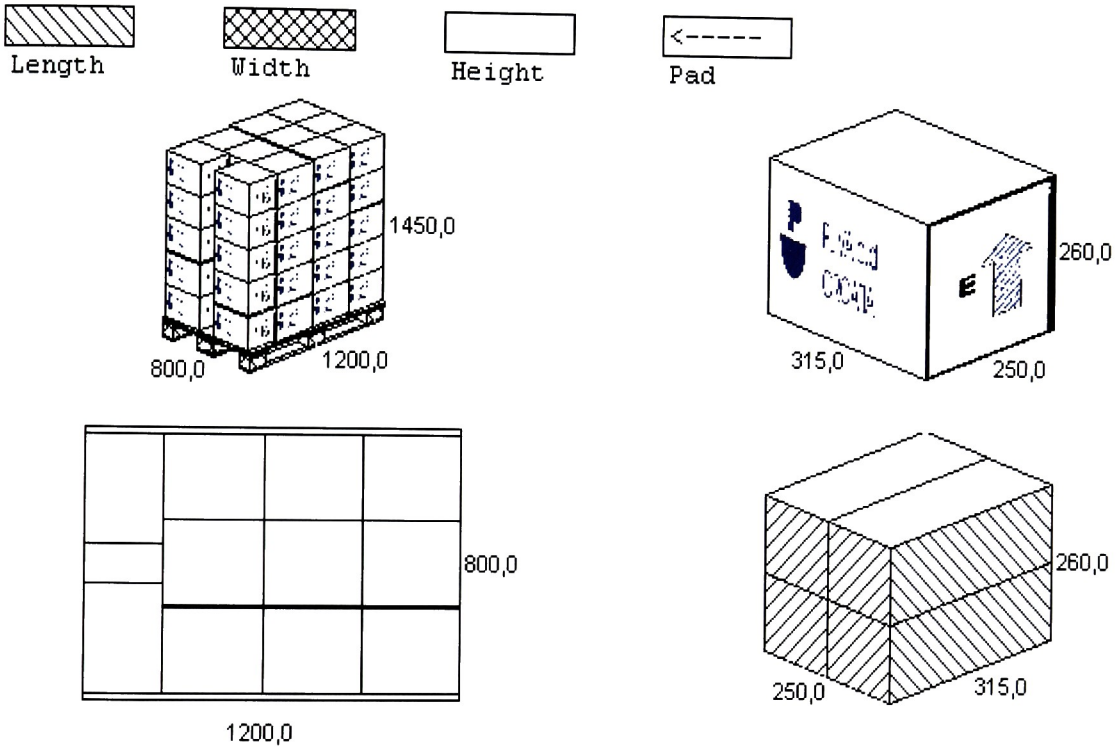
Pallet Group Analysis for potential transport boxes.
Max. Height of the load is 1450 mm.
Max. Weight of the load is 600 kg.
Euro-pallet (1200x800x150 mm, 25kg).

Figure 10.21. Cape Report of the Pallet Group analysis for the transport box TK-9A

Product Name	TK-10A for Tip 53
Product Code	Added 5
Datafile Name	tk 10a for tip 53 (24.01.00)
Solution Ref.	1 I
Cube Used	90,2 %
Area Used	90,2 %
Pallet type	Euro
Custom Arrangement	1L x 2W x 2H

11	Transport Box / Layer
5	Layer / Load
55	Transport Box / Load
4	Box / Transpor
220	Box / Load

	Outside Dimension				Weight		
	Length	Width	Height	Net	Gross	Cube	
Transpor	315,0	250,0	260,0 mm	9,900	10,400 Kg	20475	cm^3
Load	1200,0	800,0	1450,0 mm	544,500	597,000 Kg	1,39	m^3



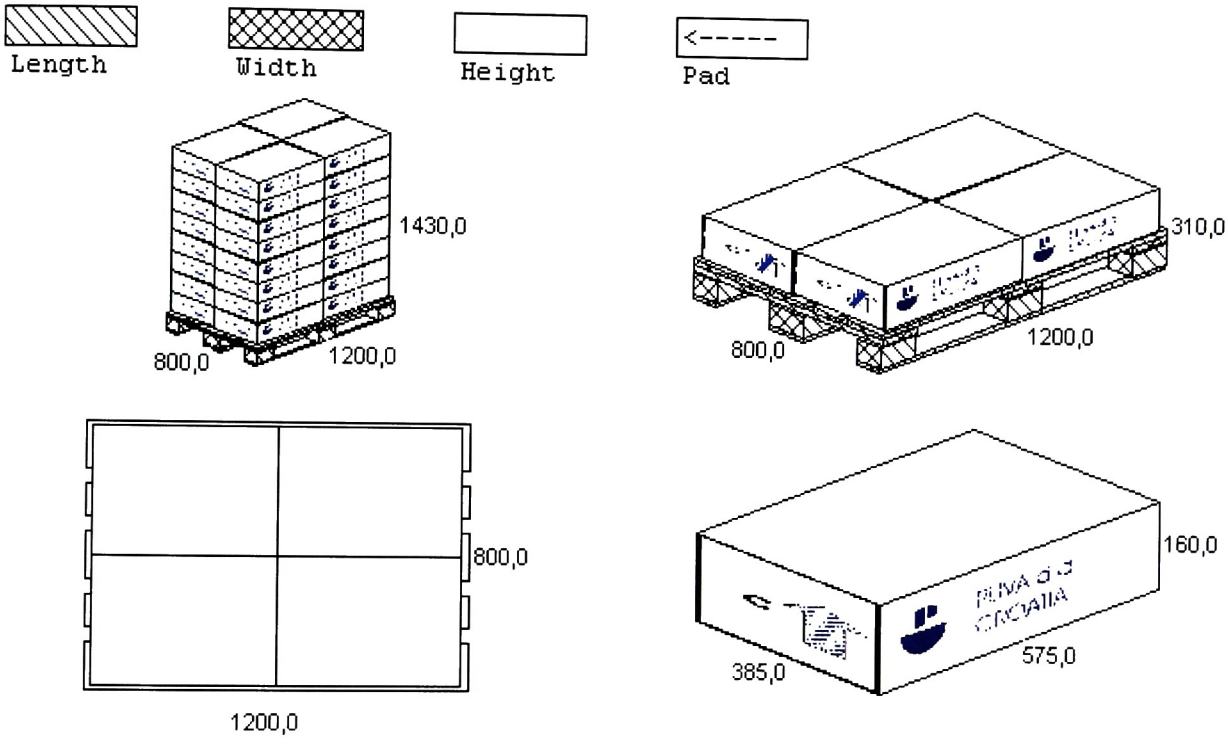
Pallet Group Analysis for potential transport boxes.
Max. Height of the load is 1450 mm.
Max. Weight of the load is 600 kg.
Euro-pallet (1200x800x150 mm, 25kg).

Figure 10.22. Cape Report of the Pallet Group analysis for the transport box TK-10A

Product Name	TK-11A
Product Code	Added 6
Datafile Name	tk 11a (24.01.00)
Solution Ref.	1 C
Cube Used	90,8 %
Area Used	92,2 %
Pallet type	Euro
Custom Arrangement	1L x 2W x 2H

4	Transport Box / Layer
8	Layer / Load
32	Transport Box / Load
4	Box / Transpor
128	Box / Load

	Outside Dimension			Weight		Cube
	Length	Width	Height	Net	Gross	
Transpor	575,0	385,0	160,0 mm	17,400	17,900 Kg	35420 cm^3
Load	1200,0	800,0	1430,0 mm	556,800	597,800 Kg	1,37 m^3



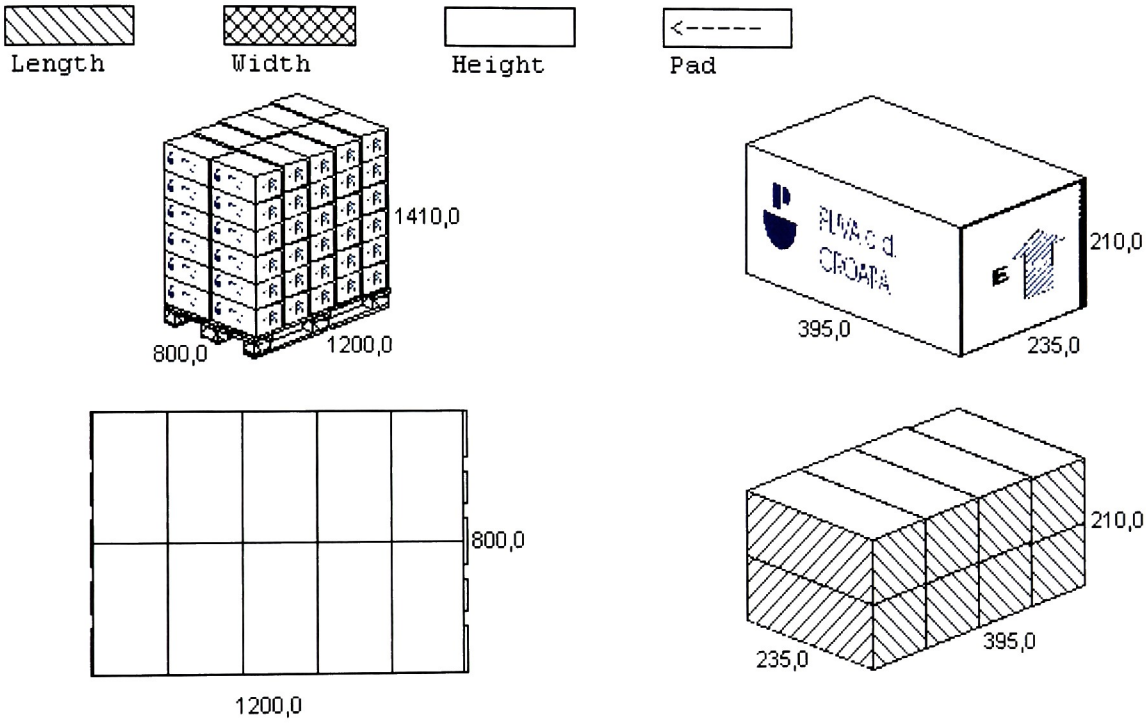
Pallet Group Analysis for potential transport boxes.
Max. Height of the load is 1450 mm.
Max. Weight of the load is 600 kg.
Euro-pallet (1200x800x150 mm, 25kg).

Figure 10.23. Cape Report of the Pallet Group analysis for the transport box TK-11A

Product Name	TK-28A for Tip 80
Product Code	Added 7
Datafile Name	tk 28a (24.01.00)
Solution Ref.	1 C
Cube Used	93,7 %
Area Used	96,7 %
Pallet type	Euro
Custom Arrangement	4L x 1W x 2H

10	Transport Box / Layer
6	Layer / Load
60	Transport Box / Load
8	Box / Transpo
480	Box / Load

	Outside Dimension				Weight			
	Length	Width	Height		Net	Gross		Cube
Transpor	395,0	235,0	210,0	mm	9,000	9,500	Kg	19493 cm^3
Load	1200,0	800,0	1410,0	mm	540,000	595,000	Kg	1,35 m^3



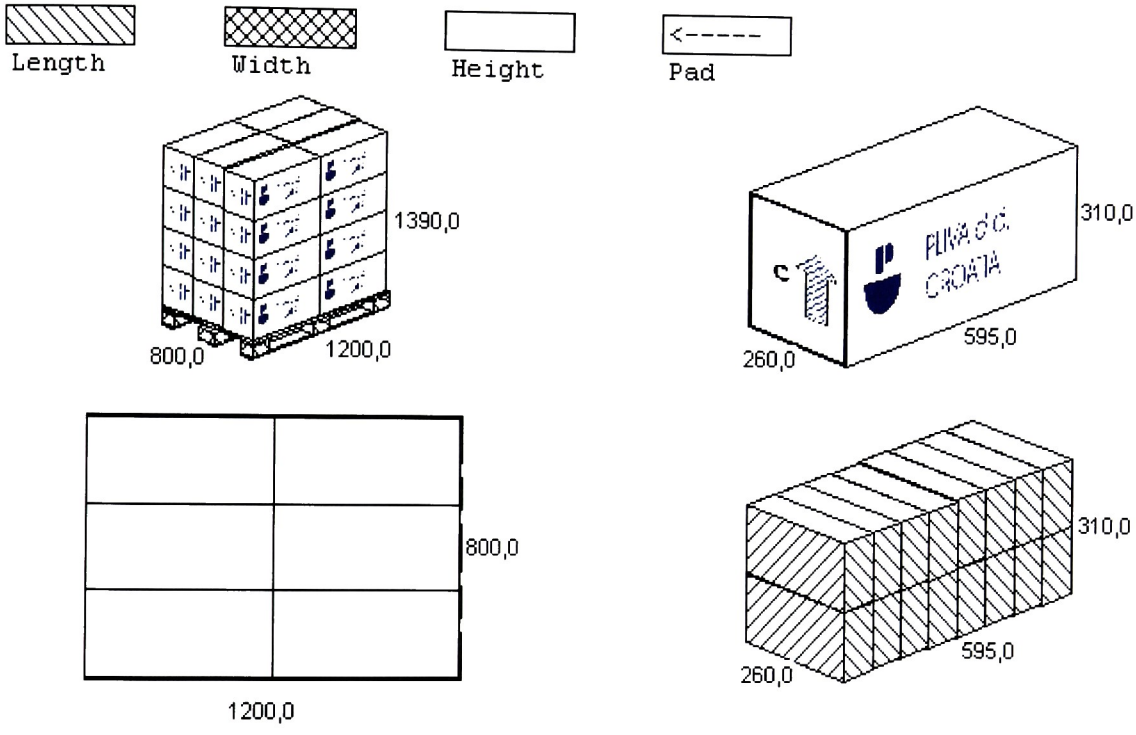
Pallet Group Analysis for potential transport boxes.
Max. Height of the load is 1450 mm.
Max. Weight of the load is 600 kg.
Euro-pallet (1200x800x150 mm, 25kg).

Figure 10.24. Cape Report of the Pallet Group analysis for the transport box TK-28A

Product Name	Tx-15 for Tip 65
Product Code	Added 8
Datafile Name	tx 15 for tip 65 (24.01.00)
Solution Ref.	1 C
Cube Used	92,2 %
Area Used	96,7 %
Pallet type	Euro
Custom Arrangement	8L x 1W x 2H

6	Transport Box / Layer
4	Layer / Load
24	Transport Box / Load
16	Box / Transpo
384	Box / Load

	Outside Dimension				Weight		
	Length	Width	Height	Net	Gross	Cube	
Transpor	595,0	260,0	310,0 mm	19,500	20,000 Kg	47957	cm^3
Load	1200,0	800,0	1390,0 mm	468,000	505,000 Kg	1,33	m^3



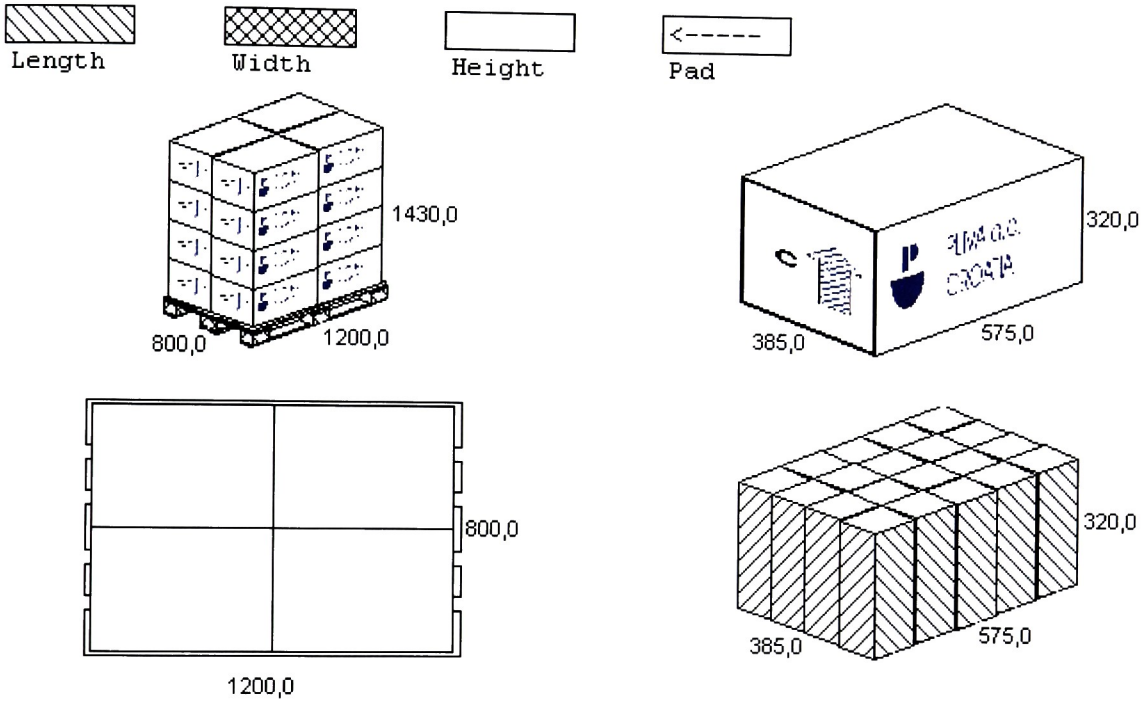
Pallet Group Analysis for potential transport boxes.
Max. Height of the load is 1450 mm.
Max. Weight of the load is 600 kg.
Euro-pallet (1200x800x150 mm, 25kg).

Figure 10.25. Cape Report of the Pallet Group analysis for the transport box Tx-15

Product Name	VOT-37 for Tip 19
Product Code	Added 9
Datafile Name	vot 37 for tip 19 (24.01.00)
Solution Ref.	1 C
Cube Used	90,8 %
Area Used	92,2 %
Pallet type	Euro
Custom Arrangement	5L x 4W x 1H

4	Transport Box / Layer
4	Layer / Load
16	Transport Box / Load
20	Box / Transpor
320	Box / Load

	Outside Dimension				Weight		
	Length	Width	Height	Net	Gross	Cube
Transpor	575,0	385,0	320,0 mm	19,500	20,000 Kg	70840 cm^3
Load	1200,0	800,0	1430,0 mm	312,000	345,000 Kg	1,37 m^3



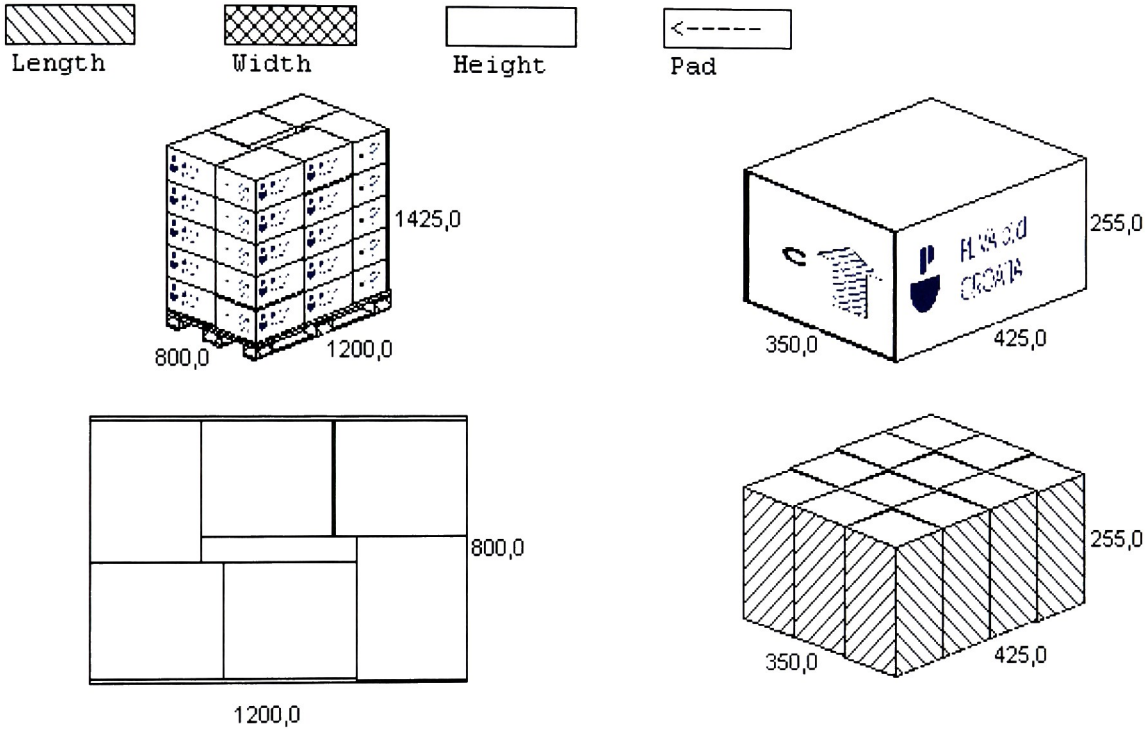
Pallet Group Analysis for potential transport boxes.
Max. Height of the load is 1450 mm.
Max. Weight of the load is 600 kg.
Euro-pallet (1200x800x150 mm, 25kg).

Figure 10.26. Cape Report of the Pallet Group analysis for the transport box VOT-37

Product Name	VOT-40 for Tip 13
Product Code	Added 10
Datafile Name	vot 40 for tip 13 (24.01.00)
Solution Ref.	1 S
Cube Used	91,2 %
Area Used	93,0 %
Pallet type	Euro
Custom Arrangement	4L x 3W x 1H

6	Transport Box / Layer
5	Layer / Load
30	Transport Box / Load
12	Box / Transpo
360	Box / Load

	Outside Dimension				Weight		
	Length	Width	Height	Net	Gross		Cube
Transpor	425,0	350,0	255,0 mm	18,600	19,100	Kg	37931 cm^3
Load	1200,0	800,0	1425,0 mm	558,000	598,000	Kg	1,37 m^3



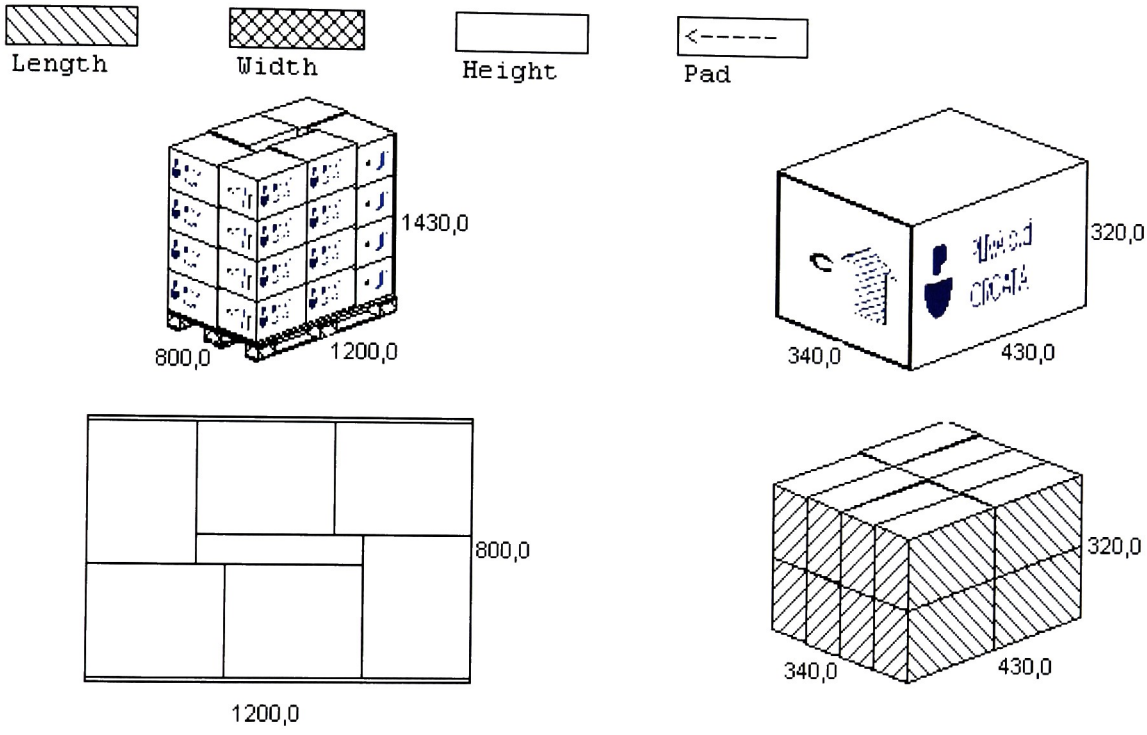
Pallet Group Analysis for potential transport boxes.
Max. Height of the load is 1450 mm.
Max. Weight of the load is 600 kg.
Euro-pallet (1200x800x150 mm, 25kg).

Figure 10.27. Cape Report of the Pallet Group analysis for the transport box VOT-40

Product Name	VOT-42 for Tip 65
Product Code	Added 11
Datafile Name	vot 42 for tip 65 (24.01.00)
Solution Ref.	1 S
Cube Used	90,0 %
Area Used	91,4 %
Pallet type	Euro
Custom Arrangement	2L x 4W x 2H

6	Transport Box / Layer
4	Layer / Load
24	Transport Box / Load
16	Box / Transpo
384	Box / Load

	Outside Dimension				Weight		
	Length	Width	Height	Net	Gross	Cube	
Transpor	430,0	340,0	320,0 mm	19,500	20,000 Kg	46784	cm^3
Load	1200,0	800,0	1430,0 mm	468,000	505,000 Kg	1,37	m^3



Pallet Group Analysis for potential transport boxes.
Max. Height of the load is 1450 mm.
Max. Weight of the load is 600 kg.
Euro-pallet (1200x800x150 mm, 25kg).

Figure 10.28. Cape Report of the Pallet Group analysis for the transport box VOT-42