B. LOAD ASSUMPTIONS

1. LOAD ASSUMPTIONS

The following load assumptions are based on normal transport stresses. Extreme and/or excessive stresses cannot be the basis for designing standard packaging units.

<table>
<thead>
<tr>
<th>means of transport</th>
<th>forwards acceleration</th>
<th>backwards acceleration</th>
<th>lateral acceleration</th>
</tr>
</thead>
<tbody>
<tr>
<td>road transport</td>
<td>1,0 g</td>
<td>0,5 g</td>
<td>0,5 g</td>
</tr>
<tr>
<td>railway transport</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>shunting traffic</td>
<td>4,0 g</td>
<td>4,0 g</td>
<td>0,5 g (a)</td>
</tr>
<tr>
<td>combined traffic*</td>
<td>1,0 g</td>
<td>1,0 g</td>
<td>0,5 g (a)</td>
</tr>
<tr>
<td>maritime transport</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baltic Sea</td>
<td>0,3 g (b)</td>
<td>0,3 g (b)</td>
<td>0,5 g</td>
</tr>
<tr>
<td>North Sea</td>
<td>0,3 g (c)</td>
<td>0,3 g (c)</td>
<td>0,7 g</td>
</tr>
<tr>
<td>Ocean going traffic</td>
<td>0,4 g (d)</td>
<td>0,4 g (d)</td>
<td>0,8 g</td>
</tr>
<tr>
<td>air traffic</td>
<td>1,5 g</td>
<td>1,5 g</td>
<td>Vertical ± 3,0 g</td>
</tr>
</tbody>
</table>

The above values shall be combined with vertical gravitational forces of 1 g and dynamic fluctuations, also vertical:

(a) = ± 0,3 g   (b) = ± 0,5 g   (c) = ± 0,7 g   (d) = ± 0,8 g

*railway wagons with containers, swaps, trucks, lorries and complete trains type UIC and RIV.

Acceleration forces can be calculated by the multiplication of mass (the packaged goods or unit) times acceleration:

\[ F = m \times g \]

Other types of acceleration forces may occur.
2. LOADS DUE TO CRUSHING IN STACKS

When storing cases on level and horizontal surfaces and given an even distribution of weights on the case lid, the value for static, vertical loads in stacks is calculated as follows:

\[ P = 10 \text{ kN/m}^2 \] (1 t/m²)

Static stacking loads are overridden by dynamic forces during the movement of transport vehicles, they may be de- or increased according to vertical acceleration forces, see table 3.

Note: Where there is a risk of punctual or linear loads occurring during transport, those responsible for the goods must take the necessary measures to spread the load more evenly.

Horizontal stresses on the case lid due to a ship's movement, especially when rolling, depend on the stacking weights involved and the lateral impact of horizontal loads.

Once the packaging company has been informed of larger than usual stacking loads \( P \), the relevant values can be calculated as follows:

\[ P = \sigma \cdot (h_{\text{St}} - h) \]

\( h \) = height of the packaged goods in m

\( h_{\text{St}} \) = stacking height in m

\( \sigma \) = specific mass of goods stacked on top according to the customer's indications (t/m³)

Example:
Stacking of packaged goods in a cargo ship. High crushing loads can be caused by excessive stacking.
3. HORIZONTAL LOADS

Horizontal acceleration forces mainly occur when transport vehicles accelerate quickly or brake. This often happens when shock-like forces occur during shunting of freight trains. This inflicts major stresses on packaging units and their goods. Shunting peaks of 4 g during t = 0.05 sec. must be used as a statistical average load in calculations:

a) for the case assembly

\[ H_1 = g_h \cdot G_T \]

\( G_T \) = tare weight in kN

\( g_h \) = horizontal acceleration

b) for the lashing securing the packaged goods

(stresses on fasteners)

\[ H_2 = (g_h \cdot G_N) - (G_N \cdot g \cdot \mu) \]

\( G_N \) = net weight in kN

\( g \) = earth acceleration forces

\( \mu \) = friction value

c) Horizontal acceleration forces attack the centre of gravity of the packaged goods or units.

<table>
<thead>
<tr>
<th>material combinations</th>
<th>dry</th>
<th>wet</th>
</tr>
</thead>
<tbody>
<tr>
<td>timber/timber</td>
<td>0.2 – 0.5</td>
<td>0.2 – 0.25</td>
</tr>
<tr>
<td>metal/timber</td>
<td>0.2 – 0.5</td>
<td>0.2 – 0.25</td>
</tr>
<tr>
<td>metal/metal</td>
<td>0.1 – 0.25</td>
<td>0.1 – 0.2</td>
</tr>
</tbody>
</table>

The importance of the shunting impact can be greater or smaller in countries where other rail transport standards apply.

It is assumed that acceleration or deceleration of 1 g in the driving direction and 0.5 g laterally and towards the rear will not be exceeded when using road vehicles (see VDI directive 2700).
4. VERTICAL LOADS

Vertical loads on the packaged goods result from crushing loads in stacks due to the weight of the goods above but also due to the mass of the packaged good itself. There are in both cases static loads during storage and static/dynamic loads during transport and handling.

5. STRESSES THROUGH FALLING AND VIBRATIONS

Vibration stresses occur with each transport movement, depending on the type of transport chosen. The customer must inform the packaging firm regarding the load assumptions for any sensitive goods. In certain cases the use of shock indicators or gauges should be considered.

6. TRANSVERSE FORCES DURING CRANE HANDLING

These forces occur on the lid during loading with lifting tackle. When assuming a cable spreading angle of 60° during the lifting manoeuvre in ill.1, we can calculate the loads on the lid as follows:

\[ F_D = 0.145 \times F_g \]

In this case \( F_g \) is the load of the force expressed in N equals mass of the packaging good in kg multiplied by earth gravitation forces \( g \).

\[ g \approx 10 \text{ m/s}^2 \]

In this calculation rope/cable friction was ignored, case height and width are of no concern. In order to avoid damage through these greatly differing spreading angles, we recommend using values of \( F_D = 0.2 \) to \( 0.3 \times F_g \) .

Example:

stowage of packaged goods in a cargo ship by crane. The packaging must be designed to withstand stresses due to rope/cable forces.
7. TILTING STRESSES

A case or a packaging unit is threatened by tilting when the centre of gravity lies above the point where lateral diagonals cross and/or is found to the side and outside of the middle section.

8. CENTRE OF GRAVITY INDICATIONS

Where goods are packaged individually and the marking of the centre of gravity is necessary, it is the duty of the customer/manufacturer to establish its position and indicate this to the packer. The centre of gravity must be marked according to DIN 55 402, DIN EN ISO 780 or according to the regulations of the country of destination.