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# Transport simulation for goods transport in non-temperature-control sea and overland freight containers

Millions of plastic parts for diagnostics are manufactured and sent halfway around the world every day, for example in air-conditioned sea freight containers. The parts are in bulk or stacked in racks, wrapped in film, cartoned, labeled, and stacked again on pallets. Calculations have shown that the non-tempered sea freight container has 10% more storage space for the transported goods. The transport costs are therefore correspondingly lower. The question is, however, whether the parts will survive the transport without damage?

Experience shows that plastic parts become brittle at cold temperatures (-30°C) and are therefore more susceptible to impact loads, while they can deform at high temperatures (70°C). Let's limit ourselves to the winter half-year and ask up to what temperature is transport possible without the goods being damaged?

**Transport simulation "Drop Impact" in the Gausstec laboratory**

In the present approach, the condition of intactness was determined as the primary quality characteristic and then the dependence between temperature and drop height during transport was derived. The EN 60721-3-2 standard specifies a maximum expected drop height.

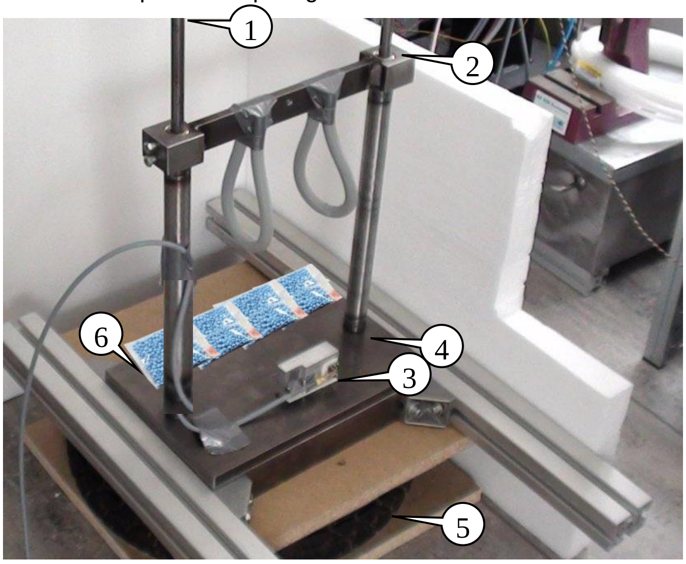


*Abbildung 1: Structure of drop tower with guide rods (1), drop frame (2), acceleration sensor (3), ram plate (4) and buffer (5), specimen (6).*

Since integrity is a binary characteristic (defective/undefective), we need many experiments at different temperatures and different drop heights for statistically relevant statements. It would be immeasurable to perform such experiments on the original packaging. How should one cool the sample in the cartons to -20°C and after the drop experiment be able to assess within a useful period of time whether there is any damage?

Instead, we determine the acceleration on a Euro-pallet at normative drop height and by repeated experiments, where the temperature is not important. In a further experiment we use a drop tower on which the primary packed samples can be installed and measure the acceleration. Also repeated here the acceleration at different drop heights, see Figure 2. Here, too, the temperature does not yet play a role. Since we now know the acceleration on the palette in the normative case and we also know the functional relationship between acceleration and drop height in the drop tower, we can now perform a large number of experiments in the drop tower, varying the drop height and the temperature as well as checking the integrity of the concrete sample in real time.
Some questions and answers:
But how to cool a drop tower to -20°C in a controlled way, how to measure accelerations so high that plastic parts break? It's all a question of equipment.

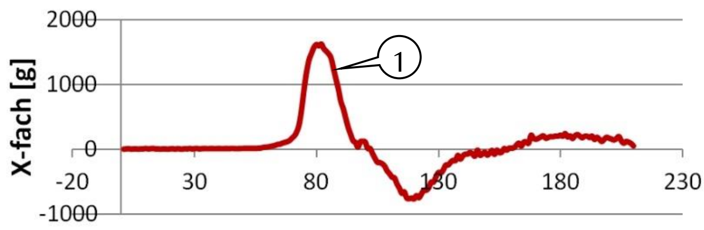


*Abbildung 2: Curve recording of an acceleration measurement on the drop tower. Maxima acceleration (1) at 50kHz time resolution.*

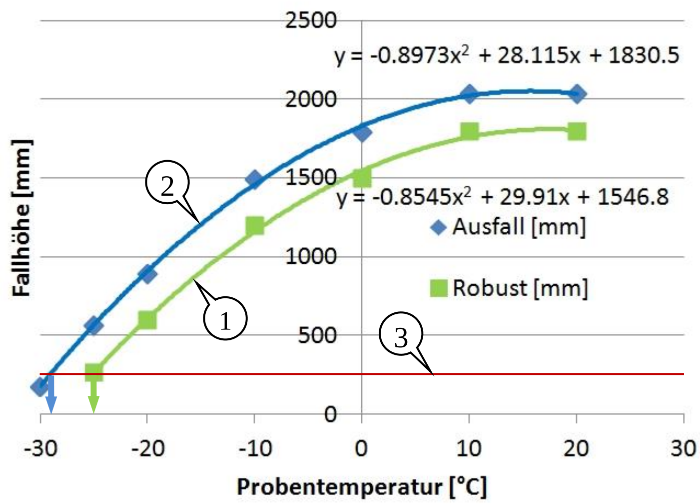


*Abbildung 3: Critical drop height as a function of temperature with survival line (1), failure line (2), normative drop height (3)*

And now the answer. With a normative drop height of 250mm, transport is possible up to temperatures of -25°C. From temperatures of -28°C, damage to the specimens must be expected.

**Setup transport simulation for Drop impact**
Gausstec has the following facilities for temperature controlled drop experiments::

- Drop tower for drop heights of 1.7m, sample chamber 250 x 250 x 300mm, measurement frequency up to 50kHz, acceleration measurement up to 6kG.
- Drop tower for temperatures -30°C to 60°C. Different adapters for different types of samples.