

# Developing a protective bumper system for storage containers

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This assignment focuses on designing and developing a modular protective bumper system for mobile storage containers.

Salland Storage, located in Deventer, the Netherlands, rents out storage containers to customers for temporary use. Such a container is shown in Figure 1. The company is expanding its rental services to construction companies, where containers are often exposed to rough handling and collisions with forklifts and other vehicles. These impacts lead to structural damage and high repair costs, limiting the lifespan and profitability of the containers. To limit the damage, a durable, attachable protection system is developed.



Figure 1. Salland Storage's storage container

The main research question guiding the assignment was:

“How can a storage container be reinforced to increase damage resistance in rough environments like construction sites?”

To ensure the best protection possible, the following research and analysis were carried out:

- Construction site analysis, providing data on common accidents.
- Forklift analysis, providing insights on the speed, weight, and design of forklifts.
- Damage analysis, done on 70 existing containers
- Container analysis, looking at the structure and features of the storage container.
- Market research, providing inspiration and proven designs.

From this,

This research defined requirements for developing three design concepts. A weighted evaluation of these concepts resulted in the selection and refinement of the most promising design, which was a height-adjustable, modular bumper system.

As the main function of the bumper system is to protect the storage container from collisions with forklifts, the bumpers had to be designed to absorb this energy, while minimising the bending under impact, as the protection can only stick out 200 mm on all sides of the container.

Using CAD software (SolidWorks), 3D models were created and tested in ANSYS Workbench for structural performance. Different designs and materials were tested and evaluated to find a combination that fulfils all requirements. This design is shown in Figure 2.

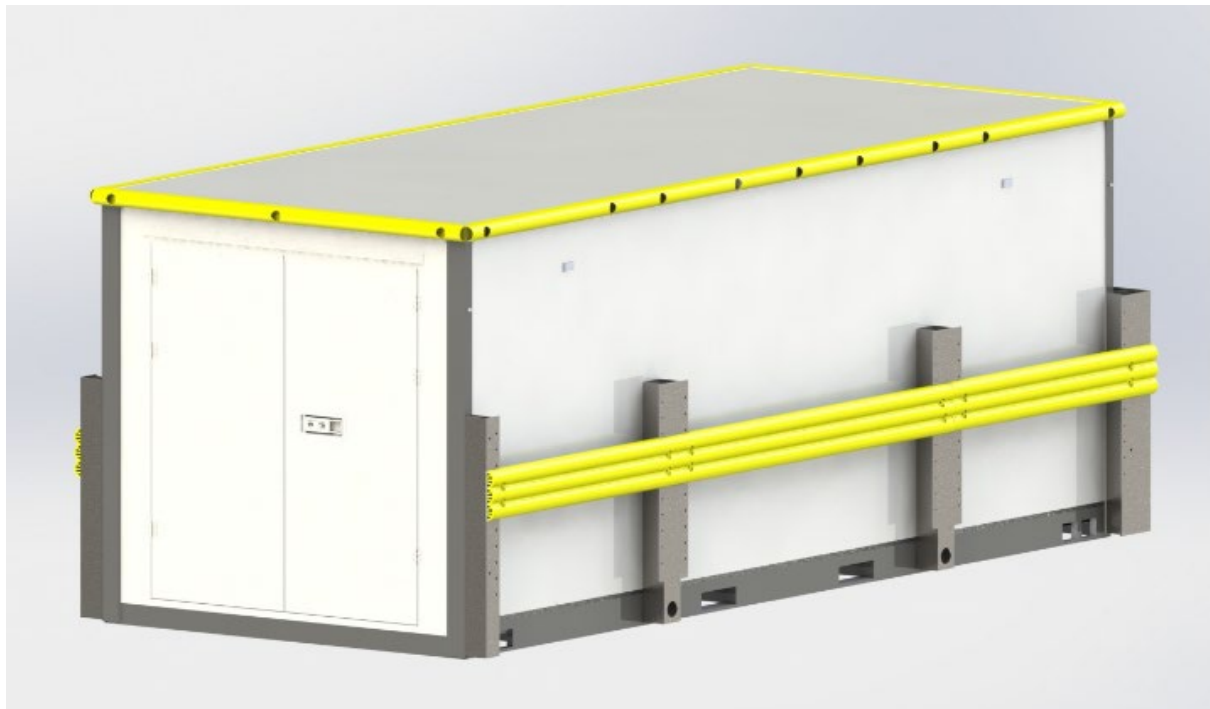
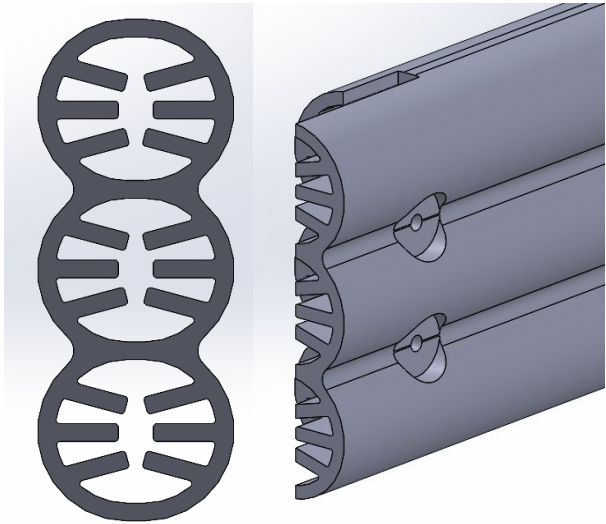


Figure 2. Protection system final design

The design incorporates modular connection points to the container that hold hollow bumpers made of rigid PVC. These connection points attach to the existing points on the container and enable the bumpers to be manually moved up and down. The bumpers are carefully designed and simulated to withstand impacts from forklifts while remaining intact. The design of these bumpers and their connections is illustrated in Figure 3.

PVC bumper



Middle and corner connections

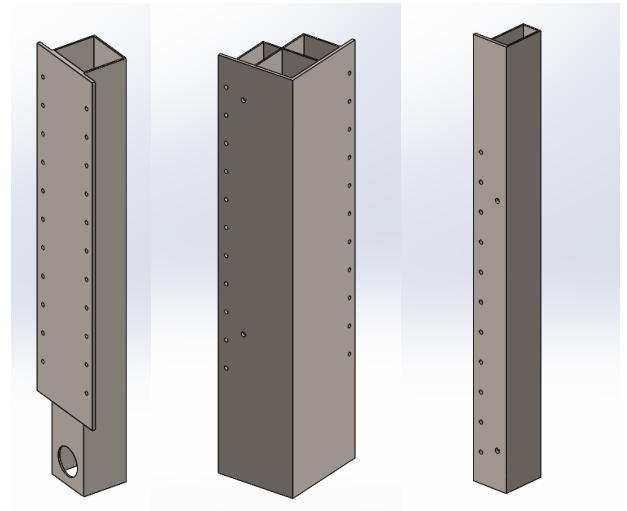


Figure 3. Protection bumper design

Simulation results indicate that the bumper system can withstand up to 59,00 N of impact force with acceptable deflection, remaining well within the material's elastic limit. However, validation through real-world testing is still necessary to confirm the protective system's effectiveness.

On top of this, a roof protection had been designed to protect the edge of the roof from scratches caused by tall objects placed against the roof. This protection also consists of hollow PVC bumpers. The design of these bumpers is shown in Figure 4.

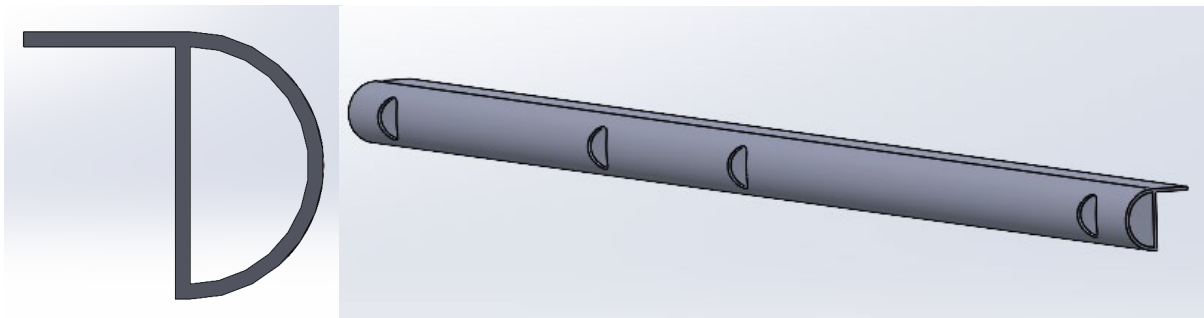


Figure 4. Roof protection design

The roof protection is connected to the roof using existing connection points on the roof, supported by rubber-coated magnets. These magnets are shown in Figure 5.



Figure 5. Rubber coated magnet

To conclude, the objective of developing a protective system that protects the storage container in rough environments like construction sites has been met. The bumper system performs well in simulations and significantly improves the container's resilience to forklift-related damage.

Future recommendations include:

- Larger-scale field testing on construction sites to assess long-term durability.
- Further production costs optimisation.
- Minimising weight while maximising the strength of the bumpers