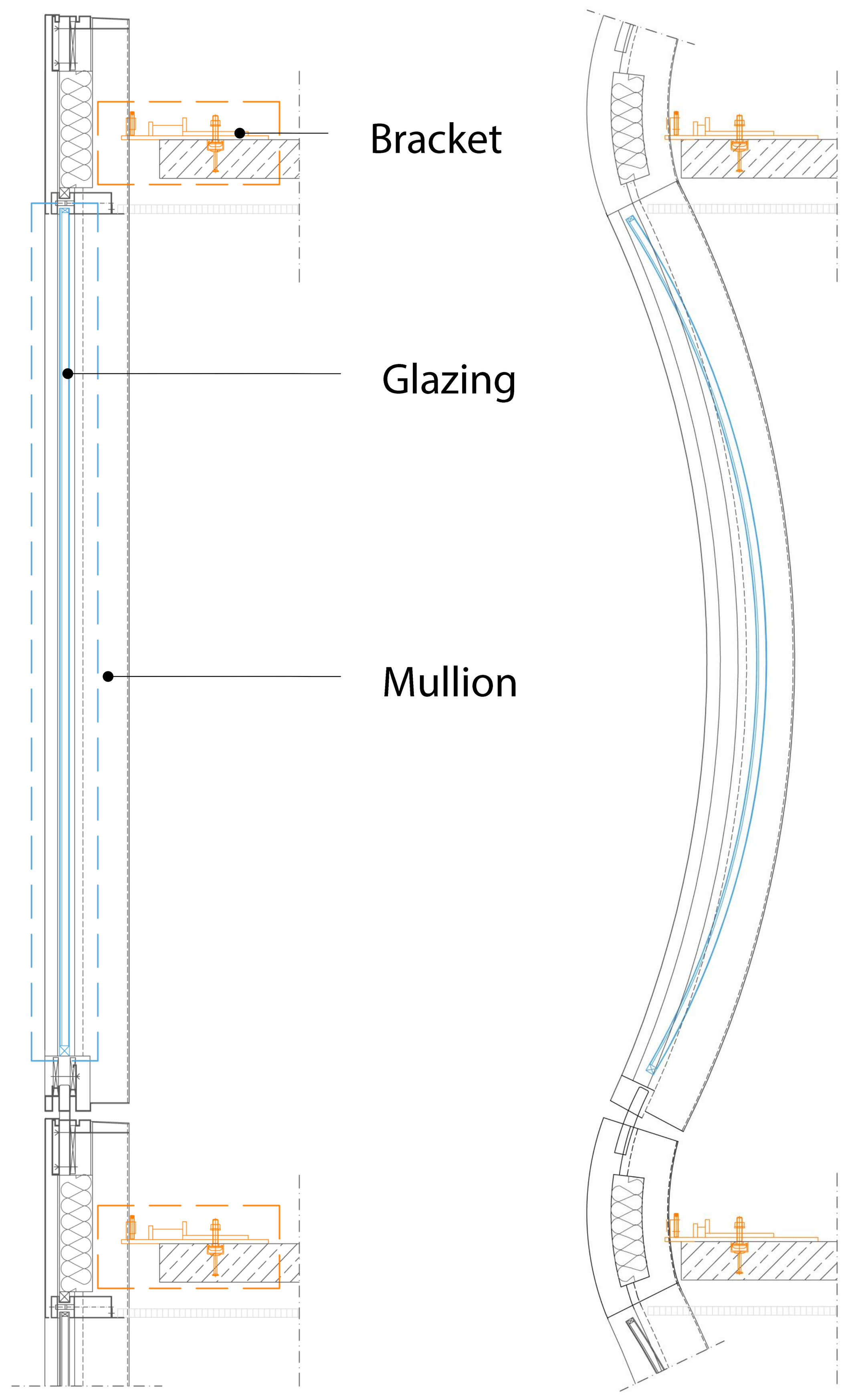
HCU HafenCity Universität Hamburg

BLAST PROTECTIVE FACADE BRACKETS



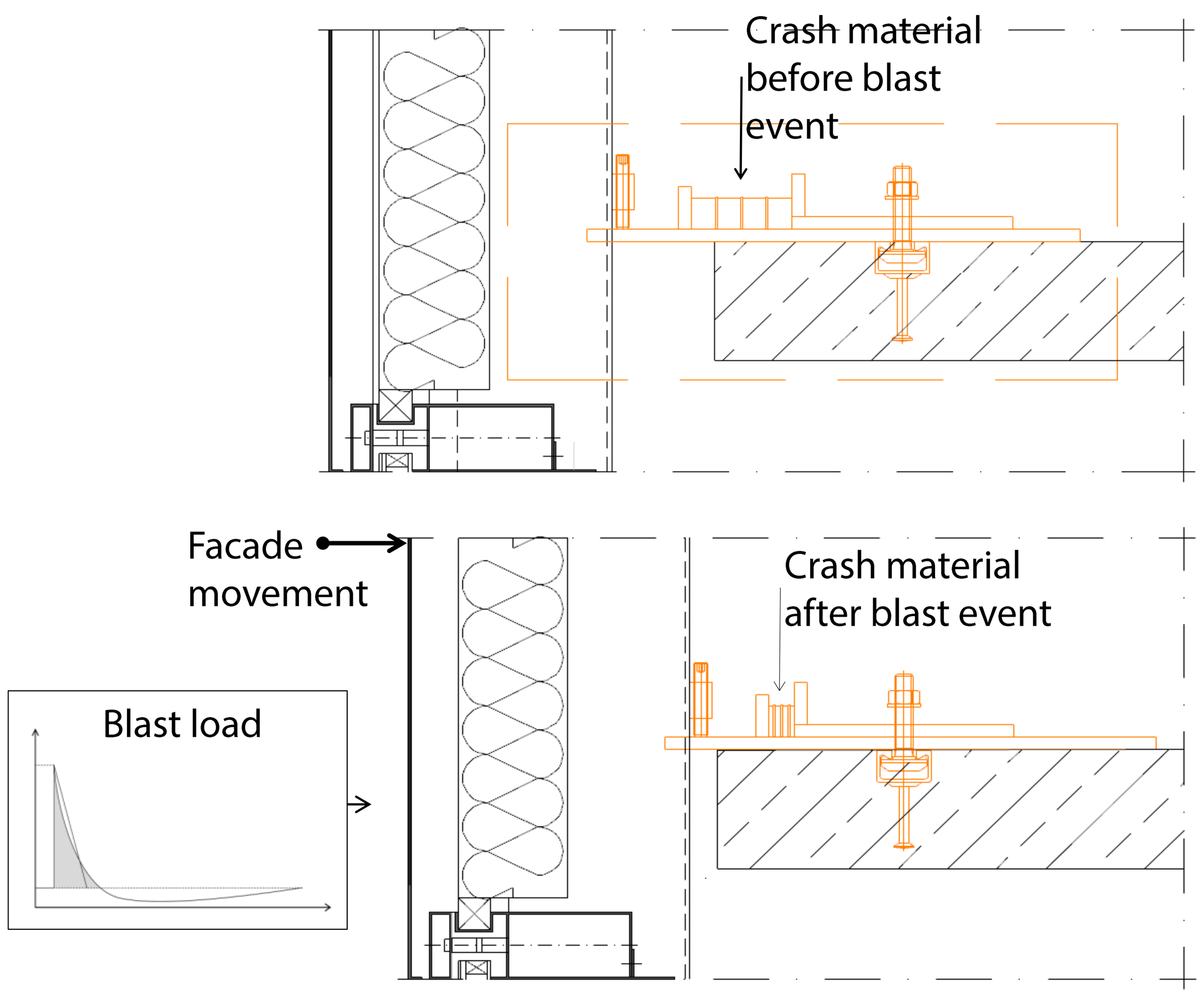
Typical facade section. Left: Unloaded. Right: Deformed under bomb blast load.

MOTIVATION

The main target in blast enhanced building and facade design is to protect people inside the building and to reduce damages in the facade and main structure to minimize the risk of building collapse. Focusing on the load path, the glazing has to be designed in a way, that it remains in the frame and defined hazard criteria are fulfilled. The mullions, transoms and brackets can be designed in a way, that blast energy is dissipated.
Mullion/transoms are able to dissipate energy by generating a plastic hinge, facade brackets can be designed as crash zone with dissipative materials.

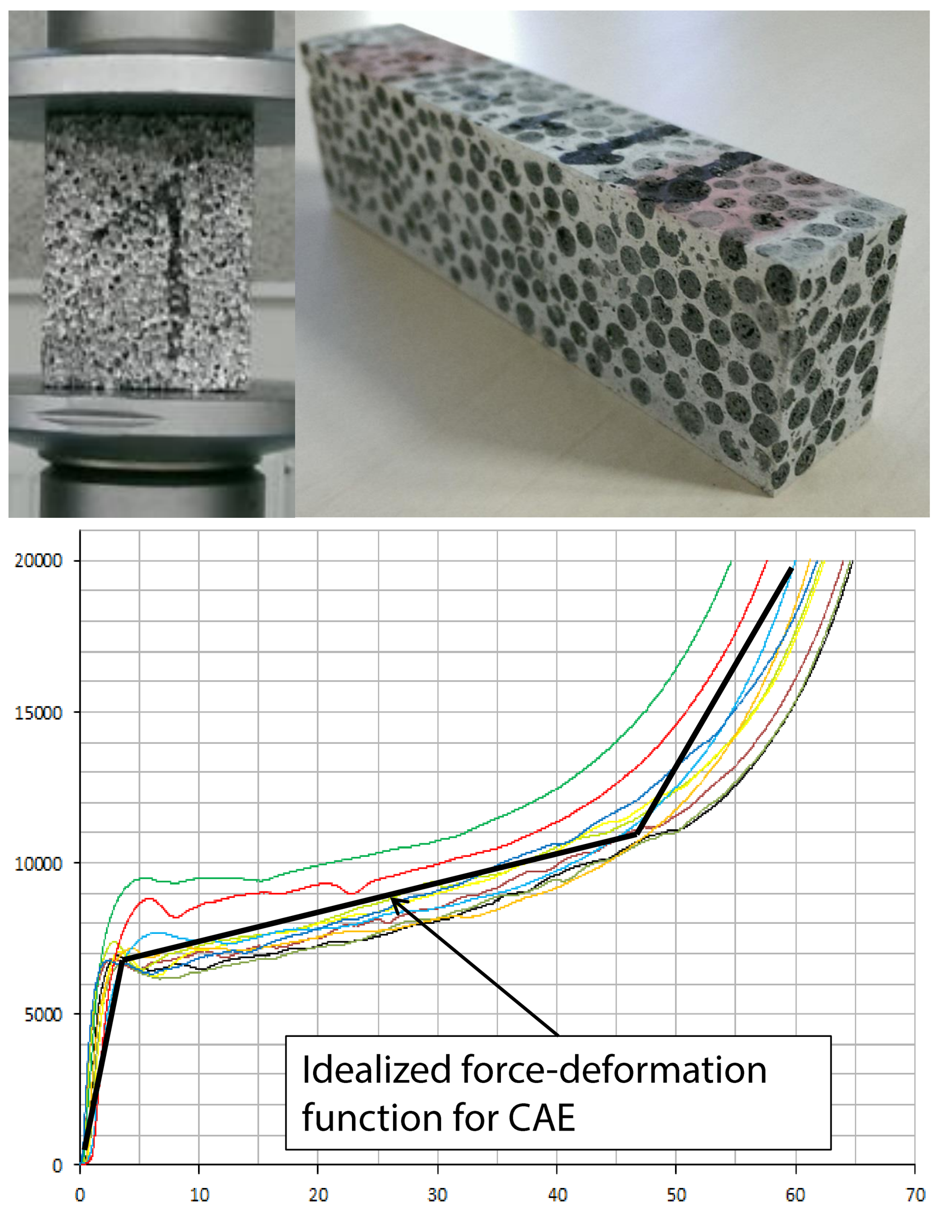
DISSIPATIVE FACADE BRACKETS

Aluminum facade elements in high rise buildings are usually fixed to the concrete slabs by anchor channels. The connection bracket between the facade element and the anchor channel must be able to compensate on site tolerances. This facade bracket can be designed as crash zone for blast loads. Therefore the bracket design requires standard load transfer in case of ordinary loads (dead load, wind) changing into a flexible and energy dissipative crash zone if the facade is subjected to an extraordinary blast load.



Principle of dissipative facade brackets for blast enhancement. Top: Bracket in initial position. Bottom: Bracket after blast event.

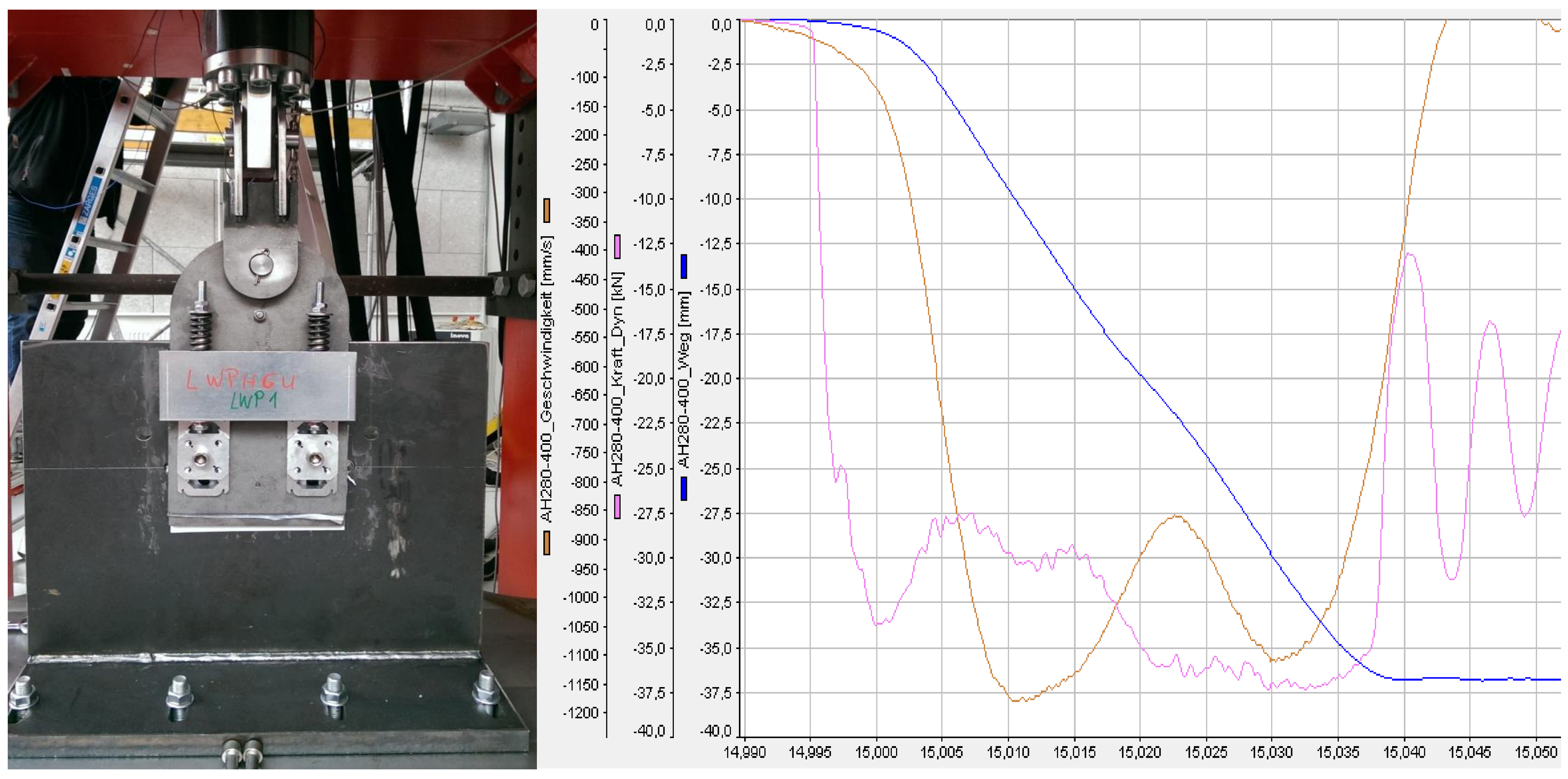
CRASH MATERIALS



Top left: Aluminium foam. Top right: Light concrete. Bottom: Force-deformation curves for typical crash materials.

Crash materials are able to dissipate a specific amount of energy by permanent deformation. It is appreciated that the crash material has a linear elastic behavior until a certain load level, in order to bear ordinary loads like wind loading. Beyond this certain load level, the plastic plateau is capable of dissipating energy for extraordinary loads like bomb blasts. Metal foam can be used for dissipative elements, but also light concrete is an economic alternative. Different recipes of light concrete have been developed for specific applications at HCU. Knowing the force-deformation function of dissipative elements enables engineers to implement this information into structural analysis programs by defining idealized force-deformation function.

METHODS



Left: Blast protective facade bracket in high speed test set up
Right: Force, deformation and velocity of piston rod during high speed testing.

Concrete slab specimen for testing.

After investigation of material properties, the different components are tested in separation. Therefore the blast protective bracket is tested in a rigid steel structure to eliminate any elasticity of anchor channel and concrete slab specimen. In a second step, the blast protective brackets are tested in concrete slab specimen with anchor channels to simulate a realistic behavior of the overall system. All tests are performed as quasi-static and high-speed tests to identify high-strain rate effects.

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