

WASTE CONTAINER DROP TESTS ONTO A CONCRETE TARGET

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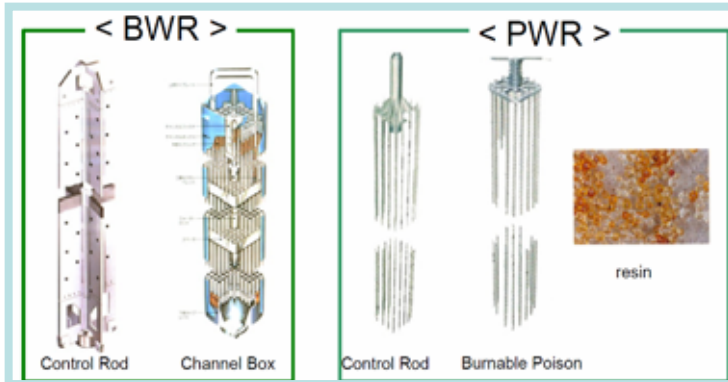
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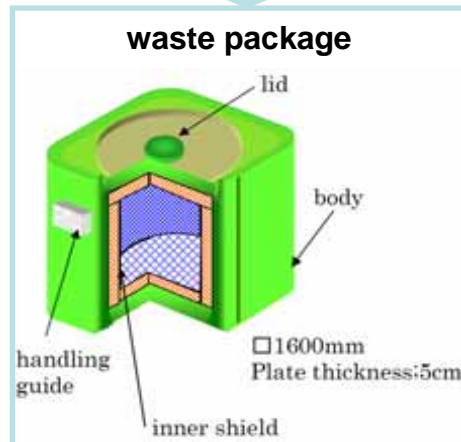
Packaging and Transportation of Radioactive Materials



Yoyushindo disposal (= intermediate disposal)



cutting and storage



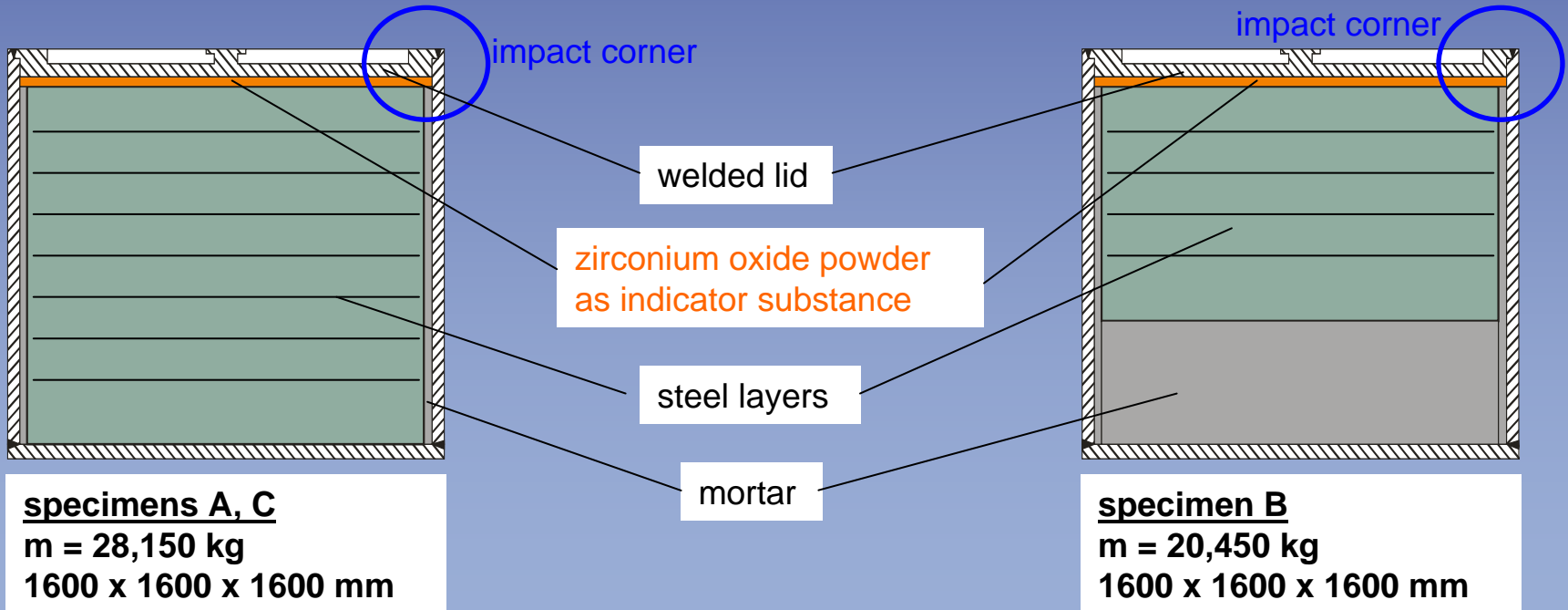
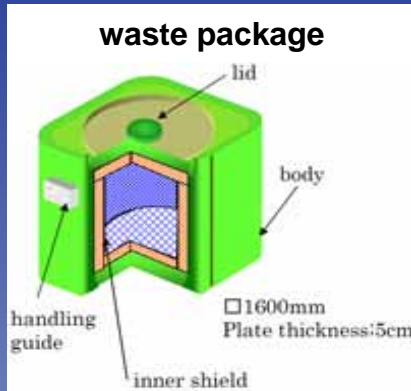
Development of a disposal container for the storage of high activity low level waste

Disposal container safety assessment:

- instrumented drop tests
- finite-element calculations
- fracture mechanics assessment

Specimens

Specimens of the waste package



Drop test program

Specimen A

28 150 kg
8-m corner drop



Specimen B

20 450 kg
8-m corner drop



Specimen C

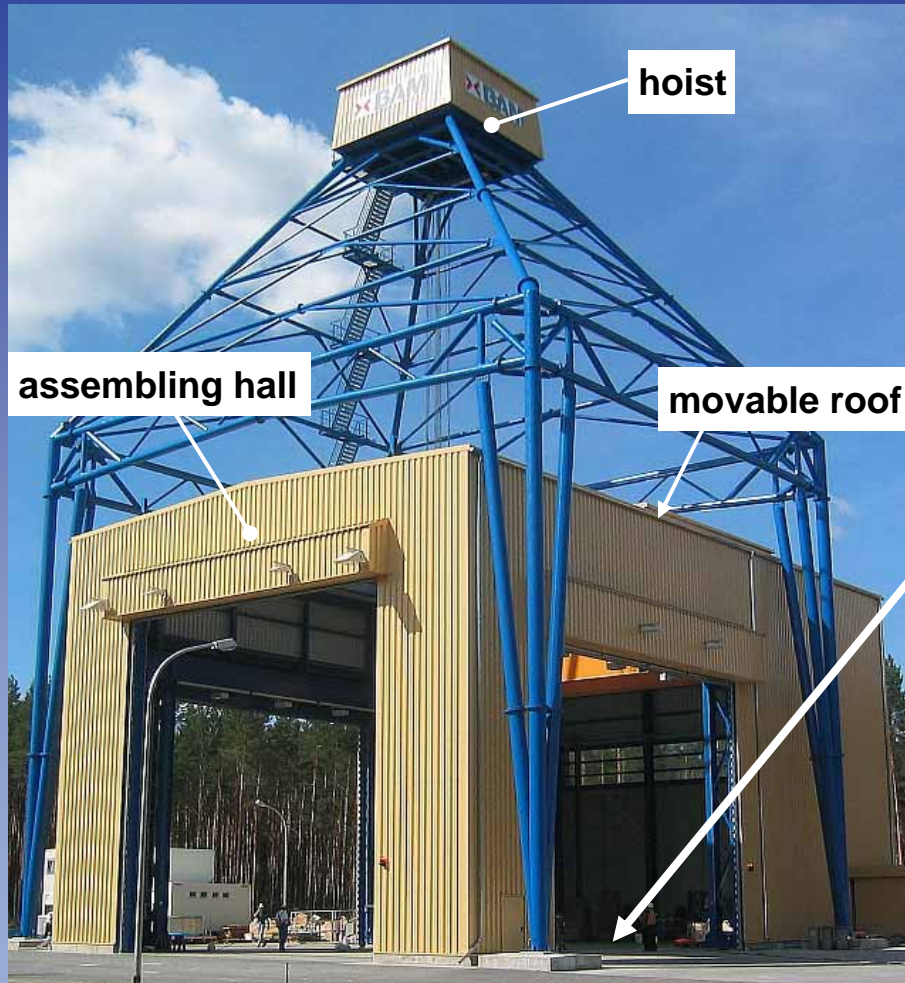
28 150 kg
8-m corner drop



Attending tests and measurements within the drop test performance:

- **strain and deceleration measurements → structural, cinematic and kinetic impact responses as validation data for finite element calculations**
- **high-speed video → motion analysis of the impact scenario**
- **3d-measurement → deformation data of the impacted corner edge**
- **leakage testing → leakage rate of the lid system**
- **particle release measurement**
- **temperature measurement**

Drop test facility at BAM Test Site Technical Safety at Horstwalde



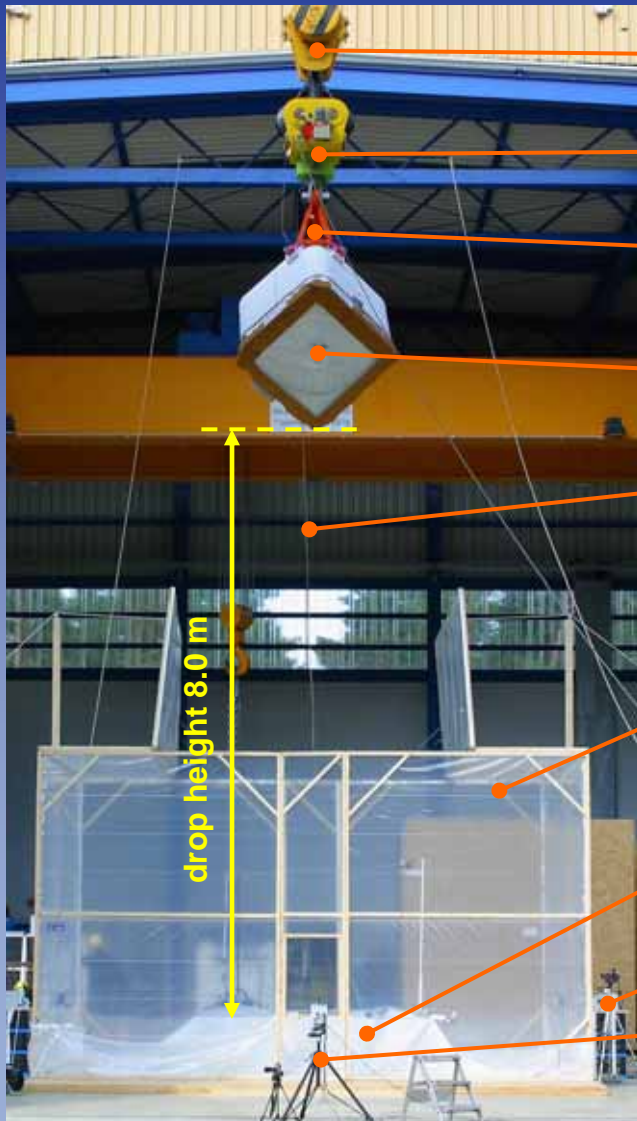
36-m high drop tower

IAEA-target (bird's eye view)

- steel impact pad
10 m x 4.5 m x 0.22 m; mass 77,000 kg
- reinforced concrete target
14 m x 14 m x 5 m; mass 2,450,000 kg



Drop test arrangement



hoist's crane hook

release system

nylon slings for attachment

specimen

measuring cables for strain and deceleration metrology

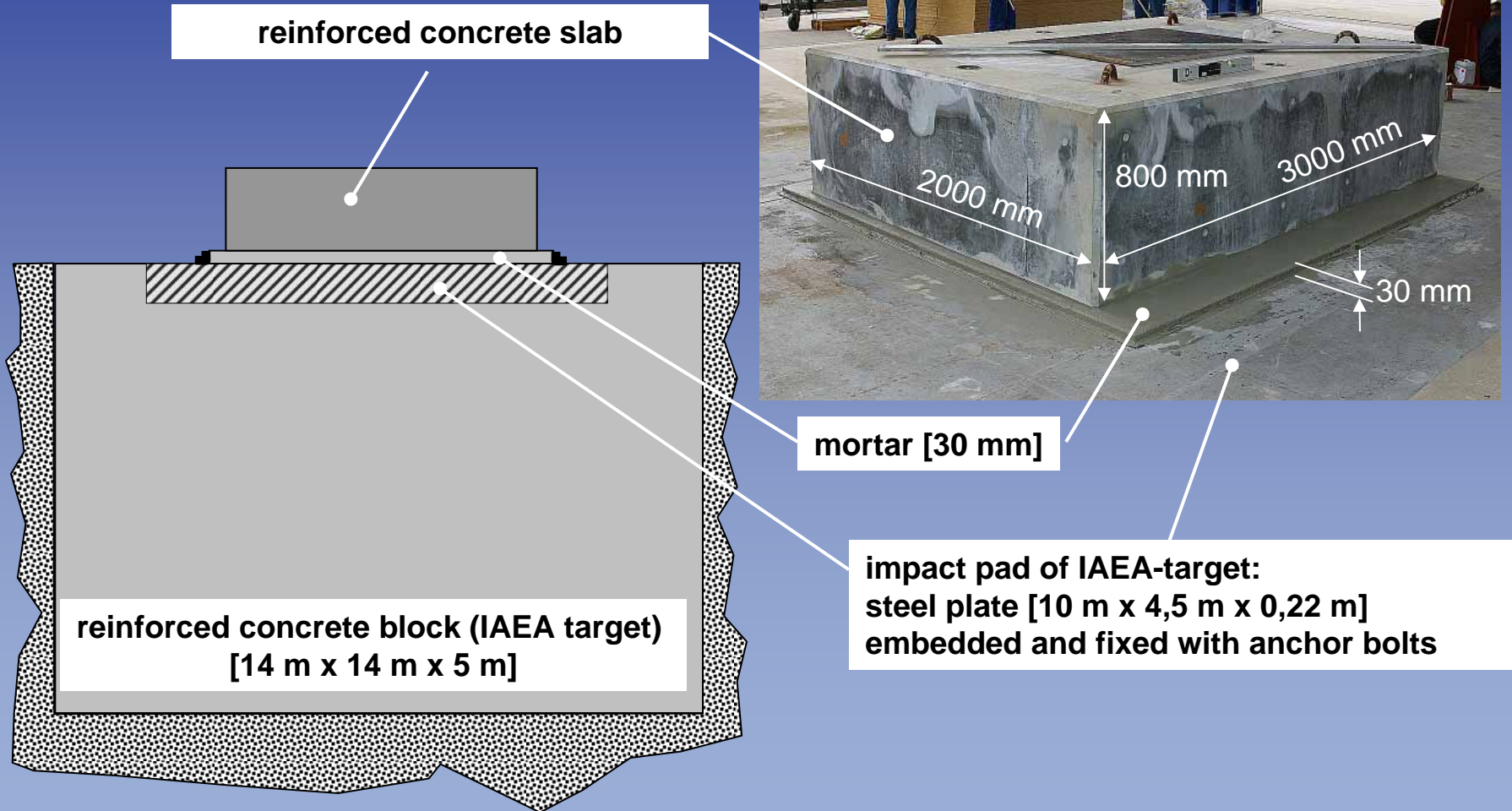
closed volume construction for particle release measurement

concrete slab covered with vinyl sheet

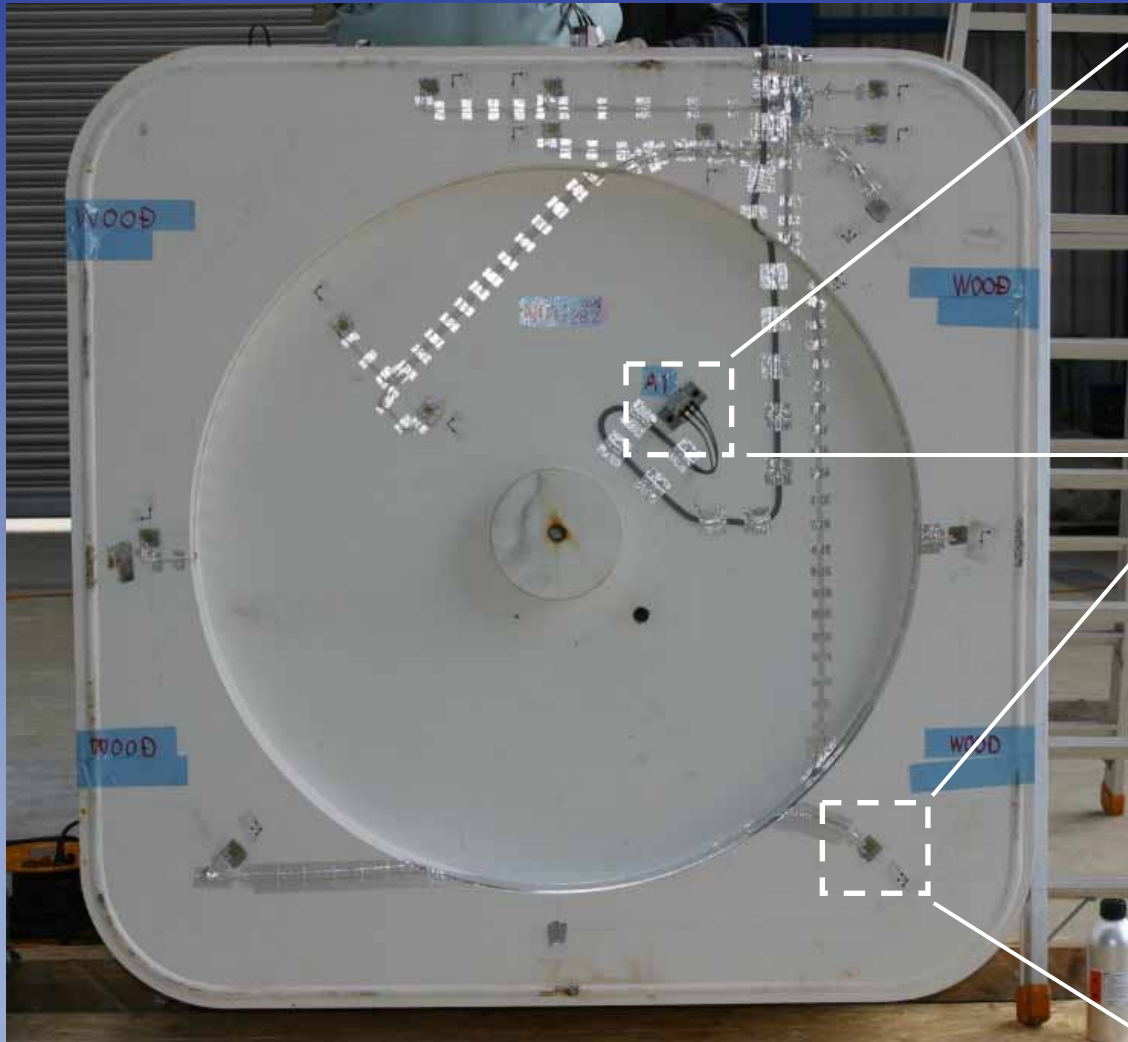
dust sampler

high speed camera

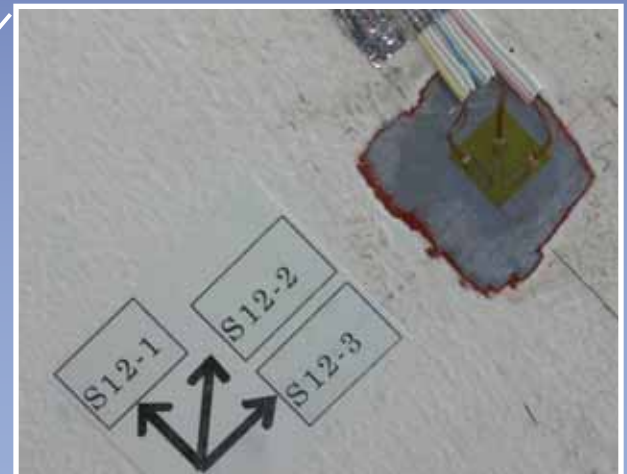
Impact target



Strain- and deceleration measurement

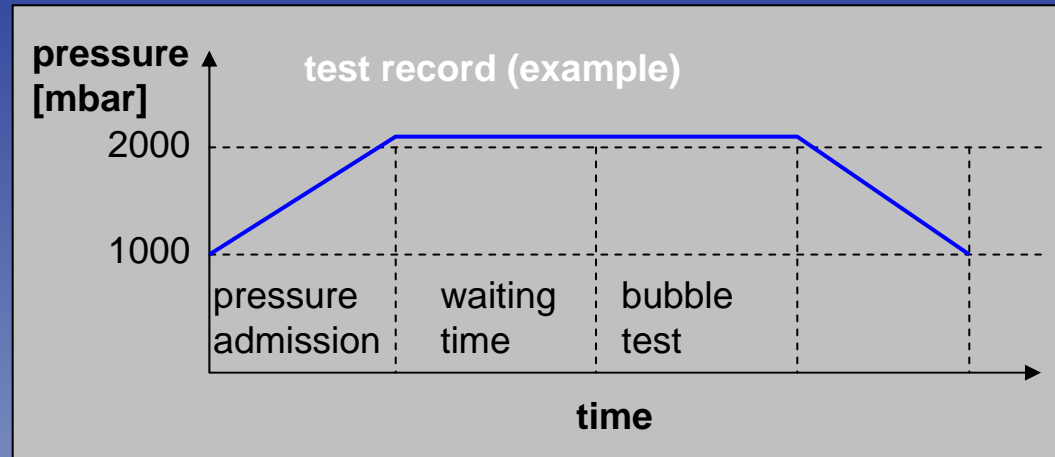


Tri-axial piezoresistive accelerometer



Three axis strain gauge

Leakage testing: bubble emission technique



➤ according European Standard DIN EN 1593

➤ pressure admission > 2000 mbar

➤ waiting time for stable conditions > 30 minutes

➤ apply of a liquid surfactant by spray to the whole welding seam and deformed corner edge for tracing possible leaks

➤ after application of the leakfinder spray an observation of any bubbles started

➤ significance: no bubbles → leakage rate at least 10^{-4} Pa m³/s

Drop test



Normal Video of the 8-m drop test

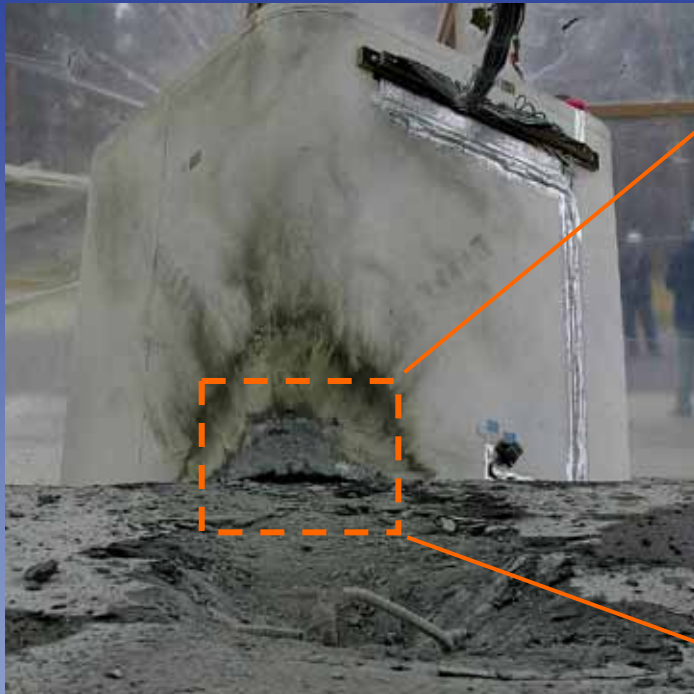


Drop test

High speed video of the 8-m drop test

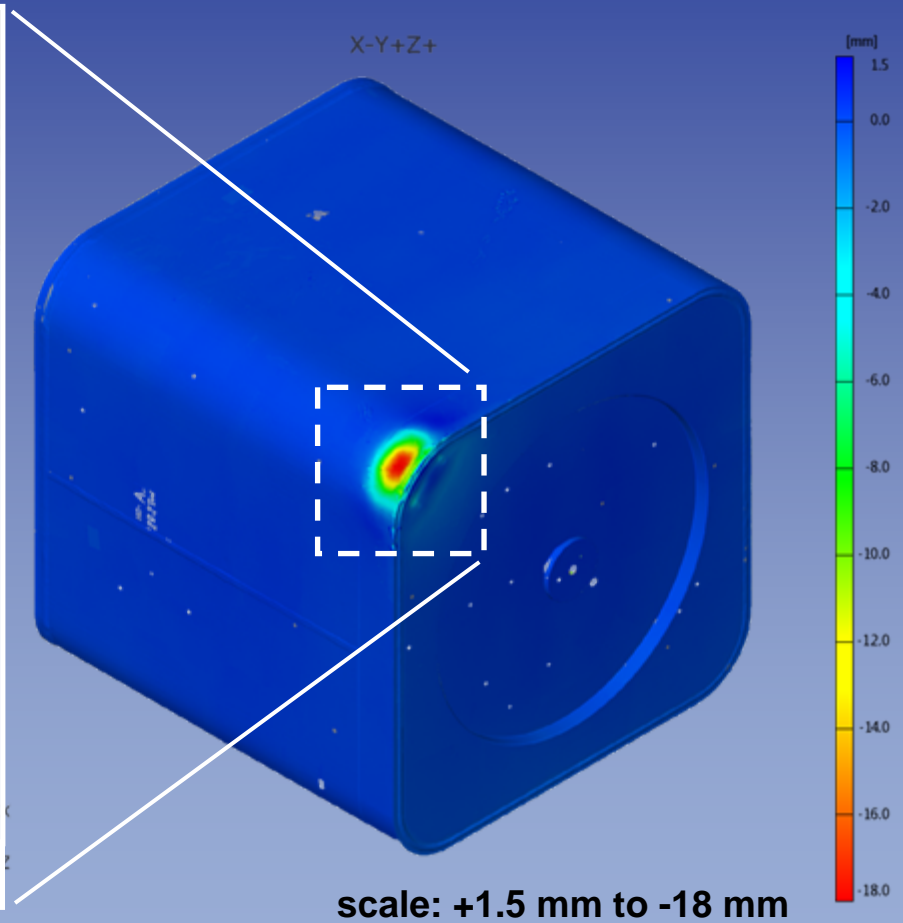
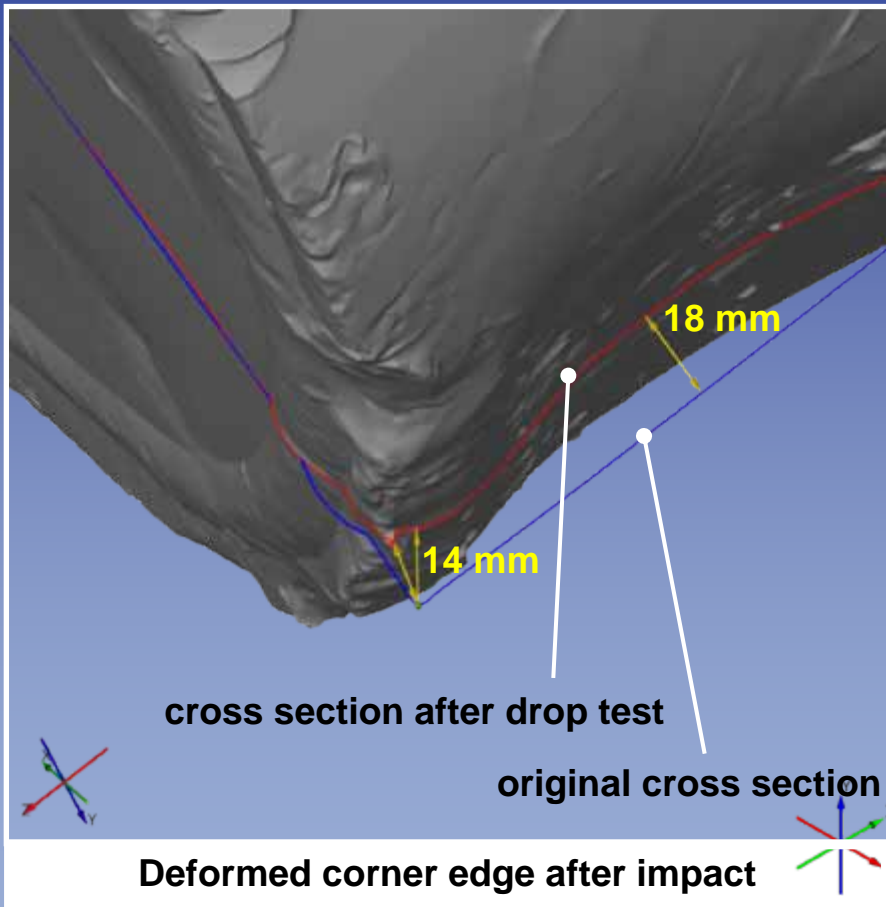


Visual inspection results of the impacted corner edge



- plastic deformation of the impacted corner edge
- lid welding seam visually undamaged except some groovings on its surface
- other parts than the impacted corner edge of the container are visually unaffected by the impact without any visible damages

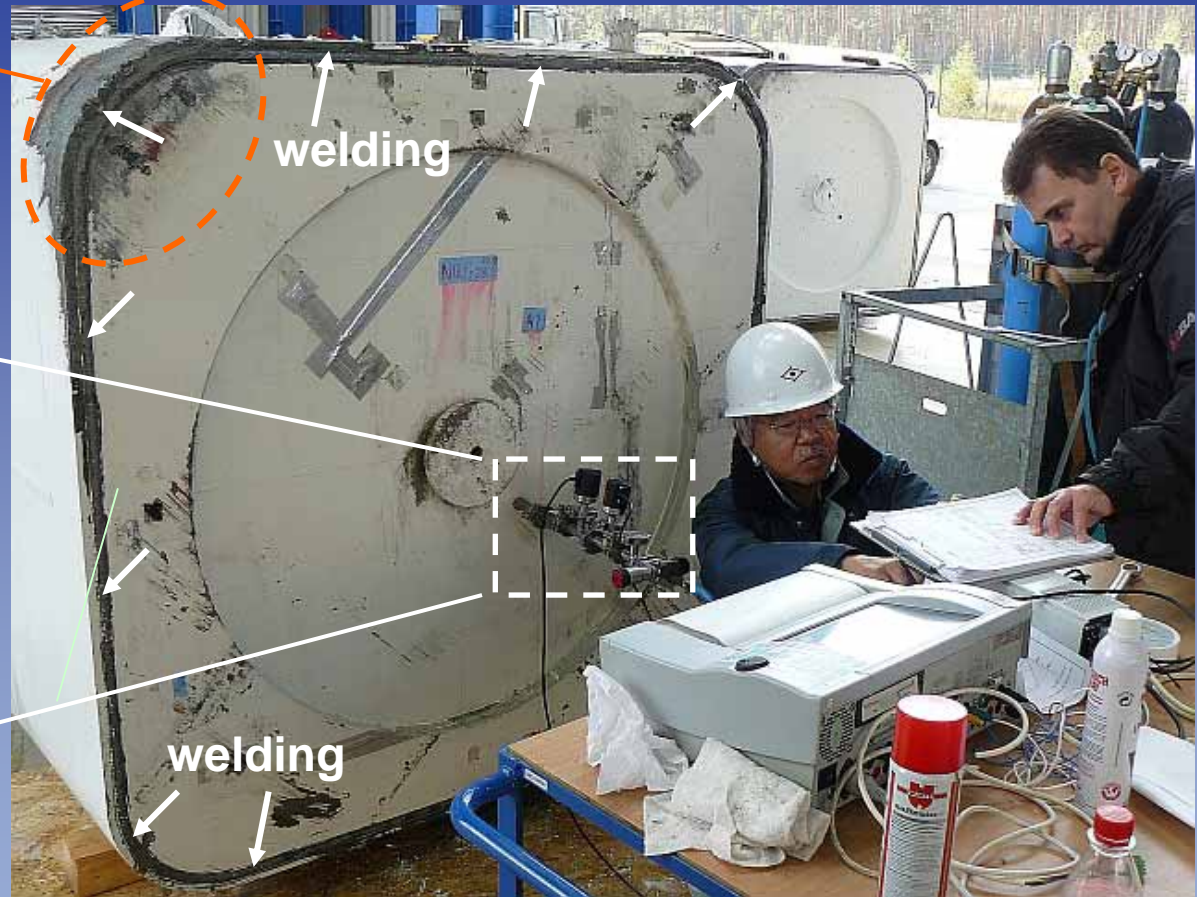
3D-measurement fringe projection method



Drop test results

Leakage testing using the bubble emission technique

impacted corner edge



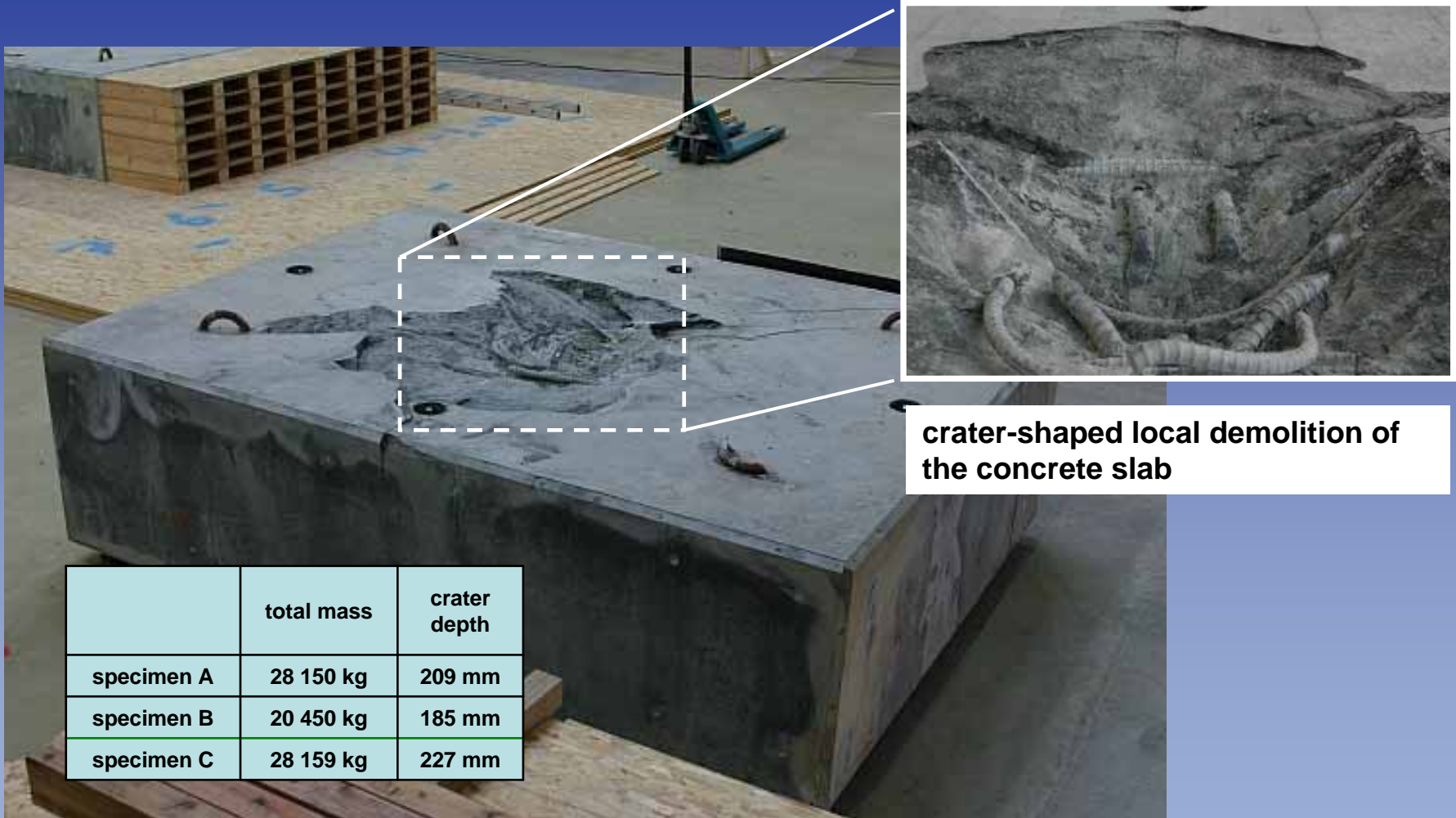
pressure sensor

valve

nitrogen

The leakage test results showed no bubbling at all neither on the welding seam nor on the deformed corner edge for all three drop tests.

Visual inspection results of the concrete slab

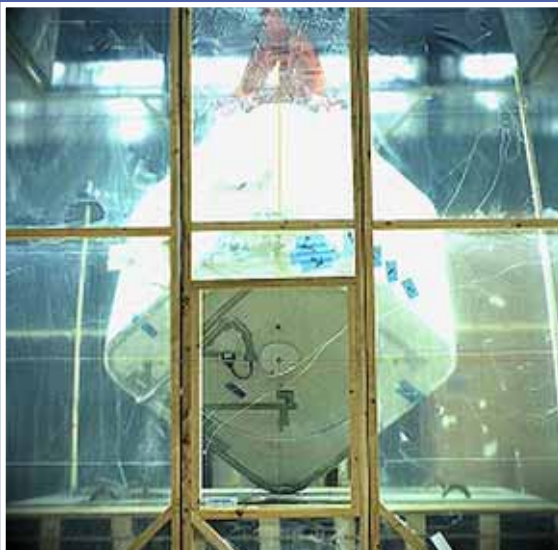


crater-shaped local demolition of the concrete slab

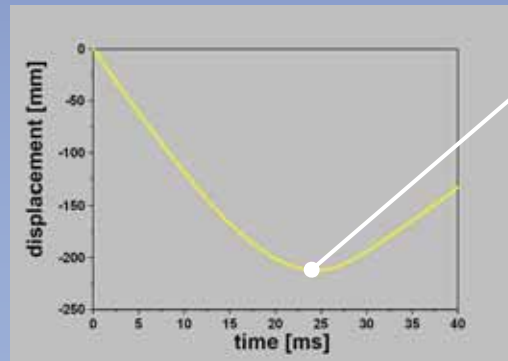
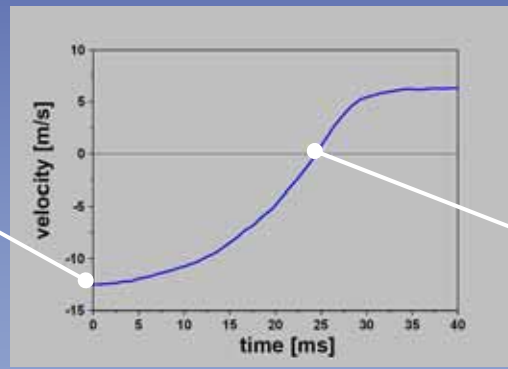
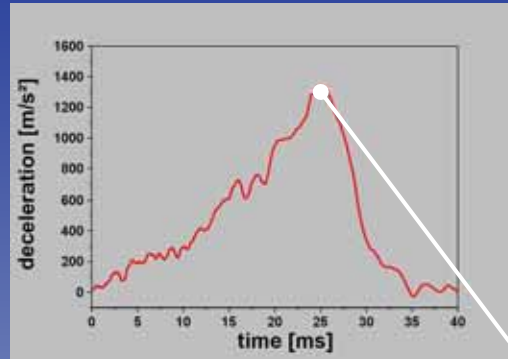
	total mass	crater depth
specimen A	28 150 kg	209 mm
specimen B	20 450 kg	185 mm
specimen C	28 159 kg	227 mm

Drop test results

Deceleration measurement: rigid body movement



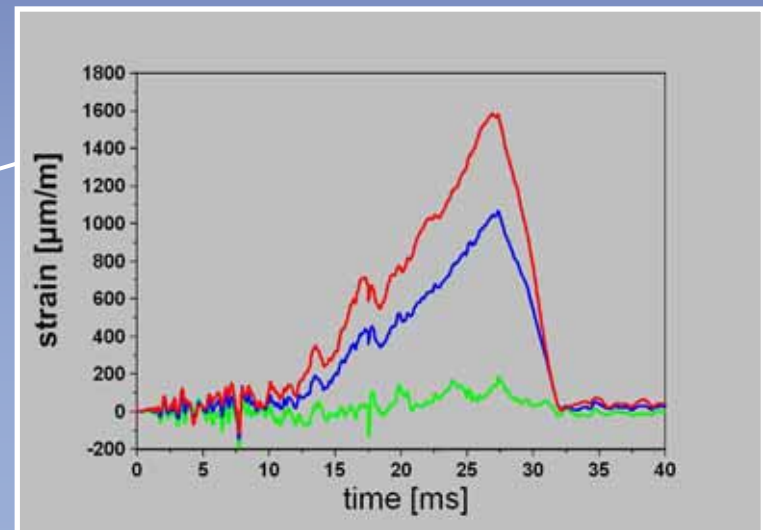
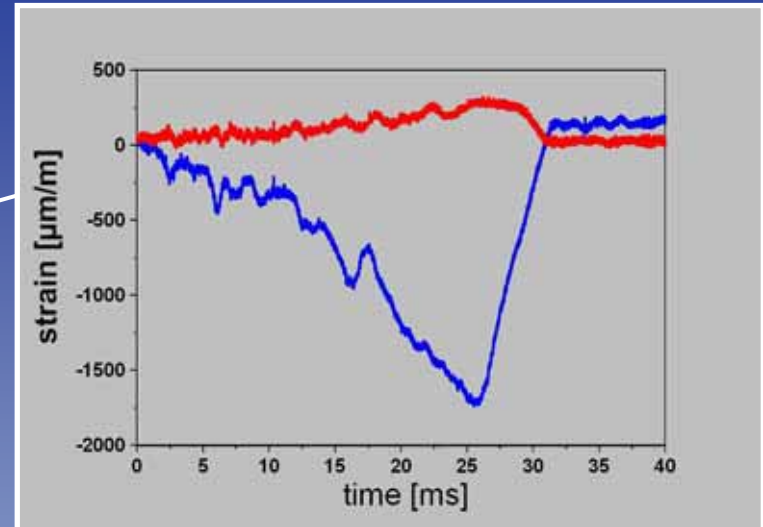
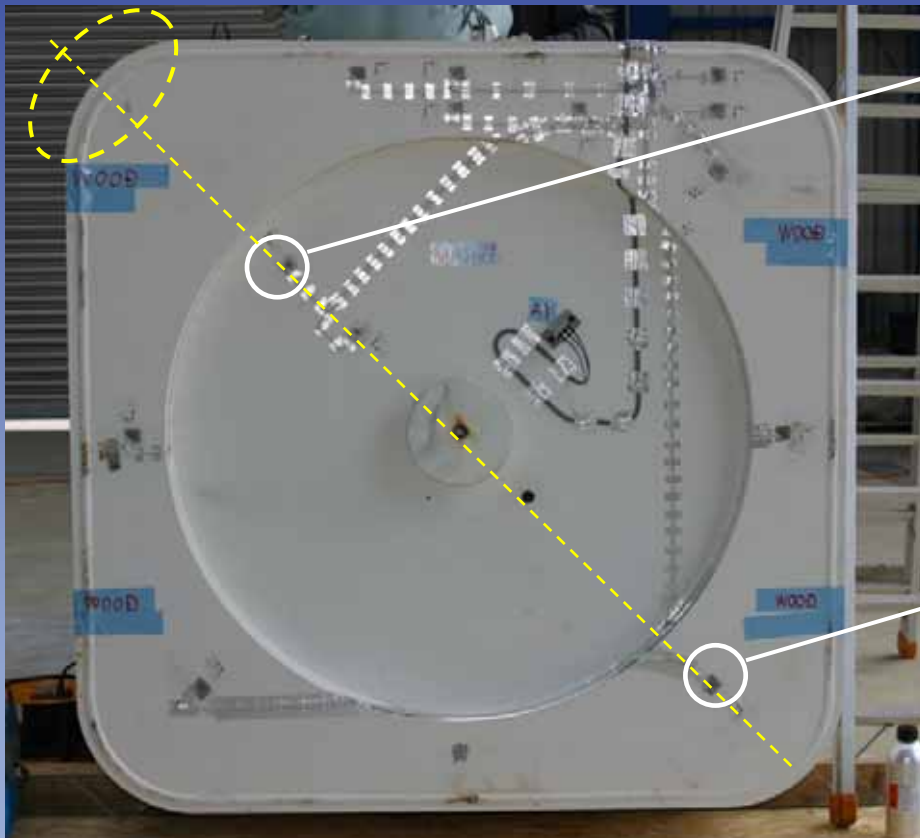
**First contact;
start of impact
velocity = 12.5 m/s**



**maximum deceleration
and displacement
velocity = 0 m/s**

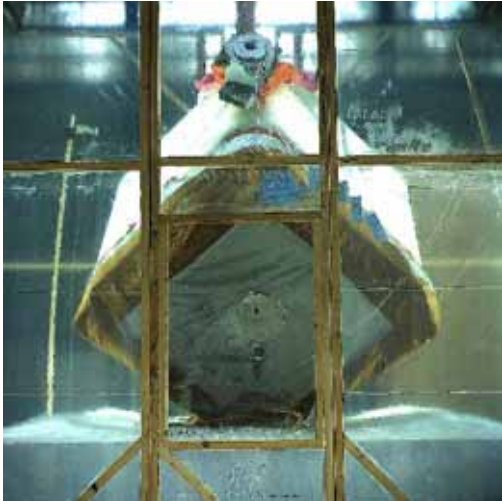
Strain measurement (examples)

Measured Strain signals



Conclusion

Specimen A



Specimen B



Specimen C



The visual inspection of the specimens after drop test showed for all three specimens similar results:

- plastic deformation of the impacted corner edge and a visually undamaged welding seam except some groovings on its surface
- other parts of the specimens than the impacted corner edges are visually unaffected by the impact without any visible damages.
- the concrete slabs showed crater-shaped local demolition by the impact of the specimens.

The results of the leakage test 'bubble emission technique' according to DIN EN 1593 and DIN EN 1779 show:

- no bubbling on the welding seam for all three specimens
- no bubbling on the deformed corner edge for all three specimens

Maximum rigid body **deceleration** approximately 130 – 140 G;
impact duration 30 – 35 Milliseconds

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Thank you for your attention
