TUHH
Technische Universität Hamburg

WASSERBAU
River and Coastal Engineering

Mobile Flood Protection Systems - research and practical applications

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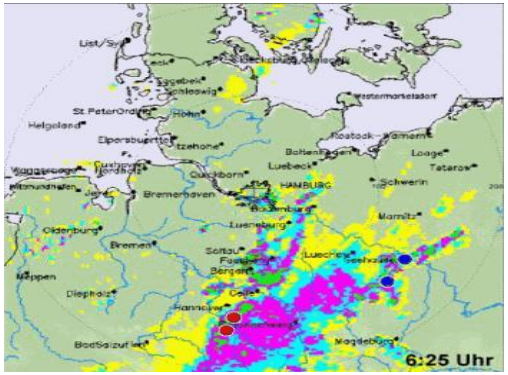
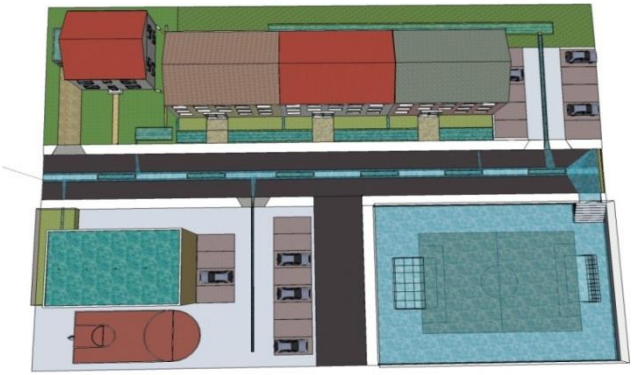
SMARTeST

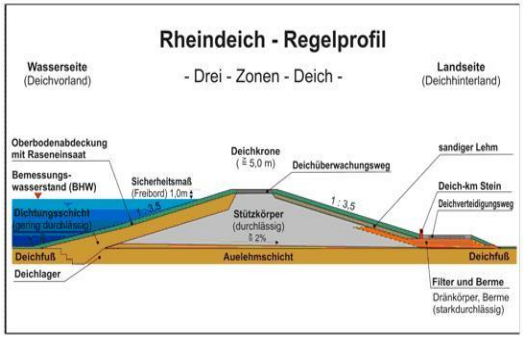
Wasserbau: Hydrologie und Hochwasserschutz

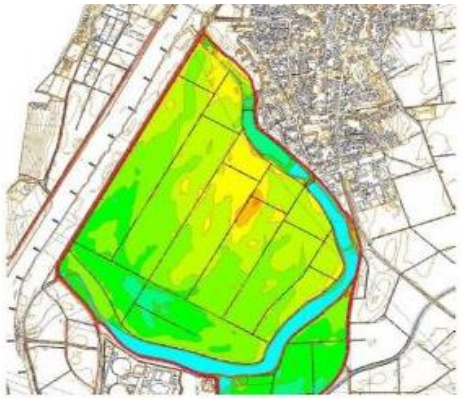
Hochwasserschutz / Flash Floods





Hochwasserschutz / Deiche, Polder und Rückhaltebecken

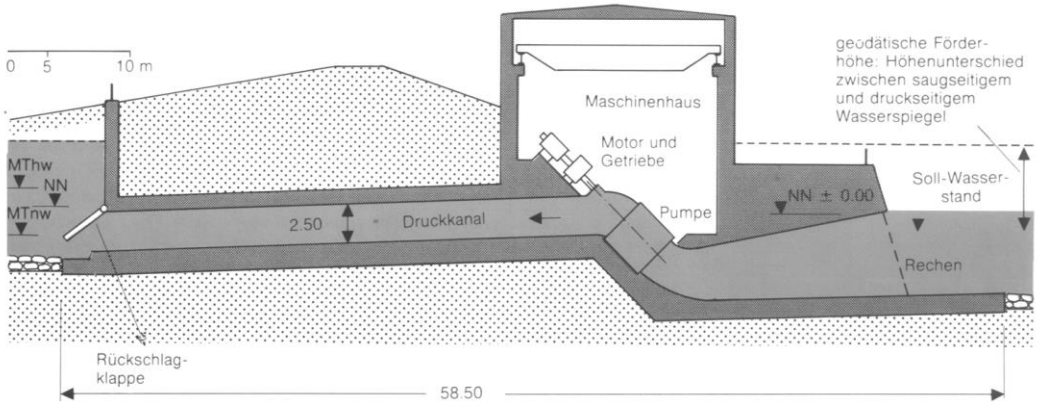




Entwässerung des Hinterlands

Urbane Gebiete

Ländliche Gebiete



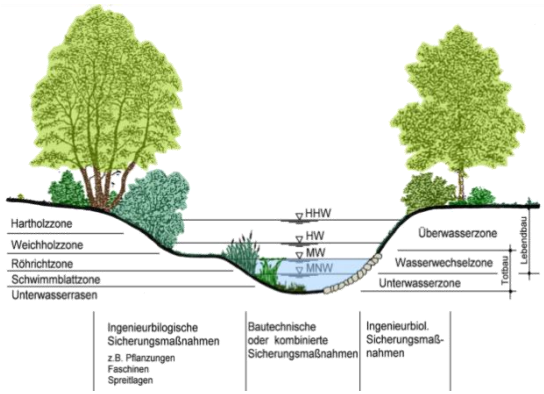
Küstenschutz

Hochwasserschutz

Schutz sandiger Küsten

Flussbau und Unterhaltung

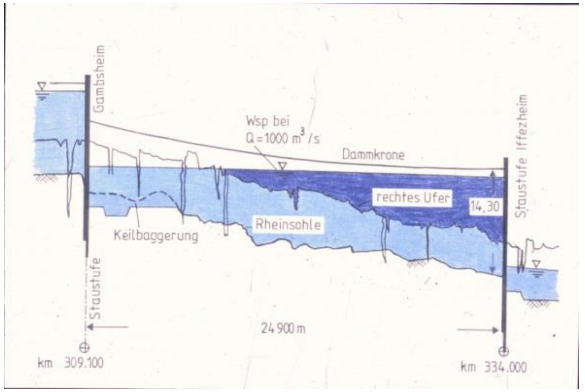
Flussbau und -regelung: Uferschutz, Leitdämme, Renaturierung, NW-, MW- und HW-Regulierung



Unterhaltung: Inspektion, Mahd, Säuberung, etc.

Verkehrswasserbau

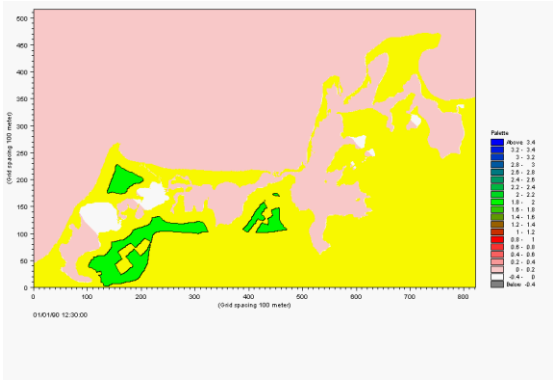
Binnenverkehrswasserbau: Binnenwasserstraßen, Schleusen und Schiffshebewerke, Binnenhäfen



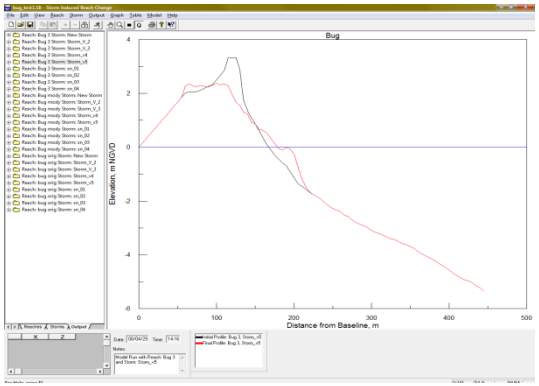
Seeverkehrswasserbau: Seeverkehrsstraßen, Seehäfen, Umschlagseinrichtungen und andere Häfen

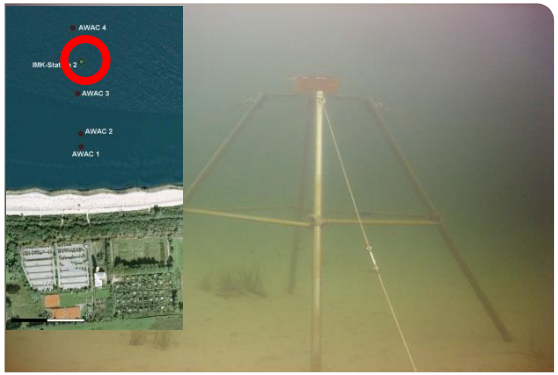
Messungen in der Natur, numerische Modelle und hydraulische Modell

Hydrodynamik



Sediment Transport und Morphodynamik





Laborarbeiten und Messungen in der Natur

Versuchsbecken

Flutanimationsstudio

Forschungsboot

Testbecken Wilhelmsburg

Mobile Flodd Protection

Why mobile flood protection?

- Technical aspects
- administrative aspects
- Aestetic aspects
- Aspects of cultural heritage and munument conservation
- Necessary funds for investment and maintenance and repairs
- Possibly the „smart solution“

EU-Projekt SMARTest

Project lifetime : 2010-2013

10 EU-Projekt Partner

Goal: Development of technologies, systems and tools for the improvement of the flood resilience of urban areas

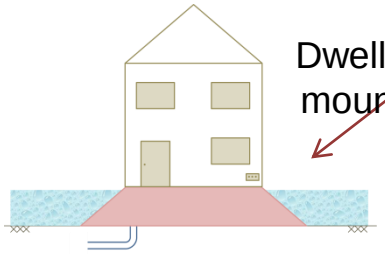
Technologies	Systems	Tools

Mobile Flood Protection

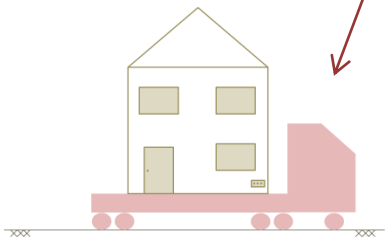
1. Measures and technologies
2. Investigations in the hydraulic lab
3. Standardization of tests

Flood Protection Measures

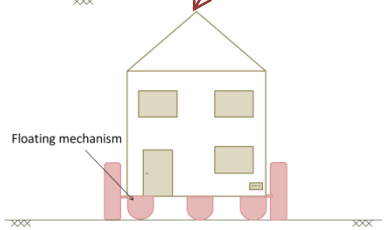
Dwellng mounds



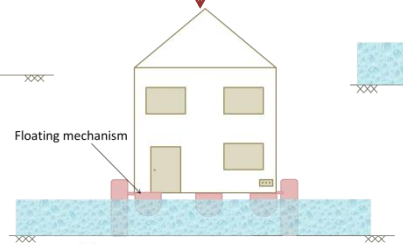
Moving



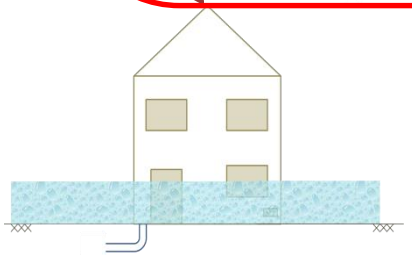
Amphibic constructions



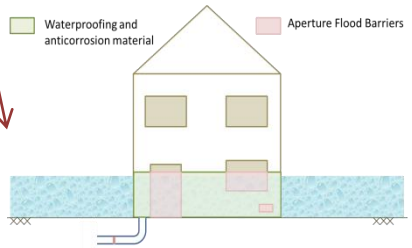
Floating constructions



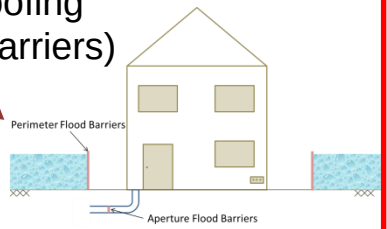
Wet-floodproofing



Dry-floodproofing (sealing)



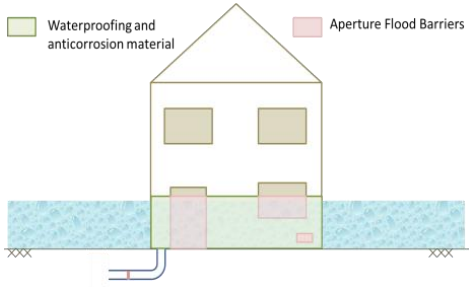
Dry-floodproofing (shields and barriers)



Flood protection technologies

- Protection of building openings
- Shielding technologies and barriers (mobile flood protection walls)
- Sealing technologies

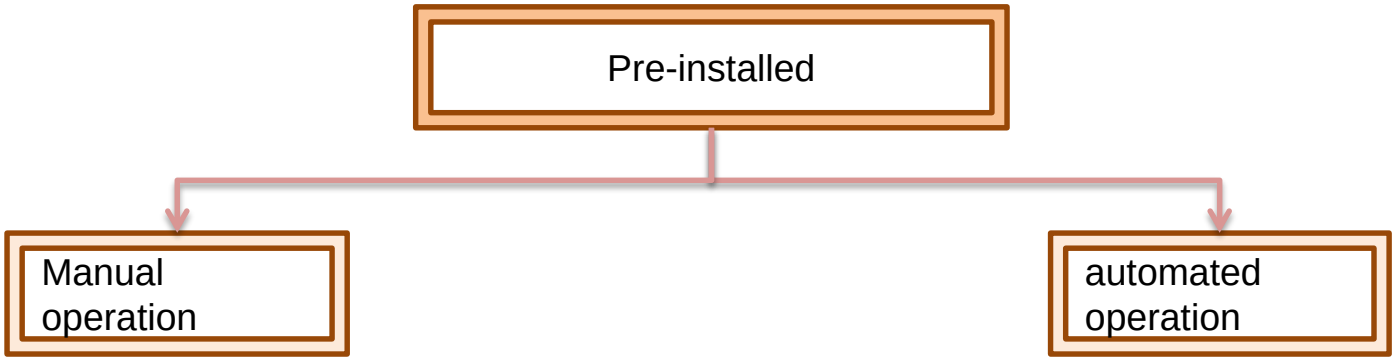
Mobile Flood Protection: Protection of construction openings

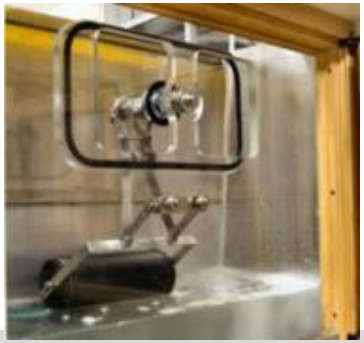


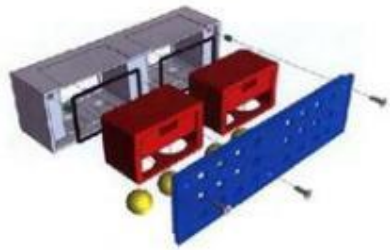
Protection of building openings

- Pre-installed
- demountable
- temporary

Mobile Flood Protection: Protection of building openings







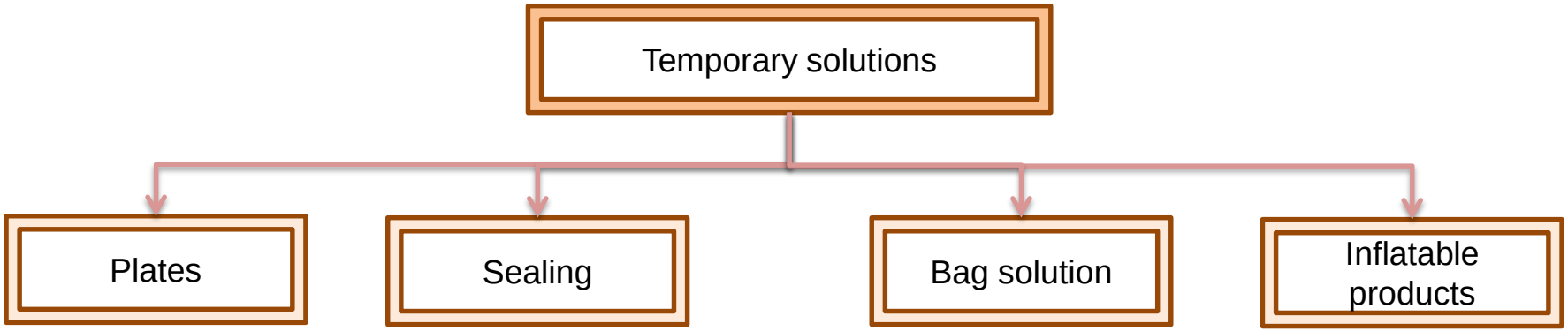
Quellen: Buchele, Aquastop, Watersave, Smart Aibricks (Floodguards)

Mobile Flood Protection: Protection of building openings

De-mountable

Quellen: FloodArk, Floodtite, Floodshield, IBS

Mobile Flood Protection: Protection of building openings

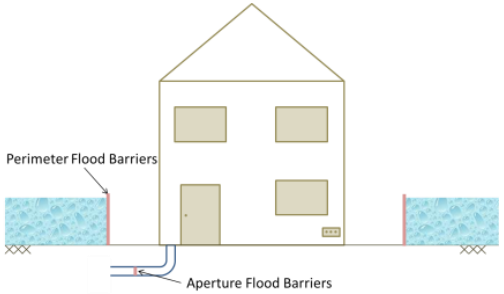


Quellen: FloodGate, Floodsentry, Aqua-sac, Howasu

Flood protection technologies

- Protection of building openings
- Shielding technologies and barriers (mobile flood protection walls)
- Sealing technologies

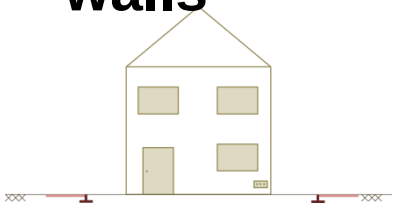
Shielding technologies and barriers: mobile flood protection walls



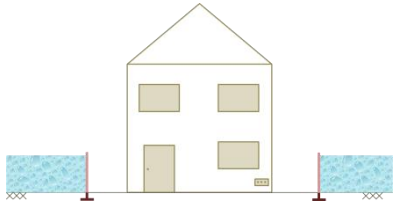
mobile flood protection walls

- Pre-installed
- demountable
- temporary

Shielding technologies and barriers: mobile flood protection walls

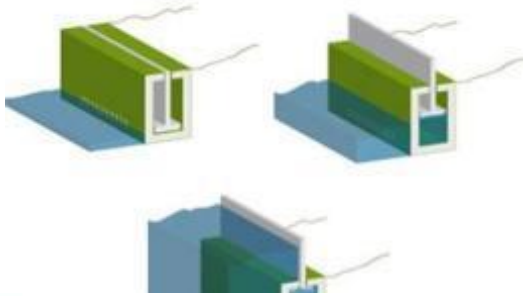


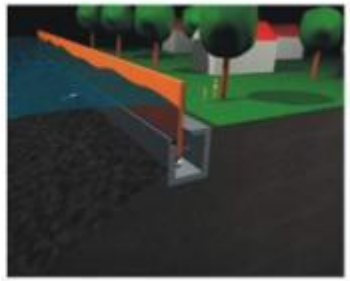
Pre-installed



Manual installation

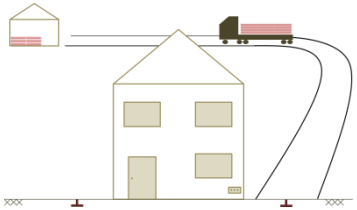
Automatic installation





Quelle: Dutchdam, HOP-Logistik, Aquaprotect
Barrières Anti-Inondation Autonome,Spring Dam, KV

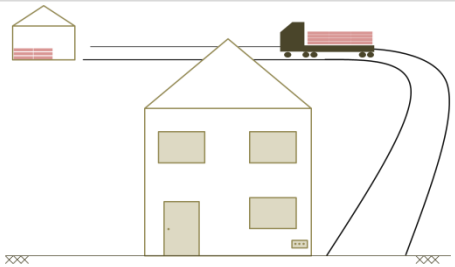
Shielding technologies and barriers: mobile flood protection walls



Demountable solutions

Quellen: NOAH, IBS, Aquabarrier-Systems

Shielding technologies and barriers: mobile flood protection walls



Temporary solutions

Stabilised through external forces

Stabilised through internal forces

Quelle: Geodesign, Aquafence, Megasecur, NOAH, Big Bag Harbeck, Deadler

Flood protection technologies

- Protection of building openings
- Shielding technologies and barriers (mobile flood protection walls)
- Sealing technologies

Sealing technologies

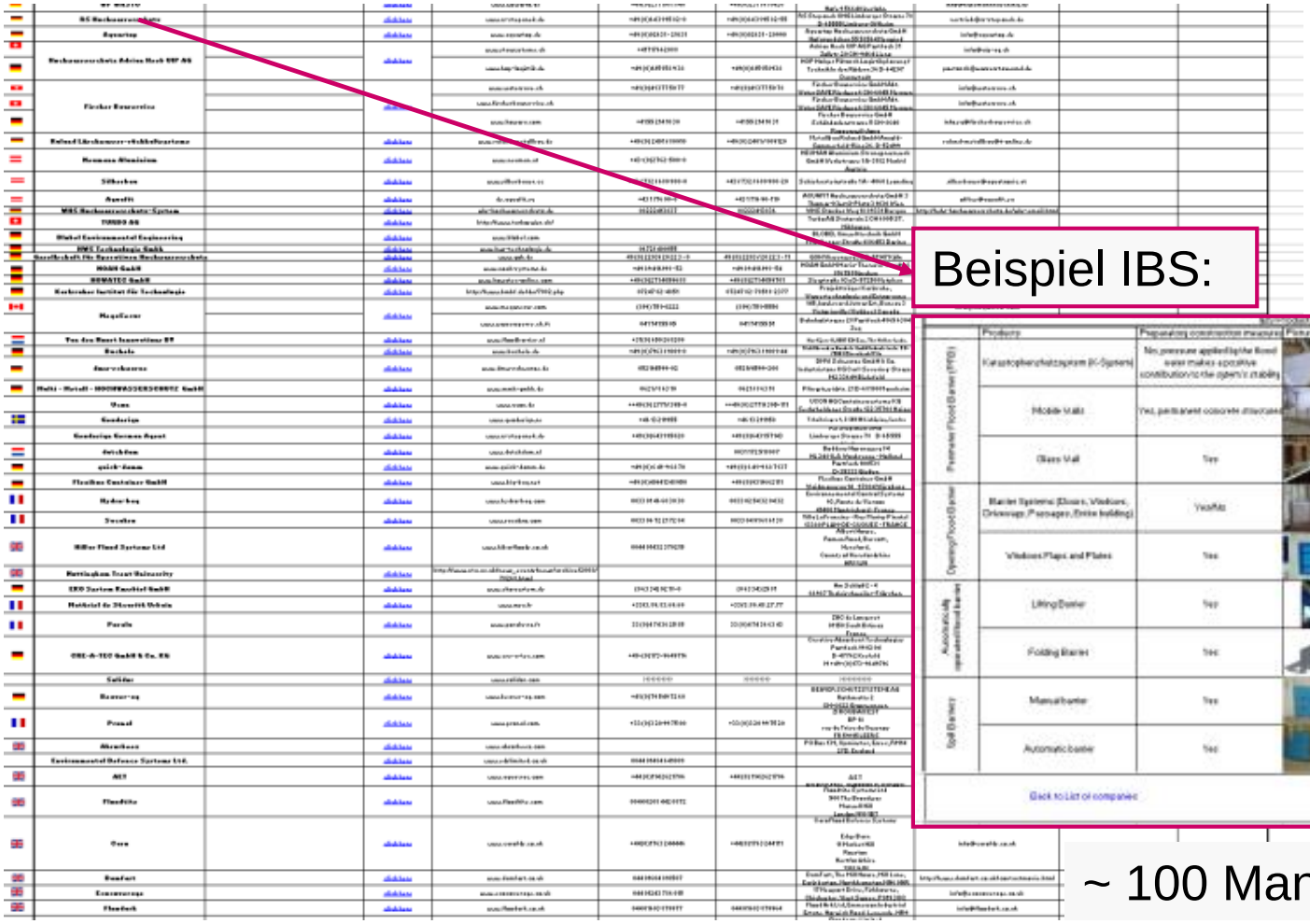
Permanently installed solutions

Nobody would ever guess that this FloodProof™ door is totally protected from flood. 24 hours a day, 7 days a week!

Water tight material

Non corroding material

TUHH Data Base:



Beispiel IBS:

SMARTeST

~ 100 Manufacturers

Model tests in the hydraulic lab

SMARTeST

Aims

- Co-operation with manufacturers for the improvement of the products
- Development of a test procedure and test protocol for the objective assessment of the functionality of the products
- Analyses for the development of a standardised test procedure and test protocol

Within the framework of the SMARTeST project 5 partners tested 25 products :

- TUHH (Germany): Perimeter Technologies & Aperture Technologies
- CSTB (France): Aperture Technologies
- IOER (Germany): Building Technologies
- BRE (UK) Building Technologies
- UPM (Spain) Building Technologies

Analyses in the hydraulic lab

Pre-installed mobile flood protection walls

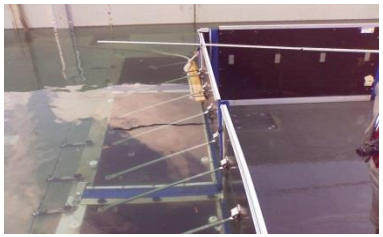
Spring Dam

AquaWand

Demountable mobile flood protection walls

AQUASTOP Damm

IBS
mobile wall



Aquafence

Temporary mobile flood protection walls (constructions)

Sandsack

Mobildeich

DAEDLER

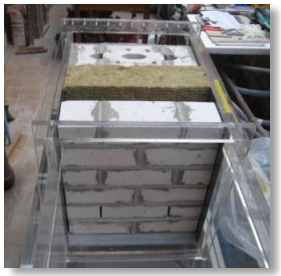
Analyses in the hydraulic lab

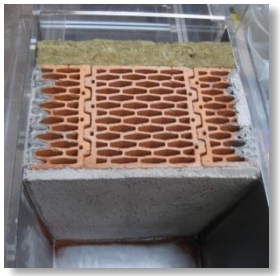
Protection of building openings

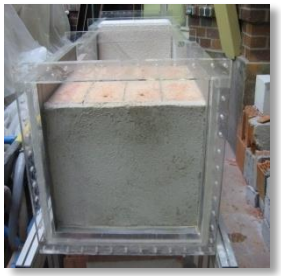
Aquastop system – Tür, Fenster und Kellerfenster
automatically Operated barriers

Flood barrier Collados/sarl PARTENAIRES
Demountable aperture flood barrier

sealing technologies for buildings



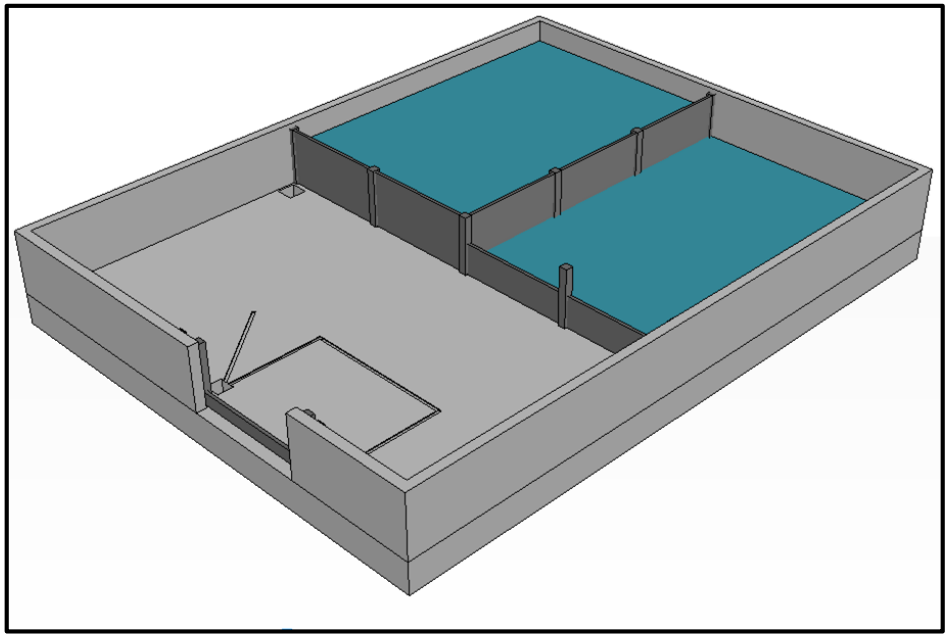


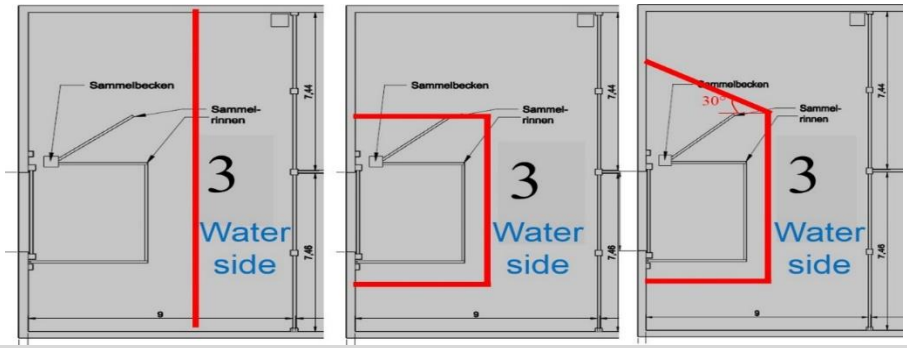


Technitherm

TUHH – test facility for mobile flood protection

- Basin ca. 15m x 20m
  max. water depth d=1,80m
- Scale 1:1
  Length of mobile protection
  up to approx. 25m





Standardisierte Prüfverfahren

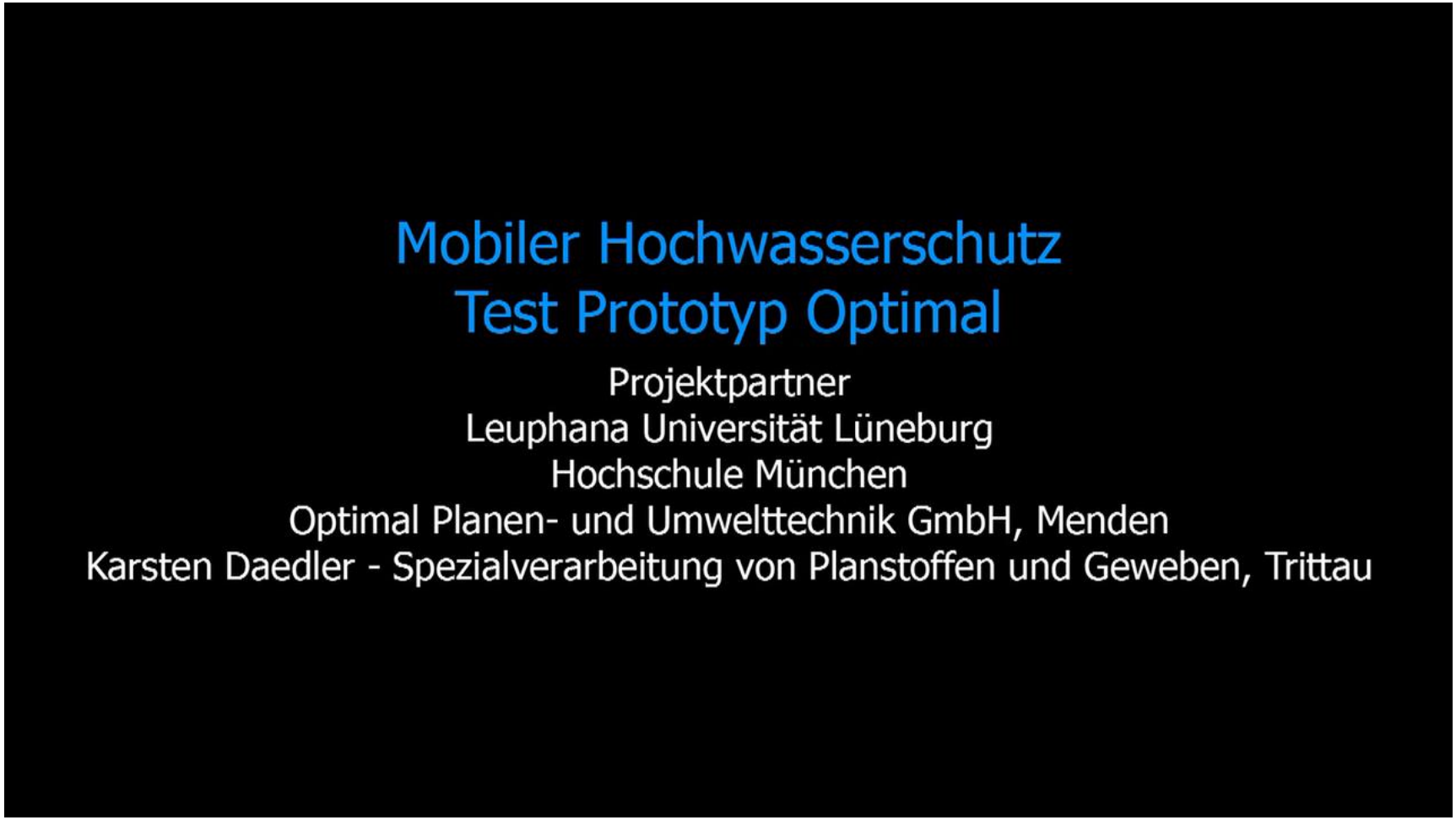
Prüfbereich	Prüfgrößen	Prüfmethode	Prüfkriterien
Qualitätskontrolle	Technische Unterlagen	Analyse und Bewertung der Installationsunterlagen und technischen Dokumente	Vollständigkeit, Lesbarkeit, Verständlichkeit, Einfachheit und einheitliche Terminologie
	Physikalische und statische Konstruktionseigenschaften	Analyse und Bewertung geprüfter Systemstatiken	Rechnerischer Widerstand gegenüber äußerer Lasteinwirkung
	Einfachheit im Aufbau	Vollständiger Auf- und Abbau eines Systems über einen längeren Abschnitt (mindestens zwei Segmente aus Wand und Stützen)	Notwendige Qualifikation und Anzahl der für Auf- und Abbau erforderlichen Personen Zeit für Auf- und Abbau Notwendige Ausrüstung Einfachheit Montage Anforderungen an Gründung
	Beständigkeit und Dauerhaftigkeit	Wiederholter Auf- und Abbau eines vollständigen Wandabschnittes (bis 100	Verschleiß, Beschädigung, Bruch und Betriebseinschränkungen einzelner Komponenten
Belastungs-nachweise	Hydrostatischer Druck	Langsames Befüllen bis zum Erreichen des Auslegungswasserstandes	Schäden und/oder Bruch einzelner Komponenten elastische und dauerhafte Verformung von Stützen und Wandprofilen Sickerrate
	Hydrodynamische Belastung	Überströmung des Systems Längs- und Direktanströmung des Systems	
	Dynamische Belastung infolge Treibgut	Schräger Aufprall eines Baumstamm-Dummies	

Determination of a test catalogue at TUHH

- Installation tests
  - Experienced teams (Manufacturer)
  - TUHH – Teams (after instruction)
  - Long-term use
- Water / leak tightness
  - Hydrostatic tests
  - Hydrodynamic tests
    - Local approach flows
    - Longitudinal flows
  - Permanent leak-tightness
  - Overflow
- Driftwood
  - Selected impulse loads using different logs and drift velocities
- Additional specific tests after consultation with the manufacturer / client => goal development of technology

Installation tests

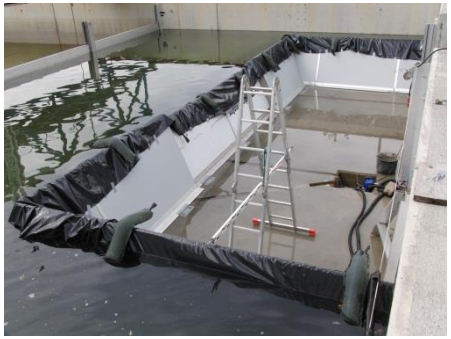
Installation test I



Installation test II

Installation test III

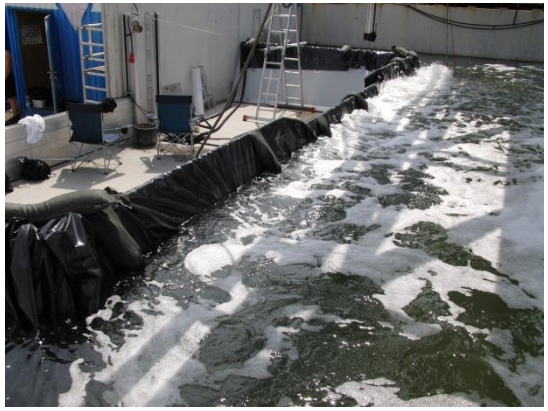
Hydrostatic loads

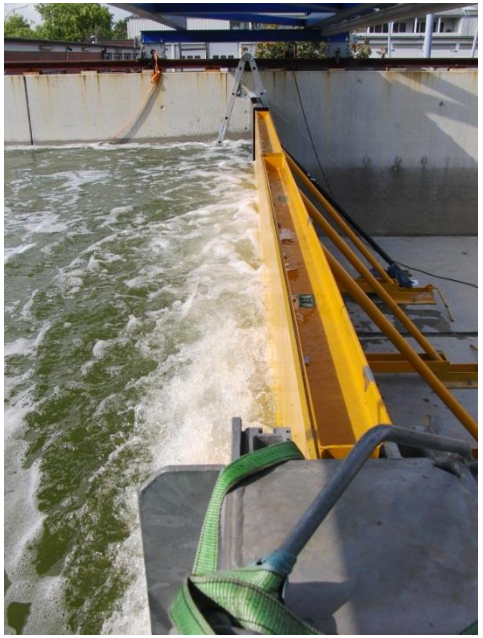



Determination of leakage rate

Measurement of deformation

Hydrodynamic loads





- Determination of leakage rate
- Determination of deformation
- Measurement of flow velocities

Driftwood tests

- Determination of leakage rate
- Determination of deformation
- Measurement of flow velocities

Test catalogue - TUHH

- Installation tests
  - Experienced teams (manufacturer) 1x
  - TUHH – teams (after instruction) 3x
  - Long-term use 10x
- Dichtigkeit
  - Hydrostatic loads 0,25 - 0,5 - 0,75 - 1,0 * Schutzhöhe
  - Hydrodynamic loads
    - Local approach flows up to u=2m/s
    - Longitudinal flows up to u=2m/s
  - Permanent leak - tightness 24h – permanent test
  - Overflow
- Driftwood
  - Selected impulse loads 225kg / 400kg v_{max}=2,5m/s
- Additional specific tests after consultation with the manufacturer / client => goal development of technology

Standardization of tests and certification / approval

Experiences from tests of mobile flood protection constructions at TUHH

- Tests allow the assessment of the performance of a product under defined test conditions. Hence, the test results are not necessarily representative for the product performance under real world conditions.
- Result of tests (especially for termporally installed technologies) are strongly depending on the actual conditions at site (soil characteristics, surface conditions, etc.) and on the installation conditions.
- Additional site specific tests have to be performed for a detailed assessment of the product performance at specific sites.
- Test results are one base for the assessment of the leakage rate / sealing performance of a product. Criteria for necessary sealing performance are strongly depending on the specific project requirements and on the specific construction / site to be protected.
- Hard pass/fail criteria are necessary for the assessment of the stability, only.

Standardization of tests and certification

What are the requirements of manufacturers and users?

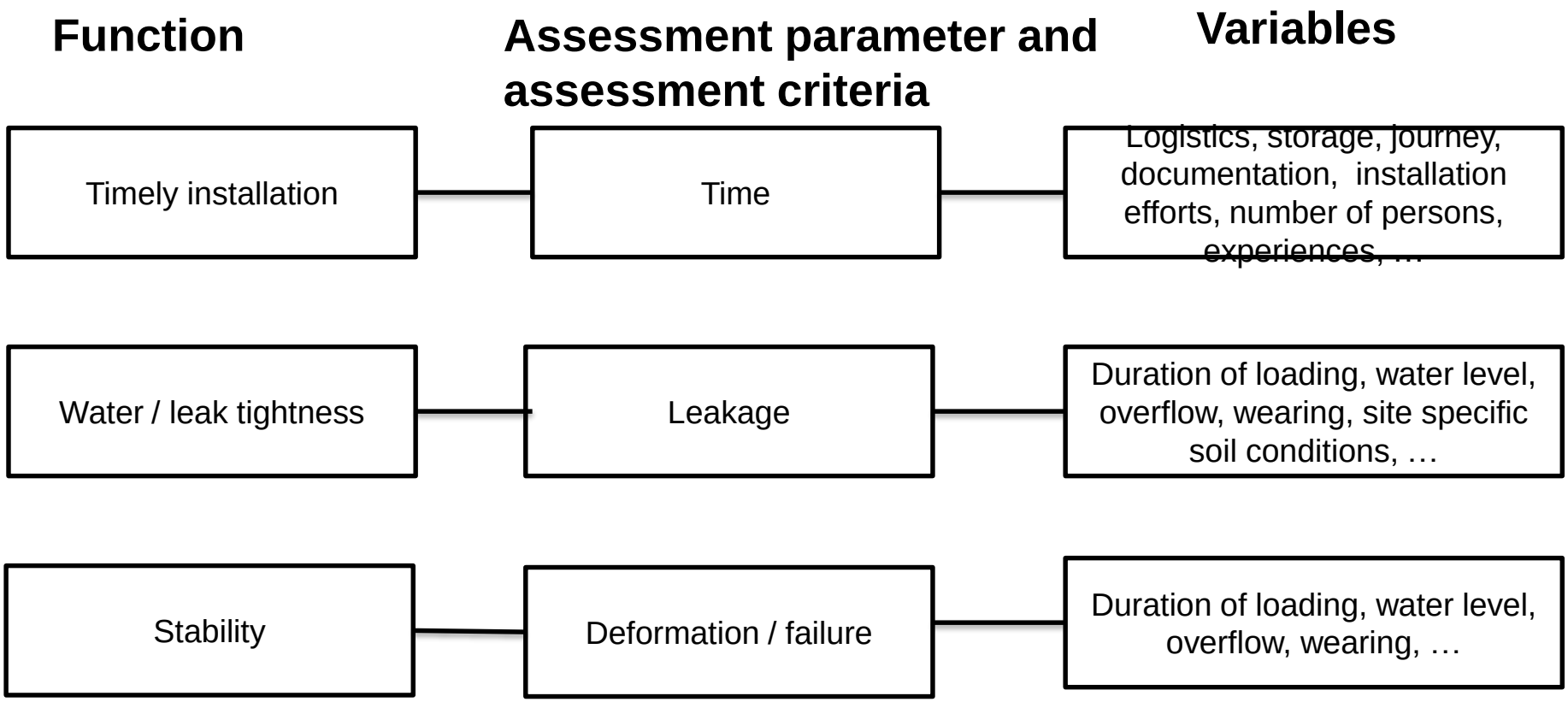
Manufacturer	User (public, private)
Proof of quality and functionality of a product as basis for marketing.	Decision support tool. Basis for insurance against flooding.

Where are we at present?

- Definition of a test procedure
- Definition of assessment parameters
- Definition of assessment criteria

Is this assessment sufficient to fulfil the requirements of the manufacturers and users?

Standardization of tests and certification



Standardization of tests and certification

Example:

Allowable leakage rates for mobile flood protection walls

FM – Approval	45l/h/m (0,75l/min/m)
British – Standards	40l/h/m (0,67l/min/m)

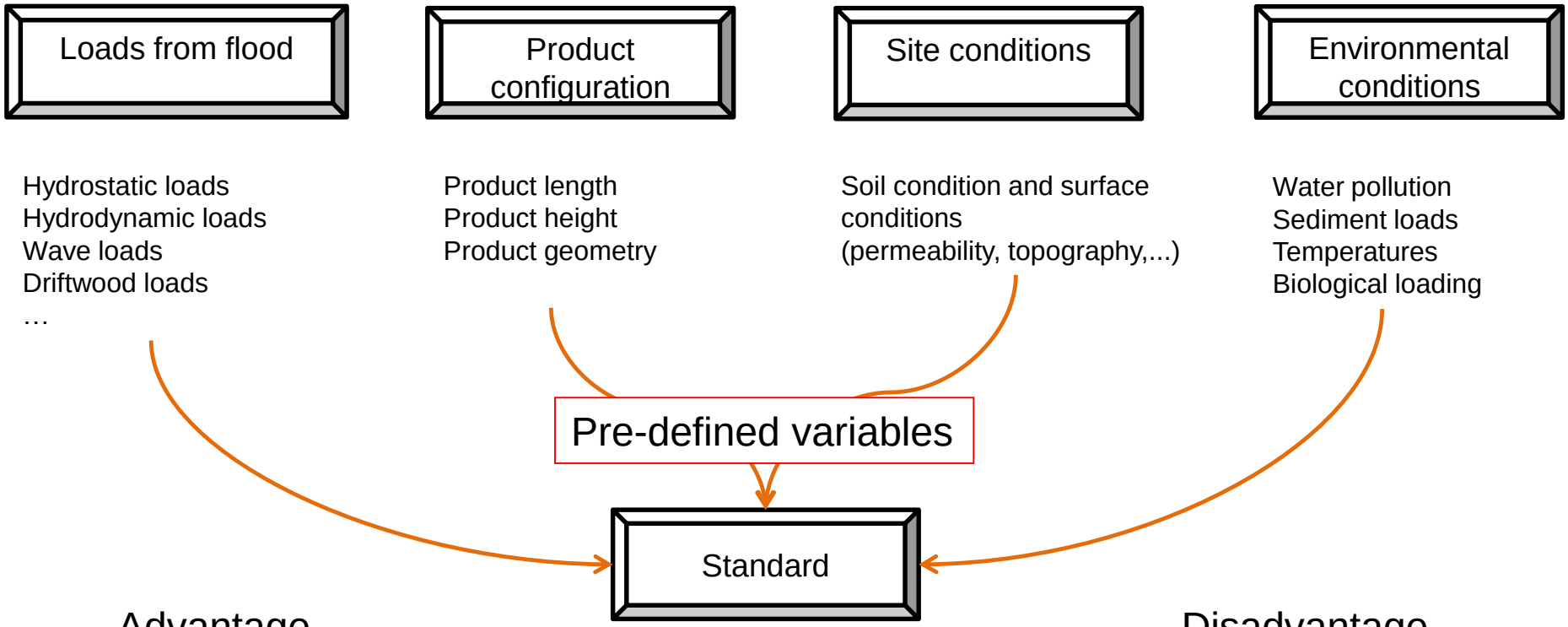
Are those pass/fail values meaningful?

Idea:

Classification (VDS, Europaverband Hochwasserschutz, etc.)

=> criteria depending on intended use

Standardized procedures



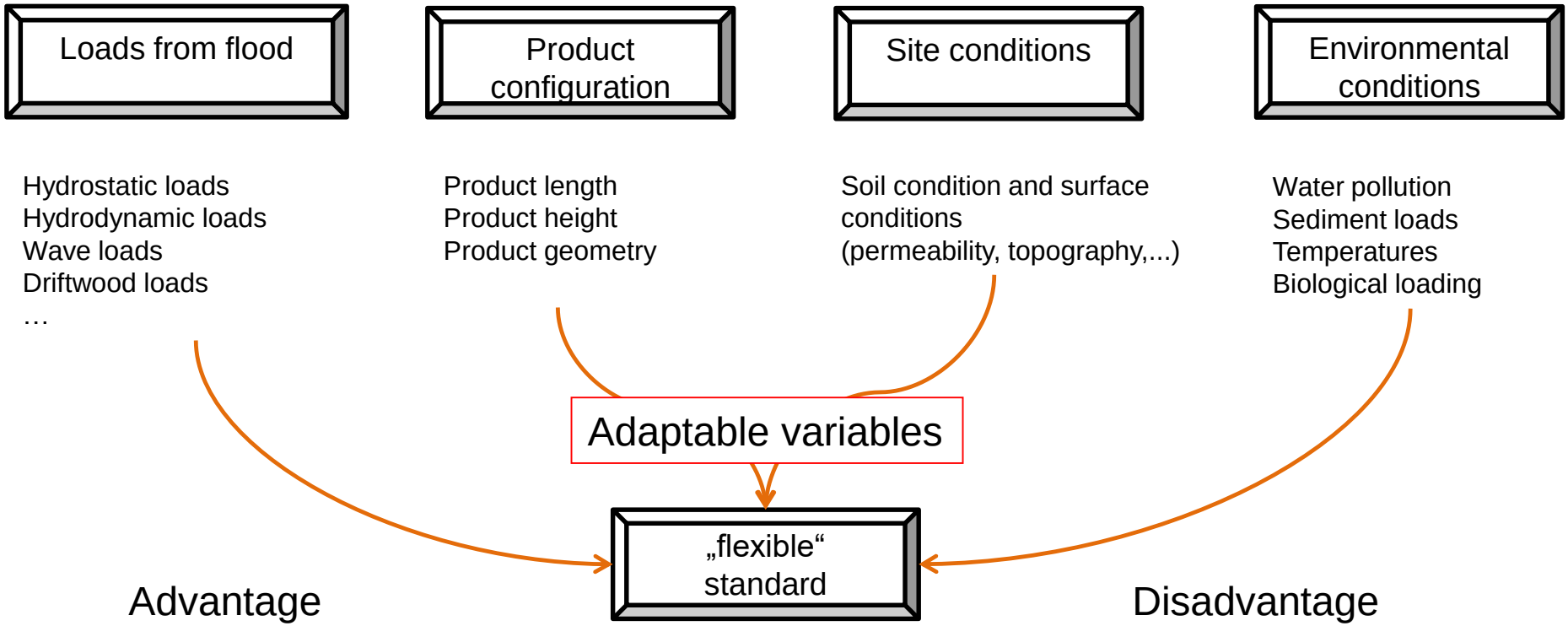
Advantage

- Allows the (objective) comparison of the performance of different products

Disadvantage

- Problematic to define relevant and standardized conditions for the wide variety of requirements and the wide variety of the products.
- Problematic to transfer the test results for the standardized conditions to the site specific conditions

Standardisierte Verfahren



Advantage

- The test conditions represent the real conditions at site comparatively good

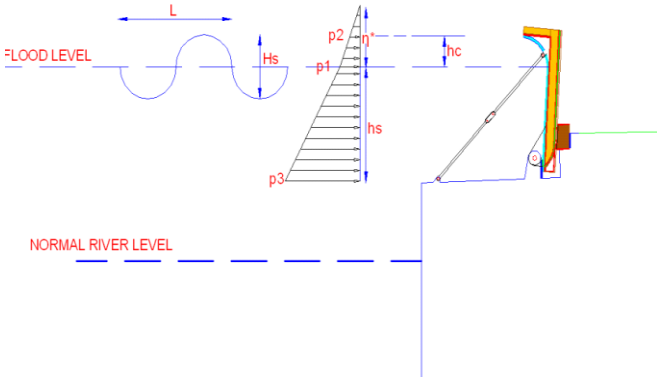
Disadvantage

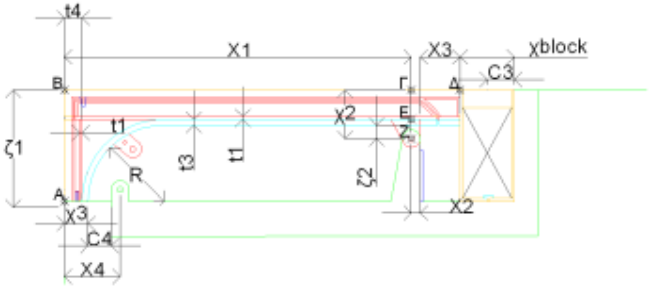
- No direct comparability of the performance of the different products (tested under different conditions)
- No classification of the products
- Wide variety of conditions (see above), which can not be implemented in all hydraulic labs.

Standardized Test

Physical tests

mathem./ physic. proofs





VDS initiative „certification of mobile flood protection“

Test guideline for mobile flood protection elements

- Definition of requirements and test methods for mobile and temporally stationary elements
  - Leakage rates
    - classes A / B / C
  - Storage- and transport
    - Volumes and weight
  - Amount of work for installation
    - Duration and complexity (indirect)
  - Proofs / Documentation
    - Stability and structural safety
    - Material
    - System description
    - User manual / users guide
    - Maintenance and repairs

Systematization of (mobile) flood protection

Level 1 Technologies		
Abatement technologies abatement systems	indirect protection / protection of an area / a building	line oriented protection of an area
sealing technologies sealing systems	Sealing of buildings or building openings	direct protection at the buidling
	Level 2 Type	
	mobile	
	fixed / im-mobile	
		Ebene 3 Installation
		aktive => self installing / preventiv installation
		passive => manually installation

Abstract and conclusions

- Mobile flood protection construction are a meaningful addition to classical „im-mobile“ flood protection measures and are
- case wise a comparatively cheap, effektive and efficient solution for flood protection tasks.
- A wide variety of concepts and technologies of mobile flood protection measures are available => not all are reliable and some inventors are not respecting the simpliest physical and organizational requirements
- In general, a wide variety of experiences of testing of mobile flood protection measures are available.
- Standardized criteria for the assessment of the applicability of mobile flood protection constructions
  - are widely and frequently required but
  - are comparativel difficult to define.
- A certification of mobile flood protectin systems is desirable:
  - but is only possible in co-operation with „certifiers“ (VDS, TÜV, etc.).
  - and needs a combination of hydraulic lab tests and theoretical and / or practical tests.
- Generel concepts for standardized tests and a certification of mobile flood protection systems are at present developed under lead management of VDS


Thank you for your attention!