



ITA COSUF Workshop, 28th – 29th October 2015

# BAB A7 Elbe Tunnel



LSBG  
Landesbetrieb Straßen,  
Brücken und Gewässer  
Hamburg



## Content of the Presentation

1. Basic Information on the Elbe Tunnel
2. Refurbishment of Tubes 1-3 (2009-2013)
3. Incidents and Lessons learned



# 1. Basic Information on the Elbe Tunnel

2. Refurbishment of Tubes 1-3 (2009-2013)
3. Incidents and Lessons learned



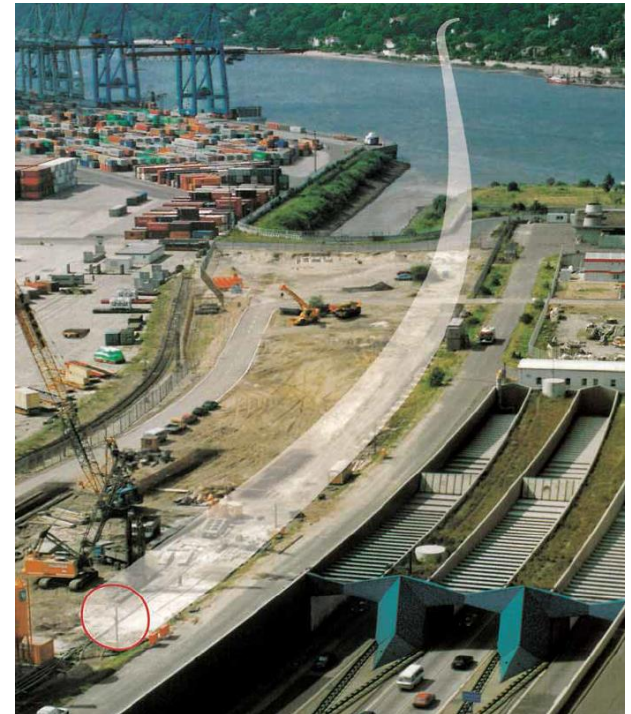
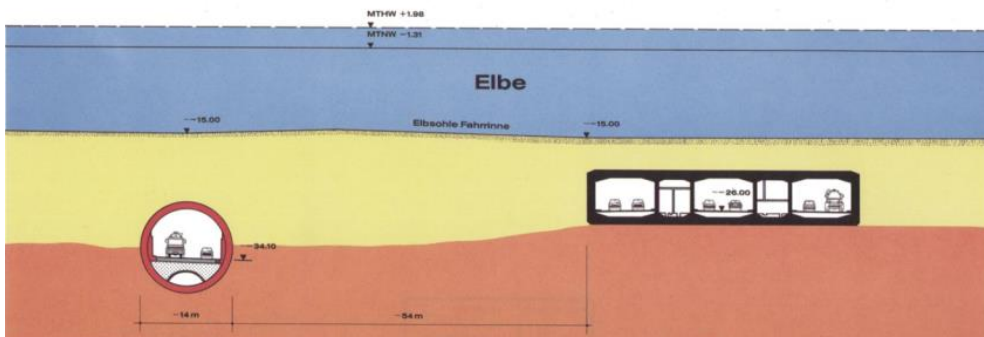
## Layout of the Elbe Tunnel

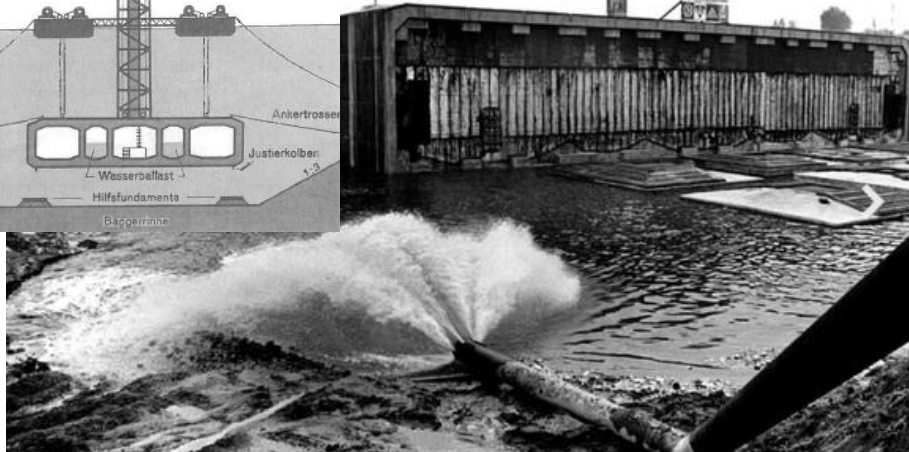
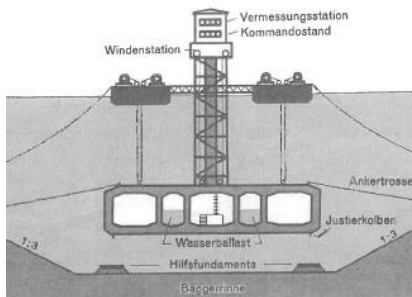
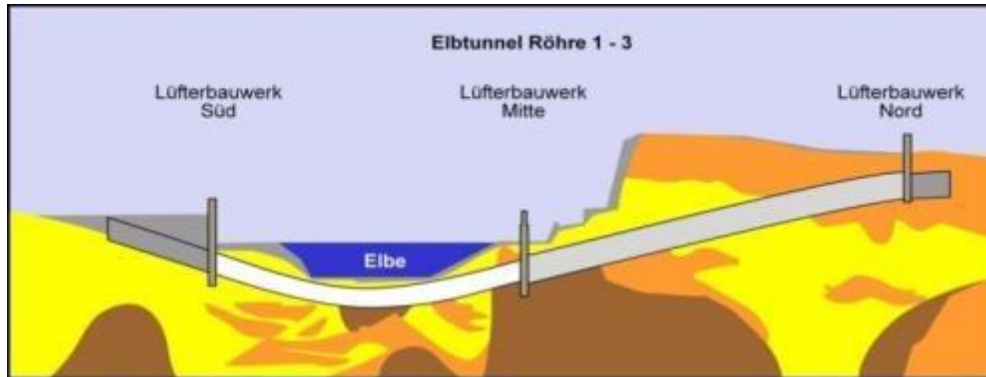
- consists of 4 tubes
- 3 tubes were built from 1968 to 1975
- 4th tube was built from 1995 to 2002
- ~ 3 km long
- 2 lanes in each tube



## Elbe Tunnel Cross Sections

- depth of the Elbe River at shipping passage ~ 15 m
- tubes 1-3  
under the water surface at  
lowest point ~ 26 m
- tube 4  
under the water surface at  
lowest point ~ 34 m





## Construction Methods Tubes 1-3 (2.8 km)

- 8 immersed segments (~1000 m)
- ~1100 m drilled with tunnel boring machine
- ~600 m cut and cover





## Construction Methods Tube 4 (3.1 km)

- drilled with tunnel boring machine
- cut and cover at portals

## Traffic Control

- flexible traffic routing
- 2<sup>nd</sup> and 3<sup>rd</sup> tube can be operated
  - unidirectional (both directions north and south) and
  - in contra flow



Screenshot of the traffic control system



1. Basic Information on the Elbe Tunnel

## 2. Refurbishment of Tubes 1-3 (2009-2013)

3. Incidents and Lessons learned



## Safety and Refurbishment Programme Tube 1-3

- to refurbish and upgrade the 40 year old tunnel tubes
- to comply with new national and European regulations
- construction period from 2009 - 2013



40 Years Elbe Tunnel

## Operational Challenges during Refurbishment

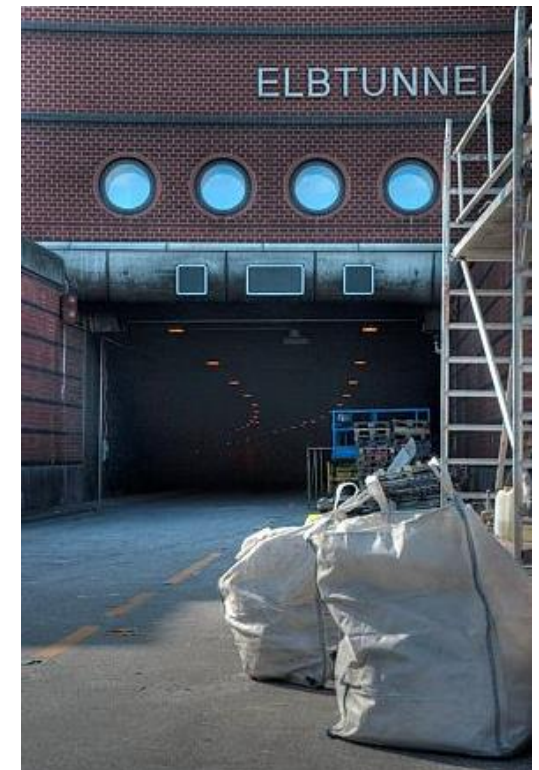
- at a time one tube was closed for refurbishment for ~ 1 year, the other 3 tubes were in operation
- the aim was to constantly improve the safety level and never deteriorate
- the tube in refurbishment had to be always functional as part of the escape and rescue ways for the tubes in operation
- tests, commissioning, training, etc. parallel to normal operation
- safety assessment for each construction phase and for each re-opening of a refurbished tunnel tube

B2	↓	↓	⊗	⊗	↓	↑	↑	↑
B3	↓	↓	↓	↑	⊗	⊗	↑	↑
B4	↓	↓	↓	↑	↑	↑	⊗	⊗

Operational Traffic Modes

## Safety and Refurbishment Programme Tube 1-3

- **Main Measures**
  - additional fire protection cladding
  - improvement of the ventilation system
  - provision of additional emergency exits
  - upgrade and extension of safety facilities
  - modification of the road drainage
- investment costs ~ 120 million €



## New Fire Protection Cladding in Tunnel Tube



## Improvement of ventilation system

- new axial fans
- enhanced exhaust volume
- new visibility / smoke meters
- air velocity metering
- linear heat sensor cable



## New Exhaust Ducts with Dampers for Smoke Extraction



- groups à 3 dampers in the tunnel walls
- dampers in the tunnel crown

## Additional Emergency Cross Ways between the Tubes



- 2 x 2 additional cross ways between tube 1/2 and tube 2/3 in the immersed tunnel section



## New Emergency Exit Doors

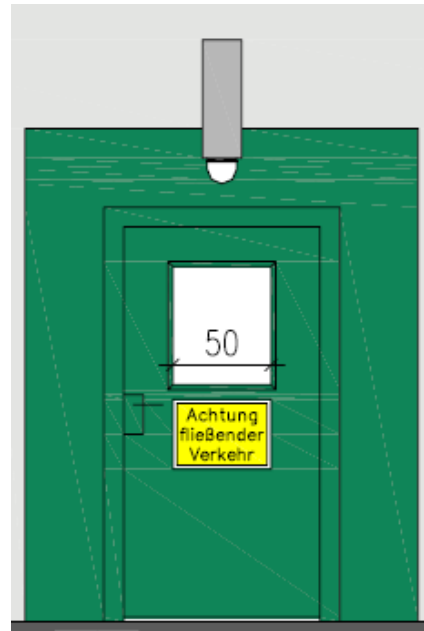


- according to German guideline RABT
- green LED frame
- illuminated exit sign with flash light
- integrated window
- force to open the doors less than 100 N

## New Emergency Exit Doors



new pictogram  
warning against traffic



according to RABT:  
Text in German:  
"Achtung fließender Verkehr"

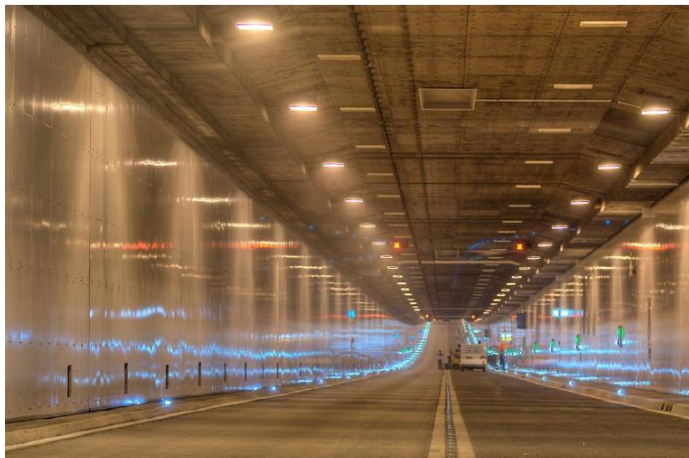


pictograms and text in  
German+English to indicate  
the door opening direction +  
tactile elements for the  
visually handicapped

## New Safety Equipment



- Emergency exit signs with integrated escape light



- LED studs to mark the roadside edge (normal and emergency situations)



- Upgraded emergency stations

## Upgraded Communications



- new loudspeaker system (SLASS) for tunnel, conventional speakers for emergency cross ways
- CCTV system – upgrade (tubes + cross ways)
- radio communication for emergency services: change from analog to digital

## Automatic Incident Detection



- based on inductive loops
- GUI of the Automatic Incident Detection System
- to be implemented in tunnel control room -> presentation Rainer Petersen

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## Elbe Tunnel – Incidents per Year

- fires ~ 2
- accidents ~ 100
- overheight vehicles (tubes 1-3) ~ 200
- vehicle breakdowns ~ 400

(ADT ~ 110 000 vehicles/day)



## Dealing with Incidents - Tunnel Control Centre



- located at the northern tunnel entrance
- staffed 24/7
- 3 authorities guarantee safe tunnel operations
  - LSBG
  - Fire Brigade
  - Police



## Functions

- LSBG
  - operation and management of the tunnel structure and technical equipment
  - maintenance
- Fire Brigade
  - fire fighting
  - technical assistance (after accident, vehicle breakdown, ...)
  - co-ordination of ambulance
- Police
  - traffic monitoring and control
  - to punish height control and other offenders



## Incident Response Staff at Elbe Tunnel



- in the tunnel control room:  
permanently min. 3 operators from 3 authorities

**On-site** in 3 – 5 minutes:

+ staff and  
contractors  
on call



fire fighters



police patrol



maintenance  
workers

## Emergency Closure of the Tunnel



- stop-signalisation at the northern portal
- improved on the occasion of integration of the 4<sup>th</sup> tube
- 3 stop-sections before each portal

## Lorry Accidents blocking the tunnel tube

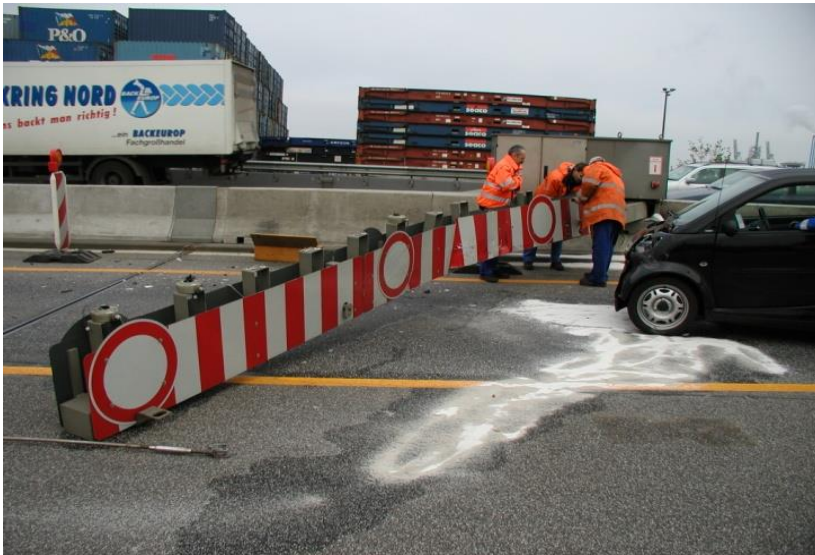


blocking of tunnel tube 1

- availability of the Elbe tunnel is crucial for the level of service in and around Hamburg
- advantage of having 4 tubes (if one tube is blocked it does not result in closing the whole direction of traffic)

## Crashes into Barriers

- barriers are used for lane closures
- although comprehensive signalisation before the barriers, crashes occur regularly
- caused by exhausted / drunken drivers



## Lorry Fire in Tube 4 (2011)



## Lorry Fire in Tube 4 (2011)

- lorry caught fire in the middle of tunnel tube 4
- cause of fire:  
self-ignition in engine compartment,  
probably because of leaking engine oil
- detection: visibility alarm in control center, while operator was checking -> heat sensor cable set off the programme for „Catastrophy“
- instant response of the fire fighters  
(3 minutes after alert in tunnel tube)
- the fire could be controlled and extinguished within 30 minutes

## Lorry Fire in Tube 4 (2011)

- fortunately no one injured
- evacuation process relatively slow:
  - poor performance of old loudspeaker system
  - people felt save despite smoke in front of them (presence of fire fighters and well performing smoke extraction)



## Lorry Fire in Tube 4 (2011)



## Reconstruction

- 50 m<sup>2</sup> of asphalt and fire protection cladding had to be replaced
- replacement of cabling in the affected section
- concrete walls intact, only joints had to be replaced

## Lorry Fire in Tube 4 (2011)



## Reconstruction

- after 10 days of reconstruction and testing the tunnel tube could be re-opened
- because of the refurbishment program in the old tubes, spare parts + contractors were quickly available



## Fire Alarms in 2015

## Fire in May 2015 in Tube 1



- no serious damage to safety facilities
- asphalt had to be replaced
- tube could be opened after a few hours (one lane)



## Fire in June 2015 in Tube 4



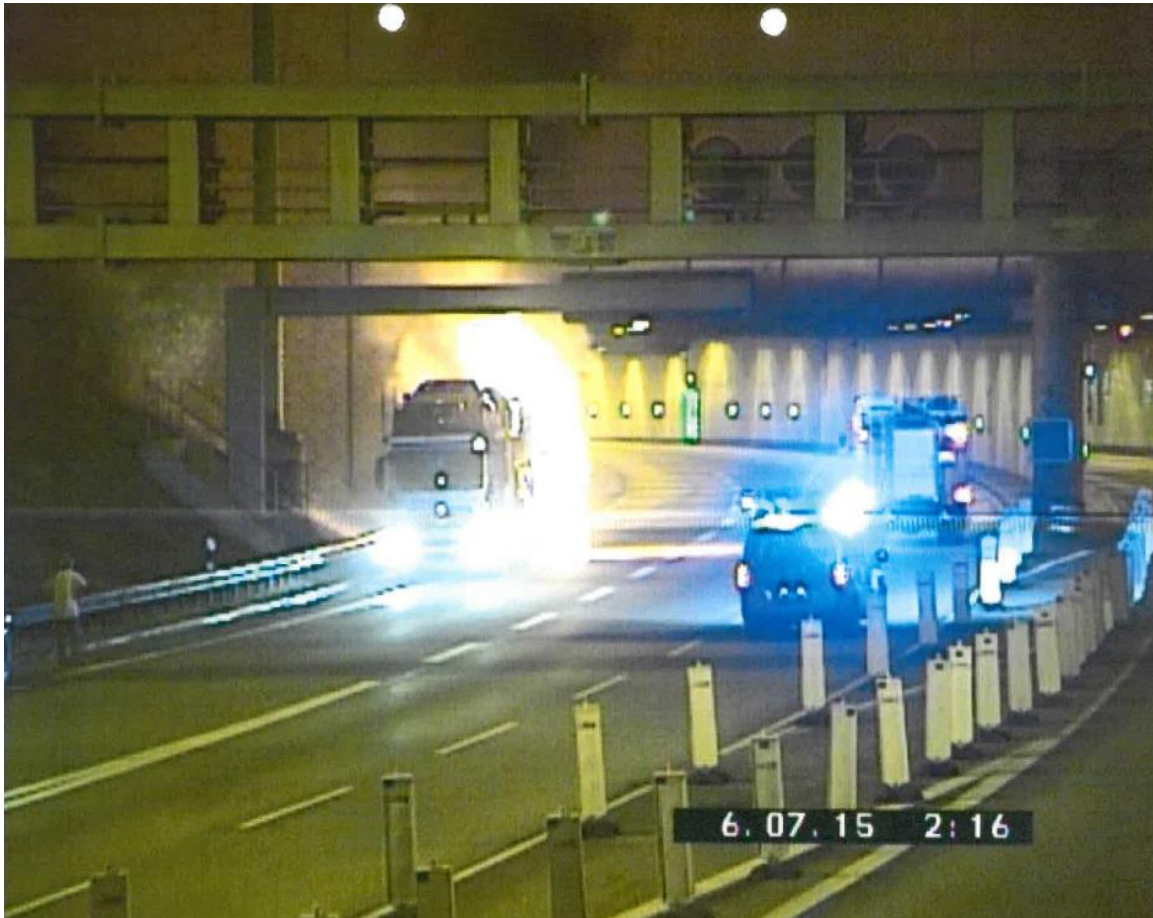
- a car caught fire in tube 4
- the driver stopped the car and used the emergency phone
- advised by the operator the driver used the fire extinguisher and was able to extinguish the fire by himself

## Fire in July 2015 in Tube 1



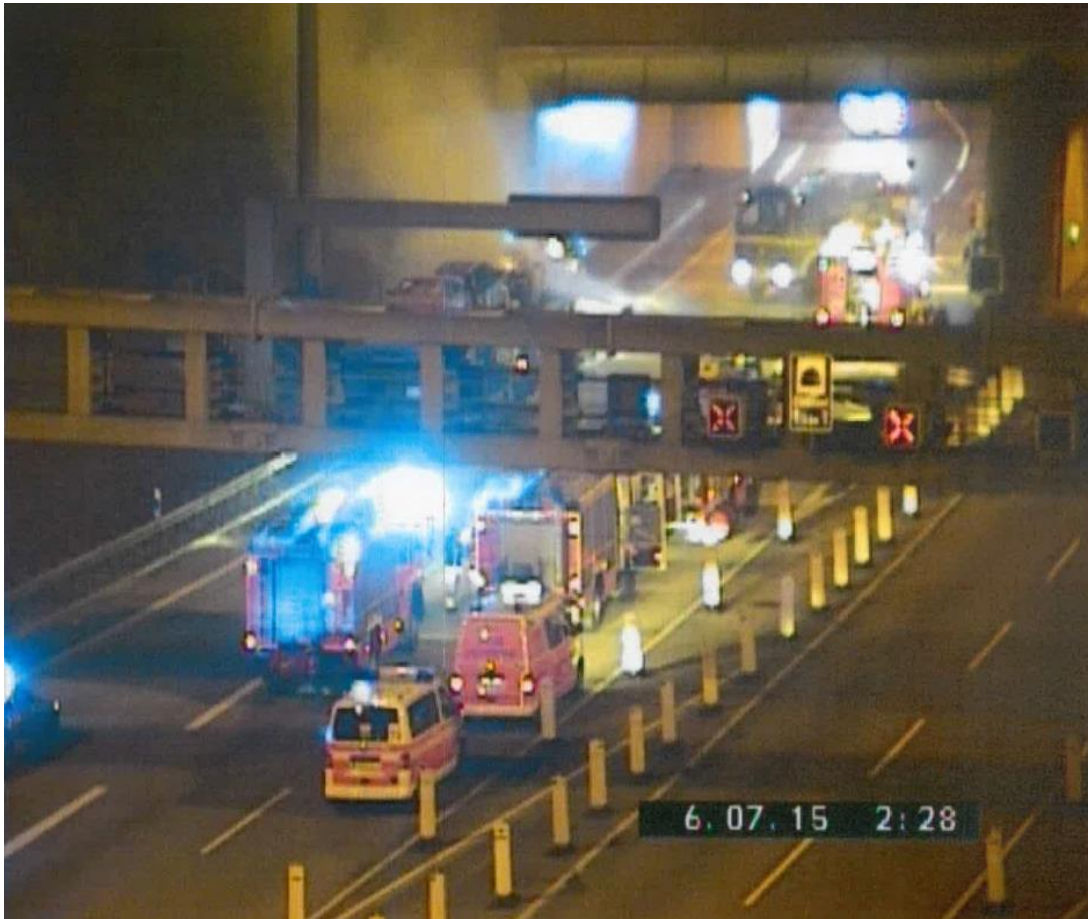
- the tyre of a trailer of a car transporter caught fire in tube 1
- being aware that his trailer is burning, the driver went ahead and stopped outside the tunnel
- then a car on the trailer also caught fire

## Fire in July 2015 in Tube 1



- after 5 minutes fire fighters and police arrived at the scene

## Fire in July 2015 in Tube 1



- additional forces at the scene
- 35 minutes after alert the fire was extinguished



## Fire in July 2015 in Tube 1

- the driver's presence of mind prevented a major incident in the tunnel
- no damage in tunnel or on the pavement outside
- after towing and cleaning the pavement, the tunnel tube could be opened 4 hours after alert

## Conclusion

- many incidents at the Elbe Tunnel, but thanks to a fast response a small degree of damage
- number of accidents in the tunnel is lower than on comparable stretches on Hamburg's motorways
- most of the accidents are minor rear-end collisions



# Many Thanks for your Attention!

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