

LBR LBO Infrastructure Summit 2016

# Challenges around large infrastructure projects and the lessons learned

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## Transportation

- Tunnel collapse
- Bridge collapse



## Power & Energy

- Flooding
- Explosion



## High-rise Buildings

- Water damage
- Fire damage



## Transportation Case study 1

### Shanghai Metro, China 2003

- Expansion of the Shanghai Metro Line 4 crossing beneath the Huangpu River
- Two parallel tunnel tubes constructed by earth pressure balance TBM

### What happened?

- Failure occurred during construction of a cross passage
- Massive ingress of water and material at a depth of 35m
- Several meters ground subsidence
- Cause – failure of ground freezing unit, failure to implement risk management

### Consequences

- Collapse of a high rise office buildings
- Flood protection dyke on the river badly damaged



## Transportation Case study 2

### Mass Rapid Transit, Singapore 2004

- An open cut tunnel excavated for MRT's Circle Line
- Excavated trench of 15m wide and 33m deep supported by 0.8-1m thick diaphragm wall
- Steel struts: 4-5m horizontal and 3m vertical spacing as ELS system

### What happened?

- 9<sup>th</sup> level of struts were being installed when collapse happened
- Unusual cracking noises were heard early in the morning till the collapse
- Collapse plan area was 100m by 130m, settlement up to 15m
- Causes – under design of strut-waler connection in the strutting system, no proper design reviews, poor construction, failure to implement risk management

### Consequences

- Part of Nicoll Highway, Singapore's major east-west harbour front road destroyed
- 4 workers killed, several injured
- 15,000 people and 700 business affected





### What can we learn?

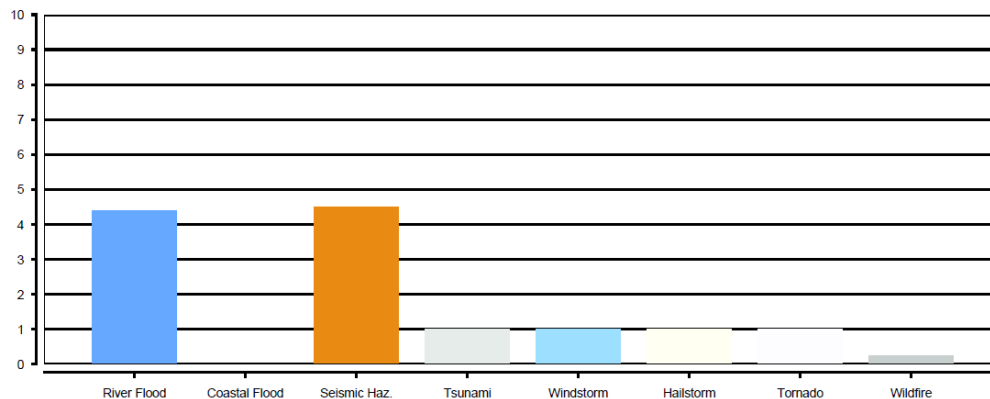
- 1 A need for robust design, risk management, design review and independent checking
- 2 Purposeful back analysis, effective instrumentation, monitoring and interpretation regime
- 3 An effective system of management of uncertainties and quality during construction, corporate competencies and safety management
- 4 The safety of temporary works is as important as permanent works and should be designed according to established codes and checked

# Sri Lanka through the eyes of a Risk Manager

- Flood risk
- Earthquake exposure
- Design codes and standards to be adopted

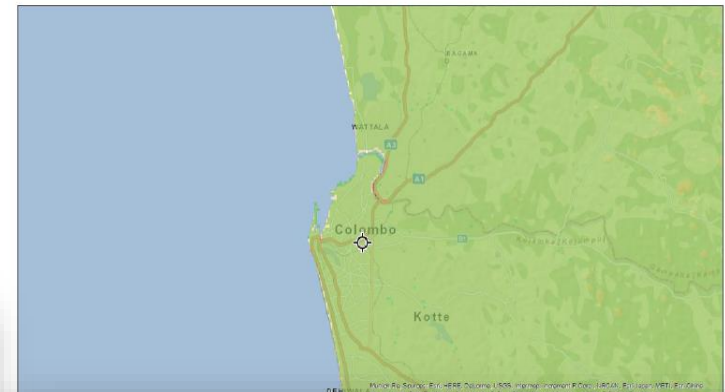
## Hazard Overview

Global intensity per peril according to Swiss Re scale 1 - 10 (0: no data)



## NATHAN Single Risk Assessment Report

Risk Location	LKA (Sri Lanka)
Longitude/Latitude	79.8723E, 6.9342N
Munich Re Risk Location Quality	Exact Coordinates (100)
People per km <sup>2</sup>	≥ 200
Elevation	10m
CRESTA Zone High Res	LKA_91 (Colombo)
CRESTA Zone Low Res	LKA_1 (Western Province)















## Risk Score Rating

Weighted and summarized Risk value for ordinary commercial and industrial business

Overall Risk Score  Medium

## Hazard Score Rating

Hazard zoning values for significant natural hazards

	low	high	hazard rating
Earthquake			Zone 0
Volcanoes			No hazard
Tsunami			No hazard
Tropical cyclone			Zone 0
Extratropical storm			No hazard
Hail			Zone 1
Tornado			Zone 1
Lightning			Zone 4
Wildfire			No hazard
River flood			Zone 0
Flash flood			Zone 3
Storm surge			No hazard

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**Thank you!**  
We welcome your questions.