

Management of Earthquake Risks using Condition Indicators

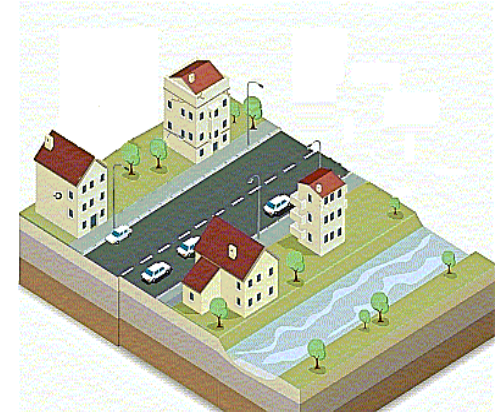
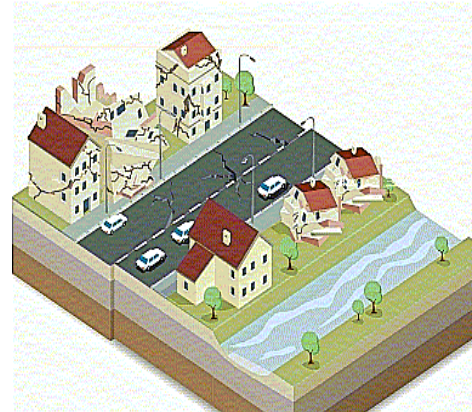
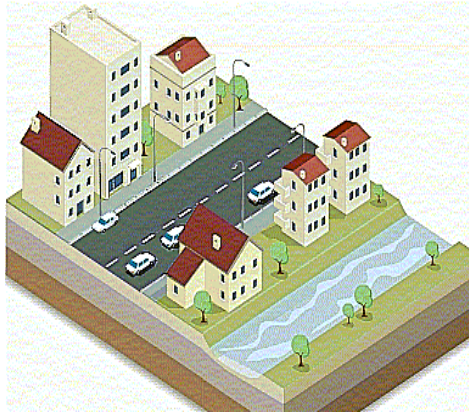
Institute of Structural Engineering (IBK)

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- Project started in June 2004.
- Interdisciplinary research group. Funded by the Swiss National Fund.
- Participating Institutes from Swiss Federal Institute of Technology Zurich
 - Institute of Structural Engineering
 - ▶ Group Risk and Safety
 - Prof. Dr. Michael H. Faber
 - Dr. Jens Ulfkjaer
 - Yahya Y. Bayraktarli
 - ▶ Group Earthquake Engineering and Structural Dynamics
 - Prof. Dr. Alessandro Dazio
 - Ufuk Yazgan
 - Institute of Construction Engineering and Management
 - Institute of Geotechnical Engineering
 - Dr. Jan Laue
 - Juliane Buchheister
 - Institute of Geodesy and Photogrammetry



Before

During

After

Optimal allocation of available resources for risk reduction

- retrofitting
- rebuilding

in regard to possible earthquakes

Damage reduction/Control

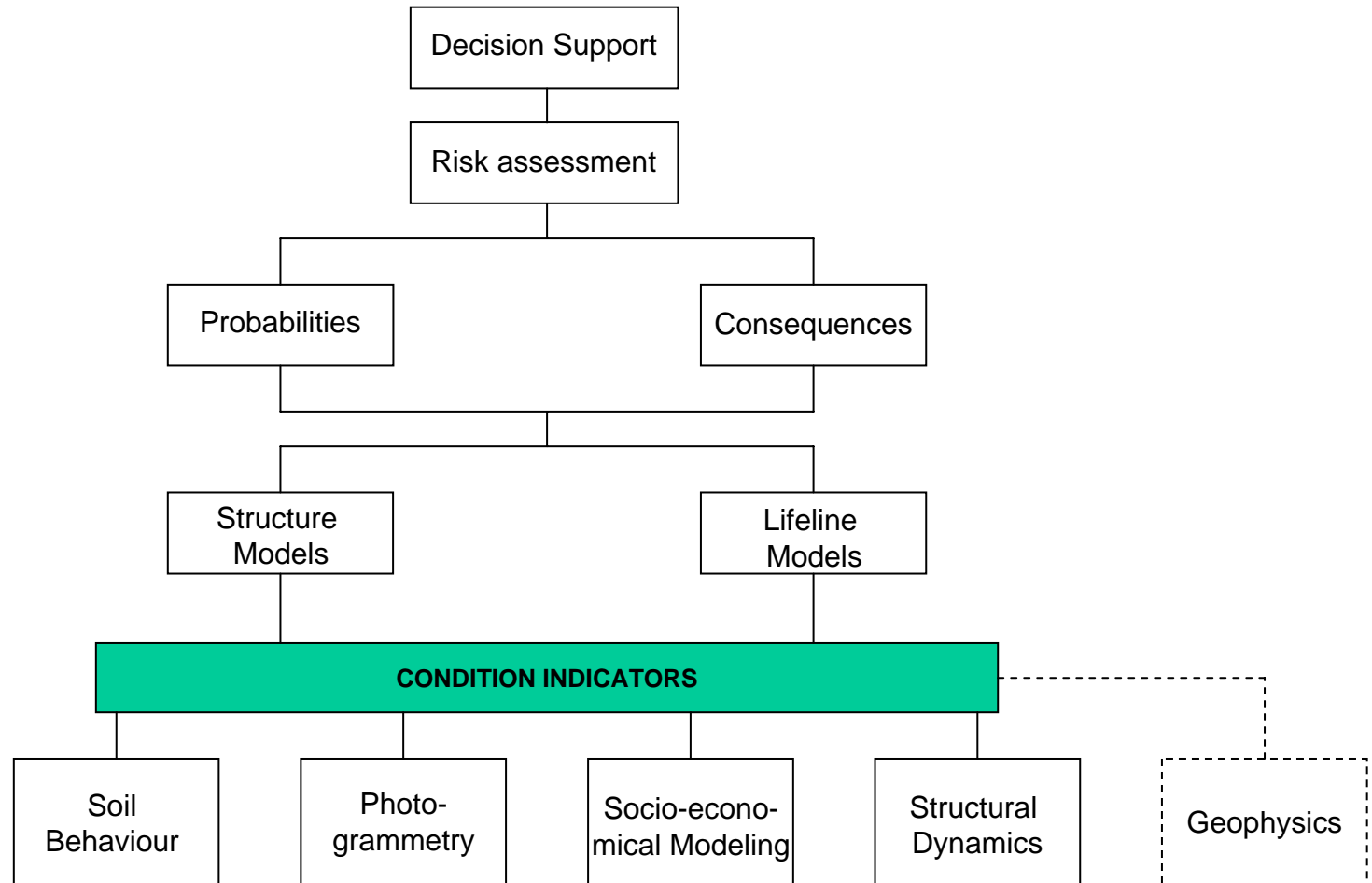
Emergency help and rescue

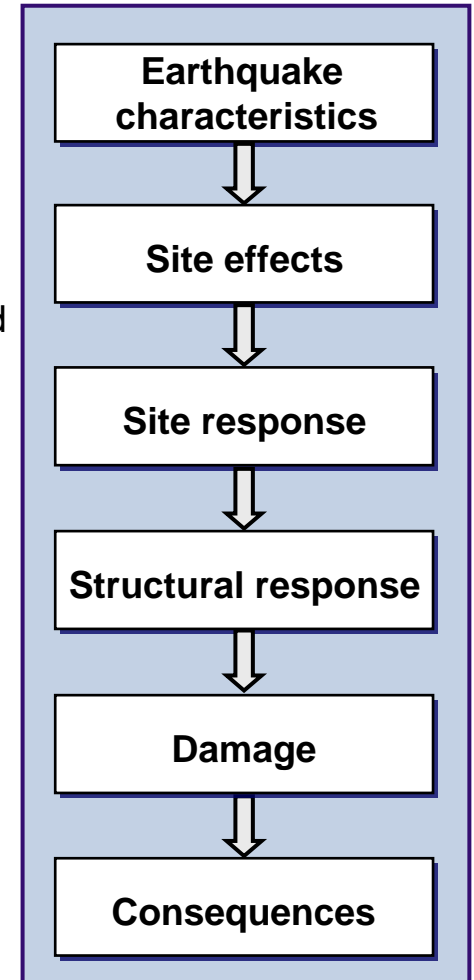
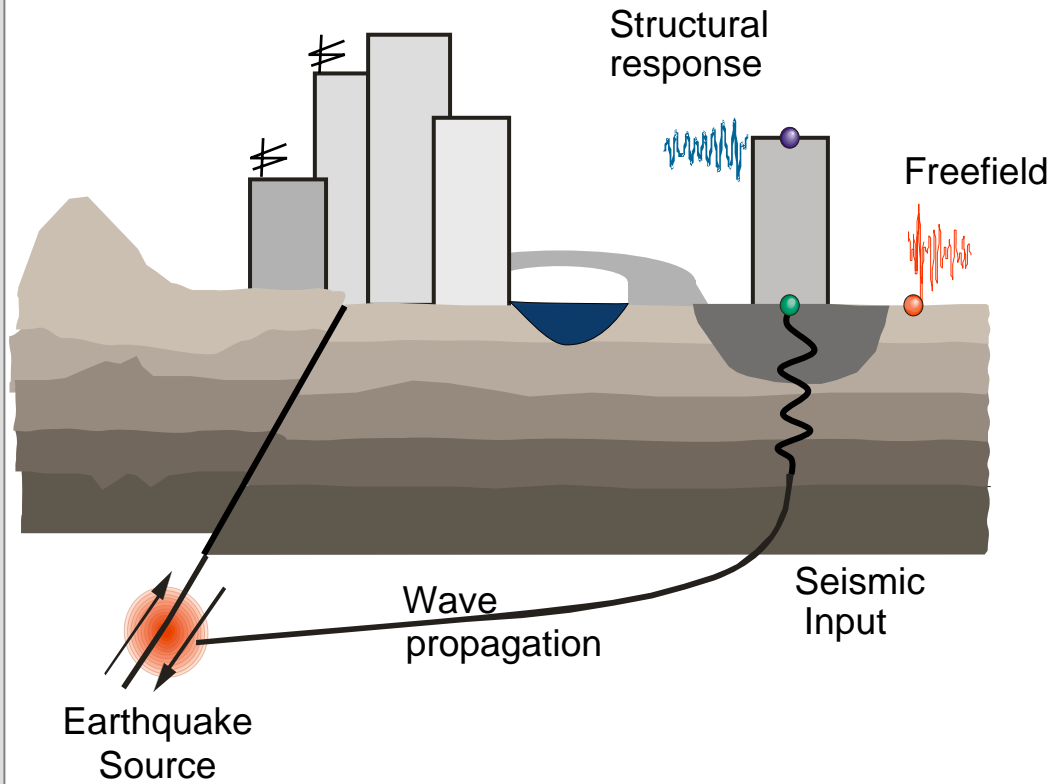
Aftershock hazards

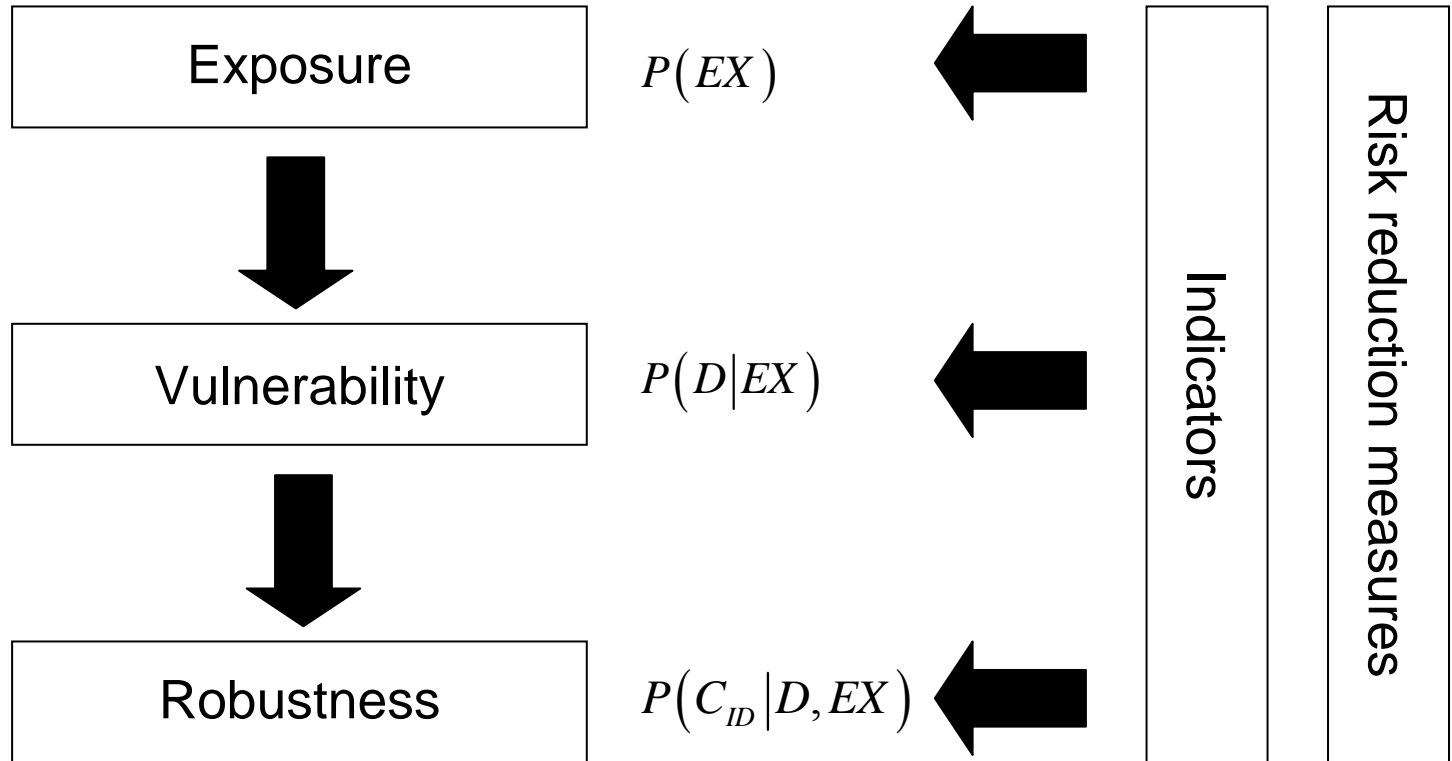
Rehabilitation of infrastructure functionality

Condition assessment and updating of reliability and risks

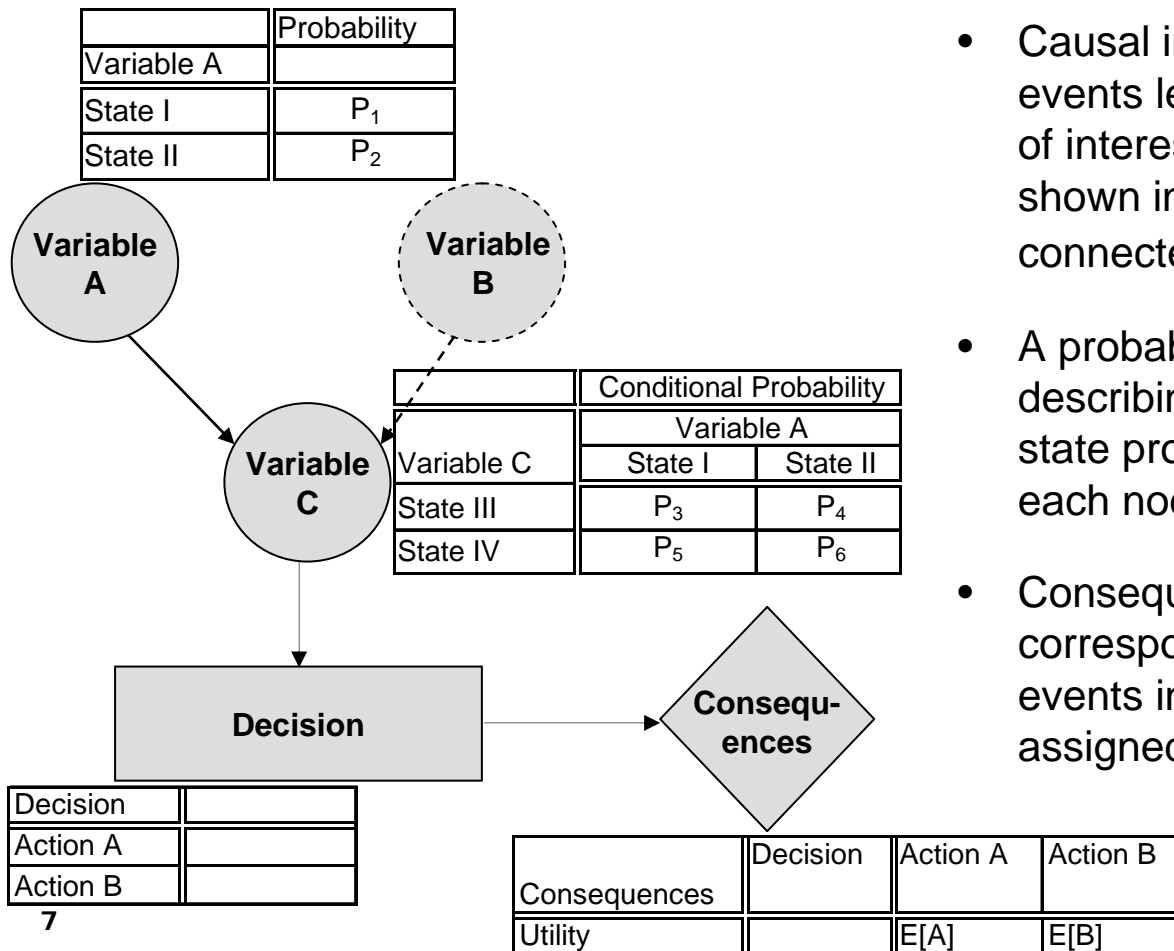
Optimal allocation of resources for rebuilding and strengthening



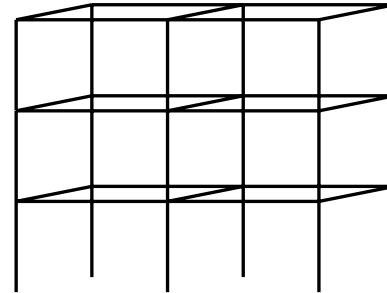




The overall theoretical framework is the **Bayesian decision theory**. Risks will be quantified using **Bayesian Probabilistic Networks (BPN)**.

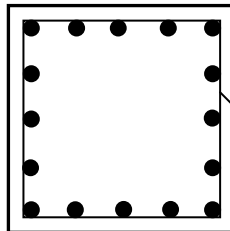


- Causal interrelations of events leading to events of interest are graphically shown in terms of nodes connected by arrows.
- A probability structure describing the conditional state probabilities for each node is assigned.
- Consequences corresponding to the events in the BPN are assigned.

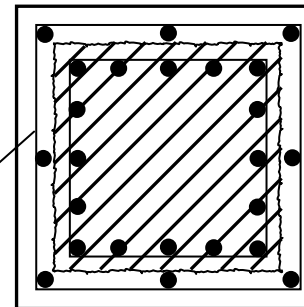


Decision situation, whether to retrofit or not.

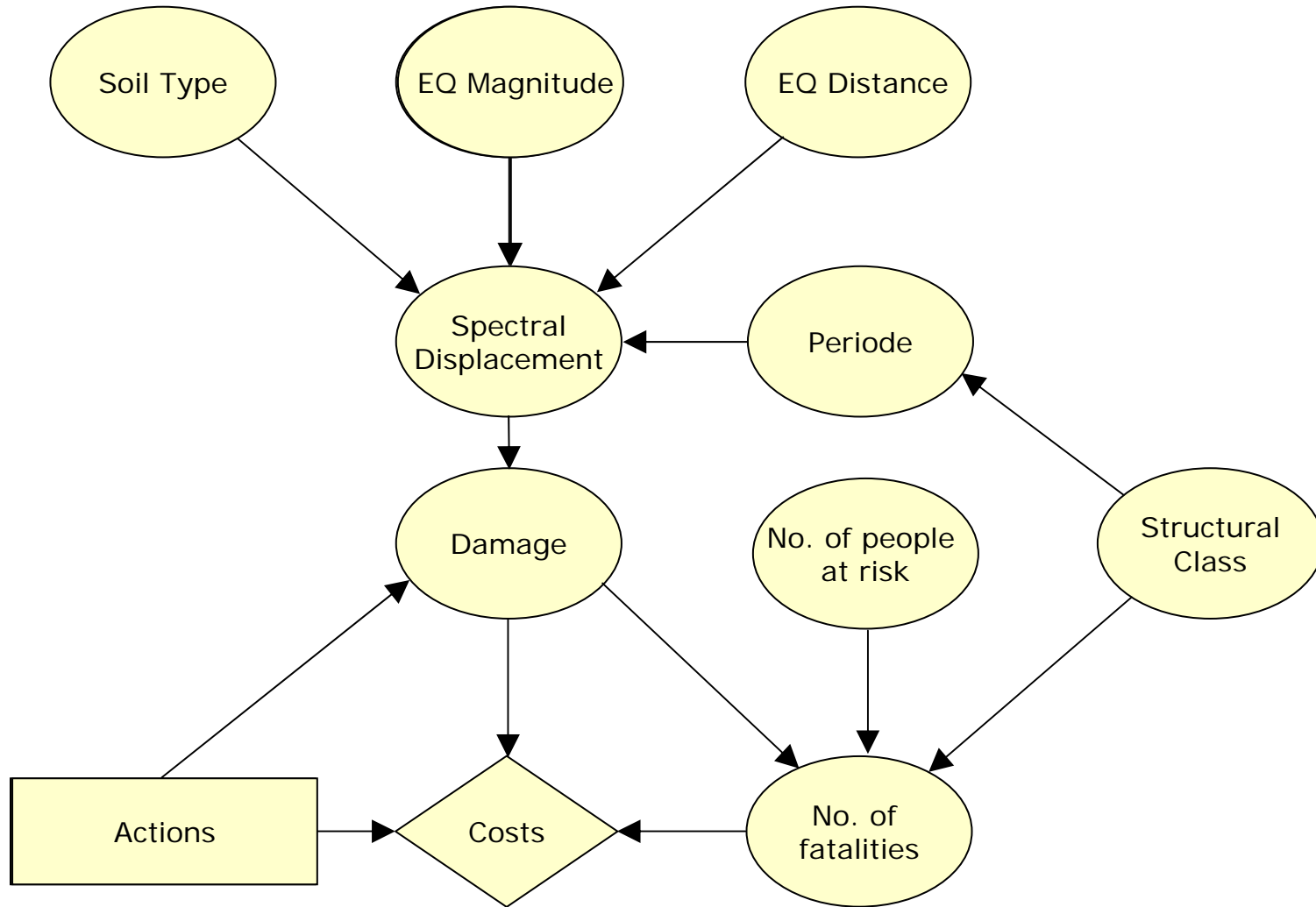
columns
30x30 16 ϕ 16

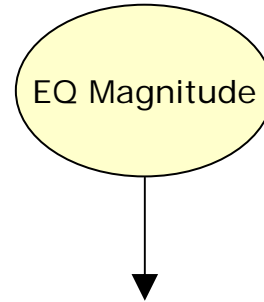


stirrups ϕ 8@18



Jacketed columns
50x50 24 ϕ 16



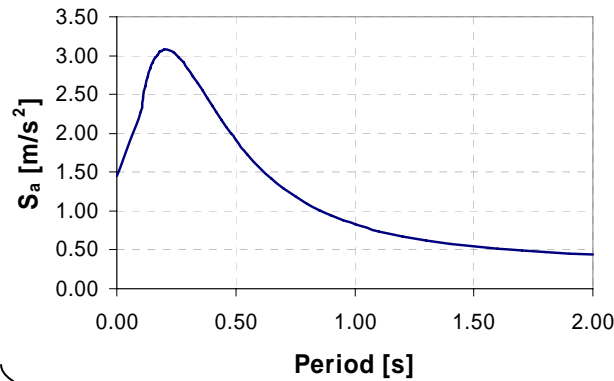
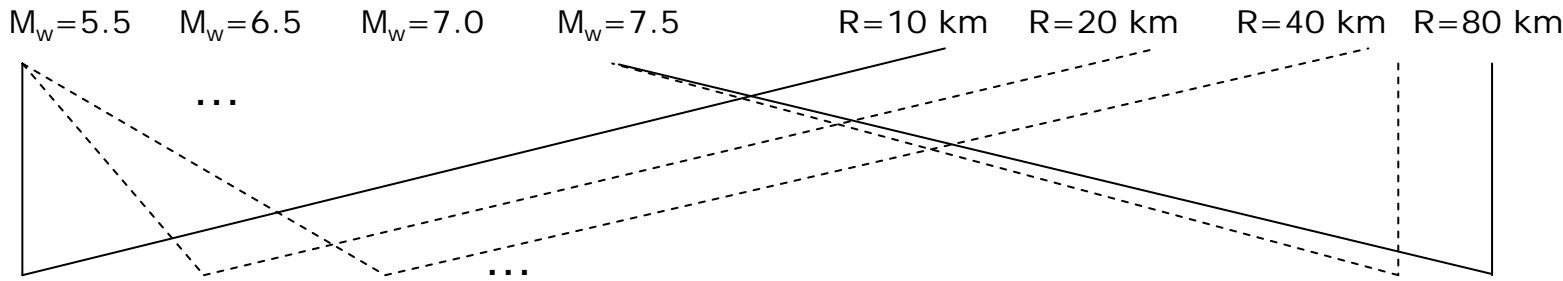


- Gutenberg & Richter (1944)
Magnitude recurrence relationship

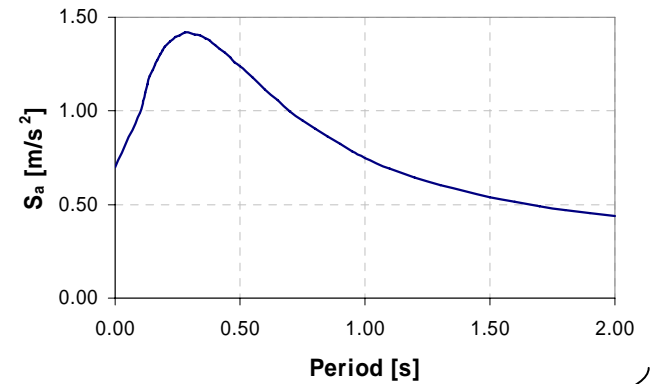
$$\log N_m = a + b M$$

Actions

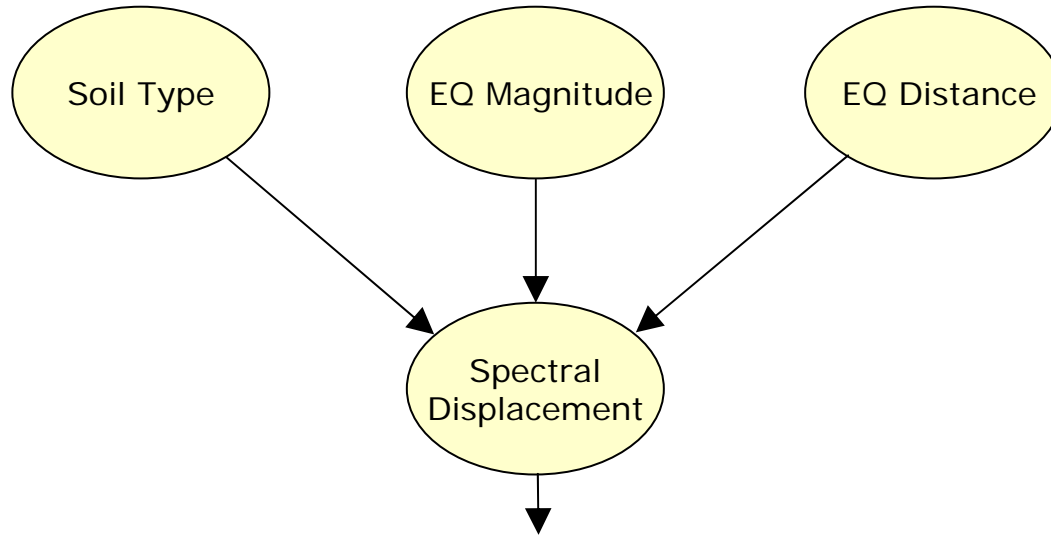
- Attenuation relations

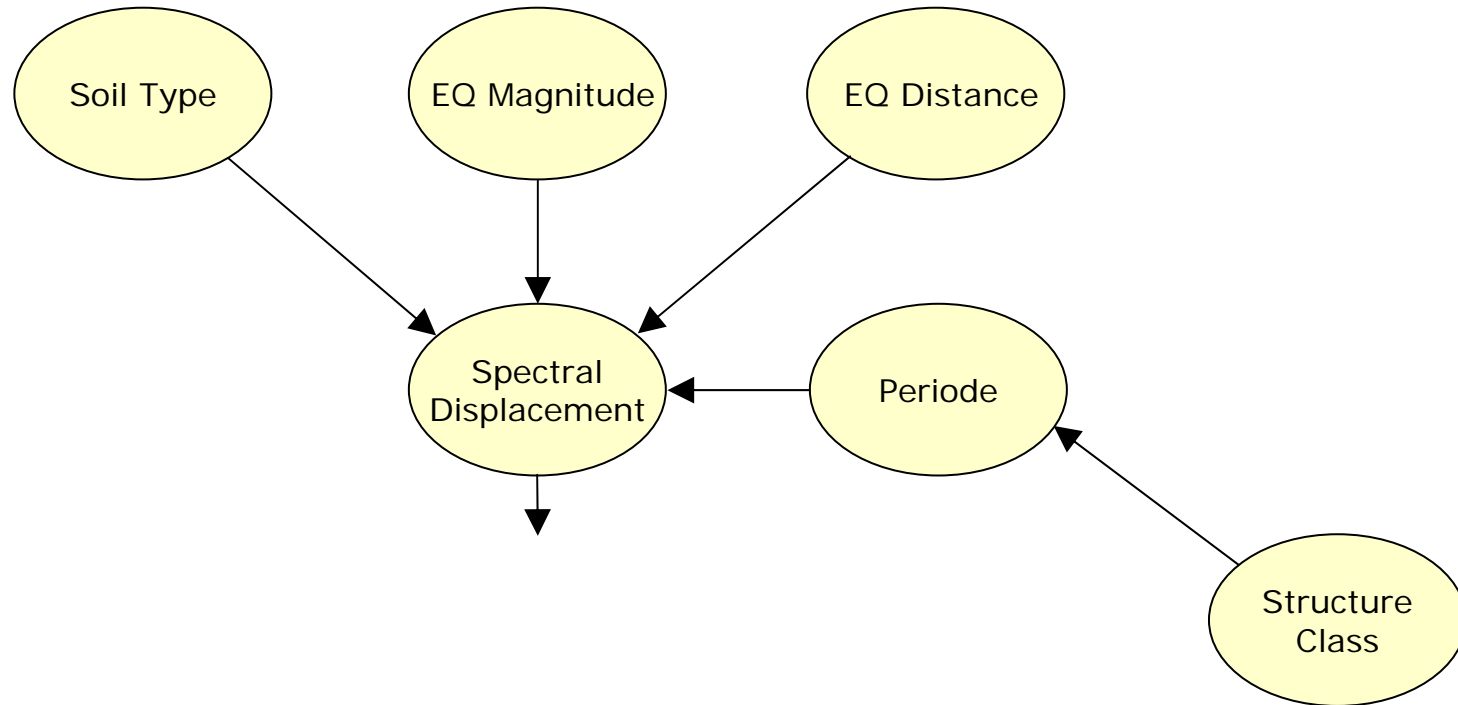


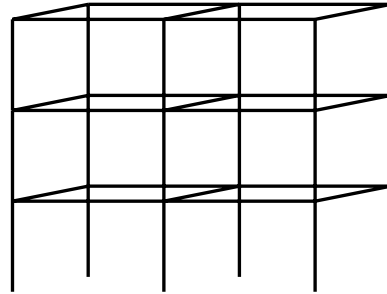
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For each spectra 20 time series were simulated.

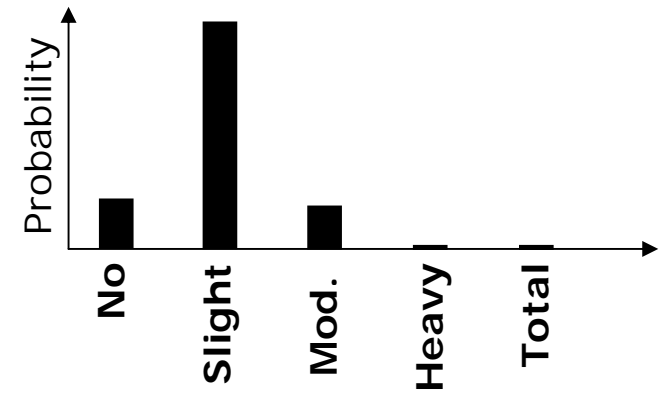
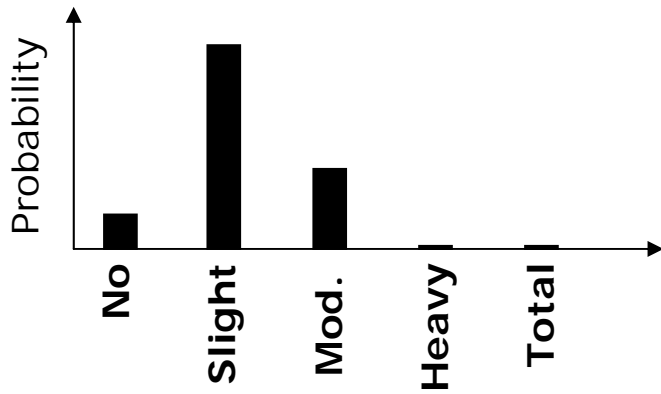
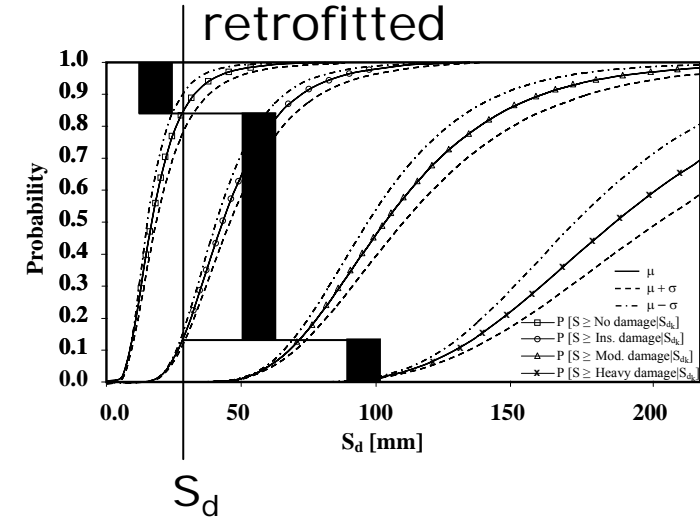
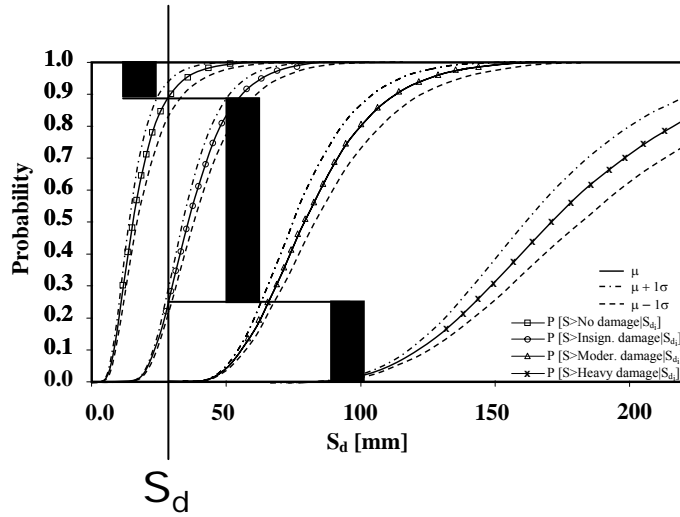


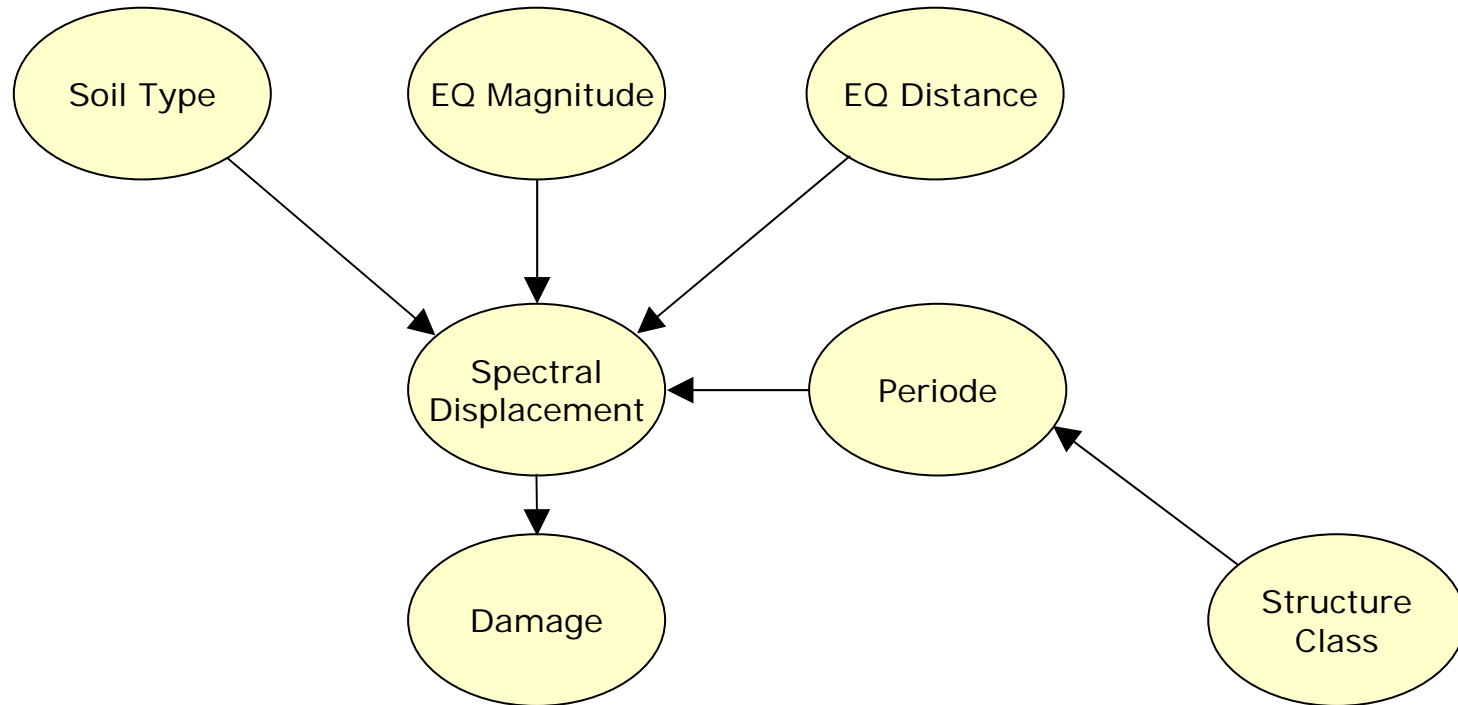




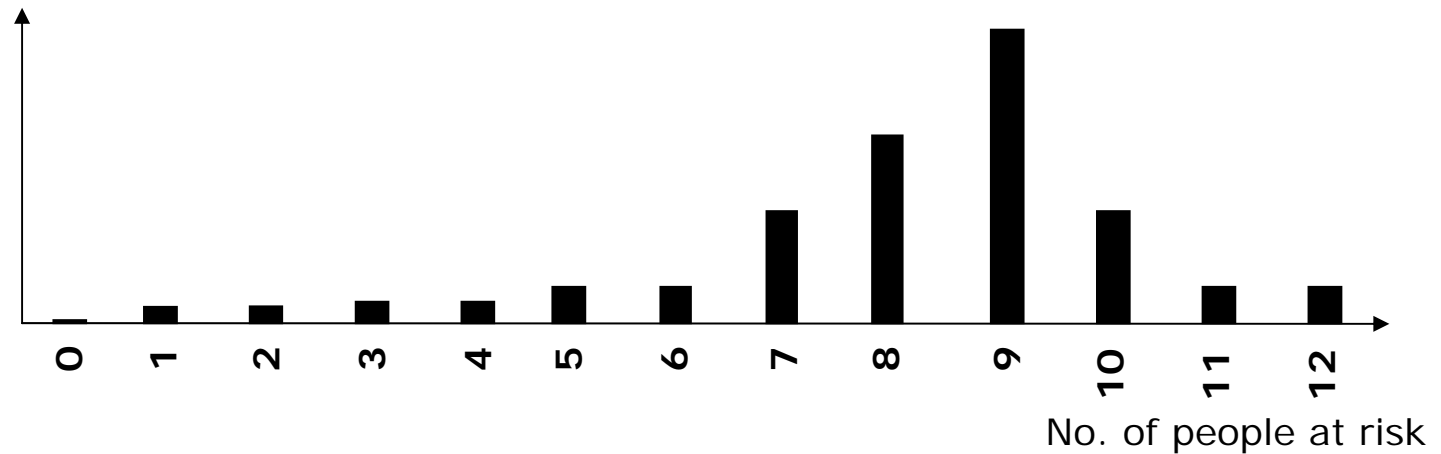
For each time series the maximum interstory drift ratio (MIDR) is calculated by PreOpenSeesPost.

Details will be given in the presentation of Jens-Peder Ulfkjaer.

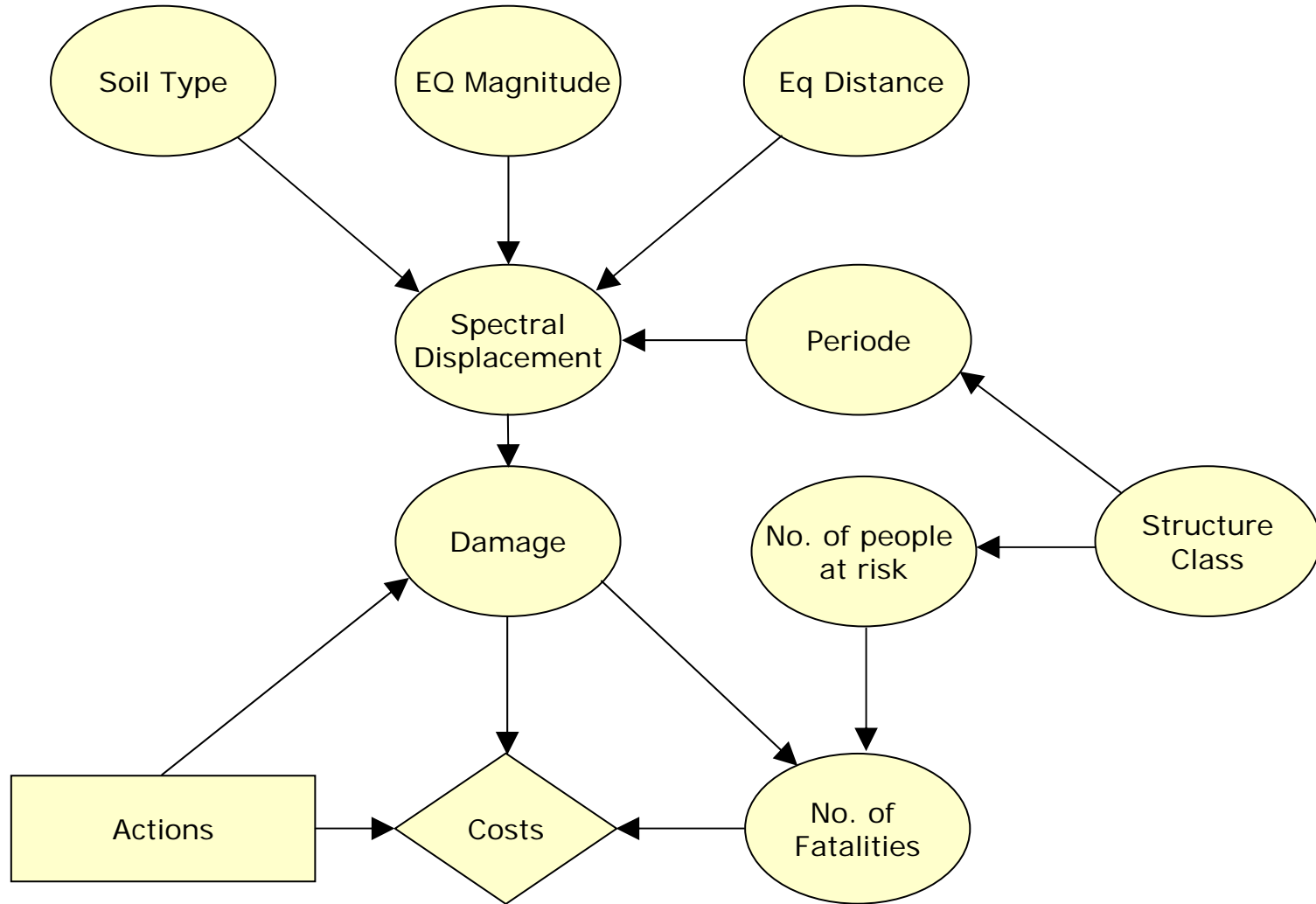




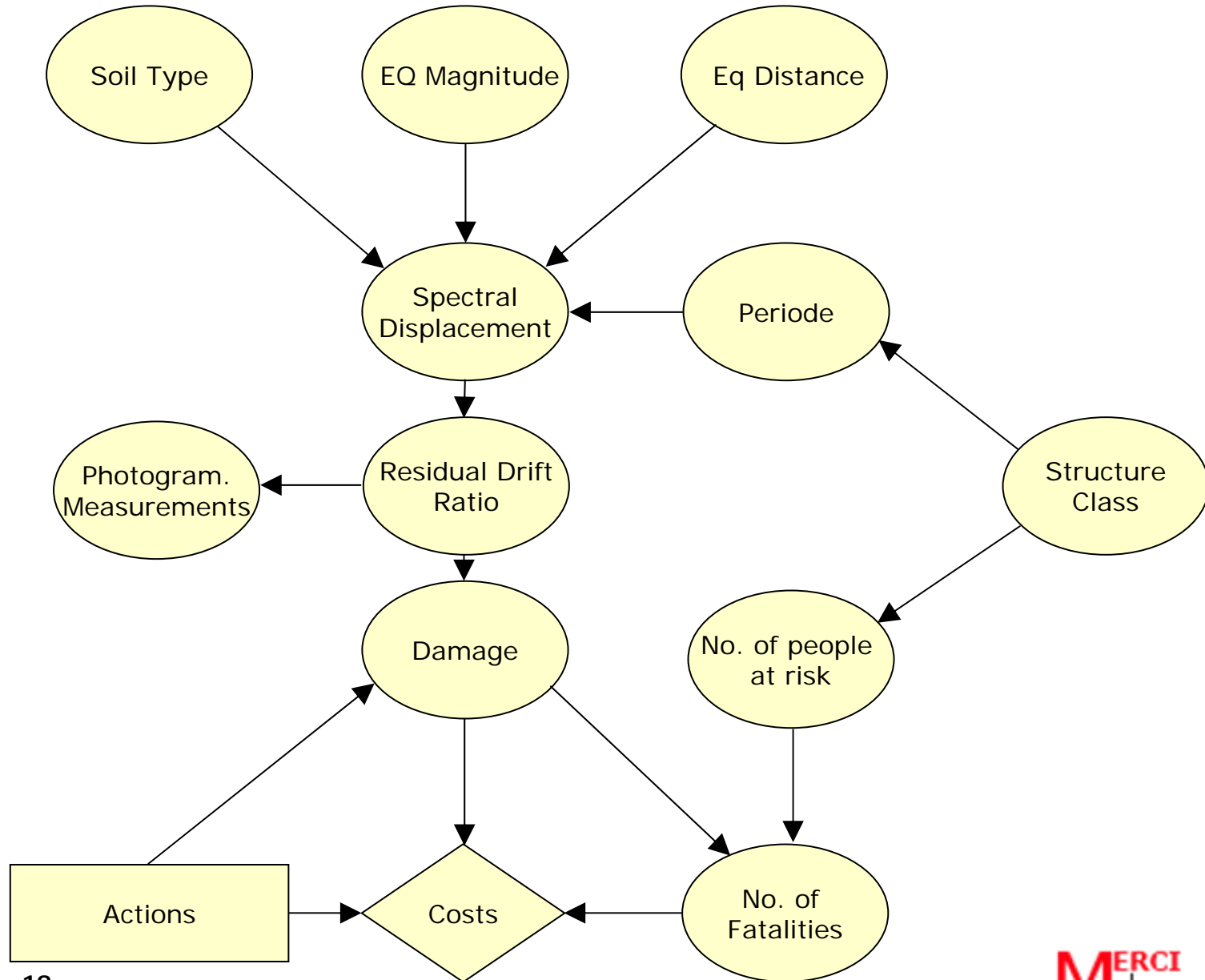
- Distribution of the No. of people at risk is assumed at the moment by engineering judgement.

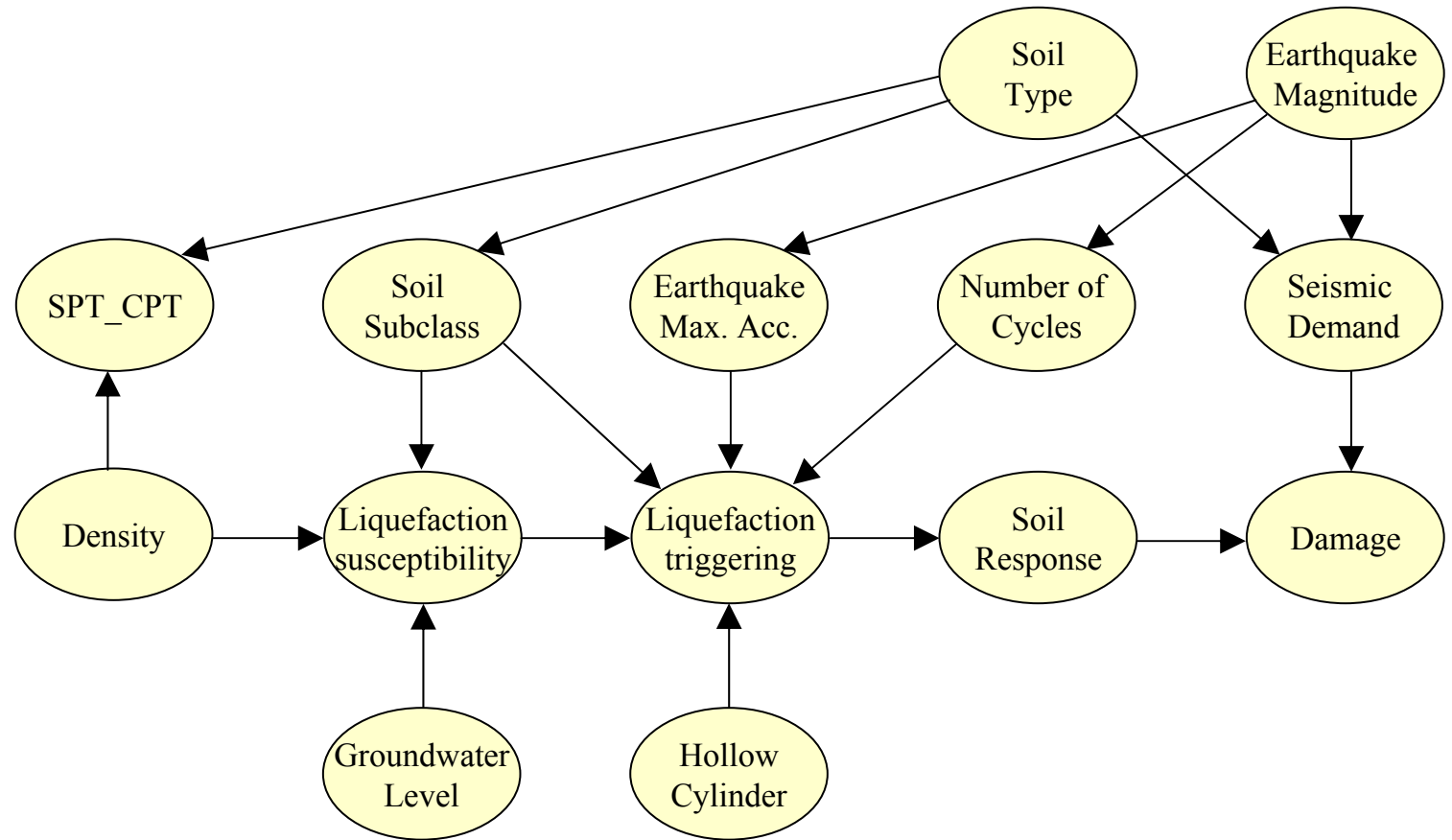


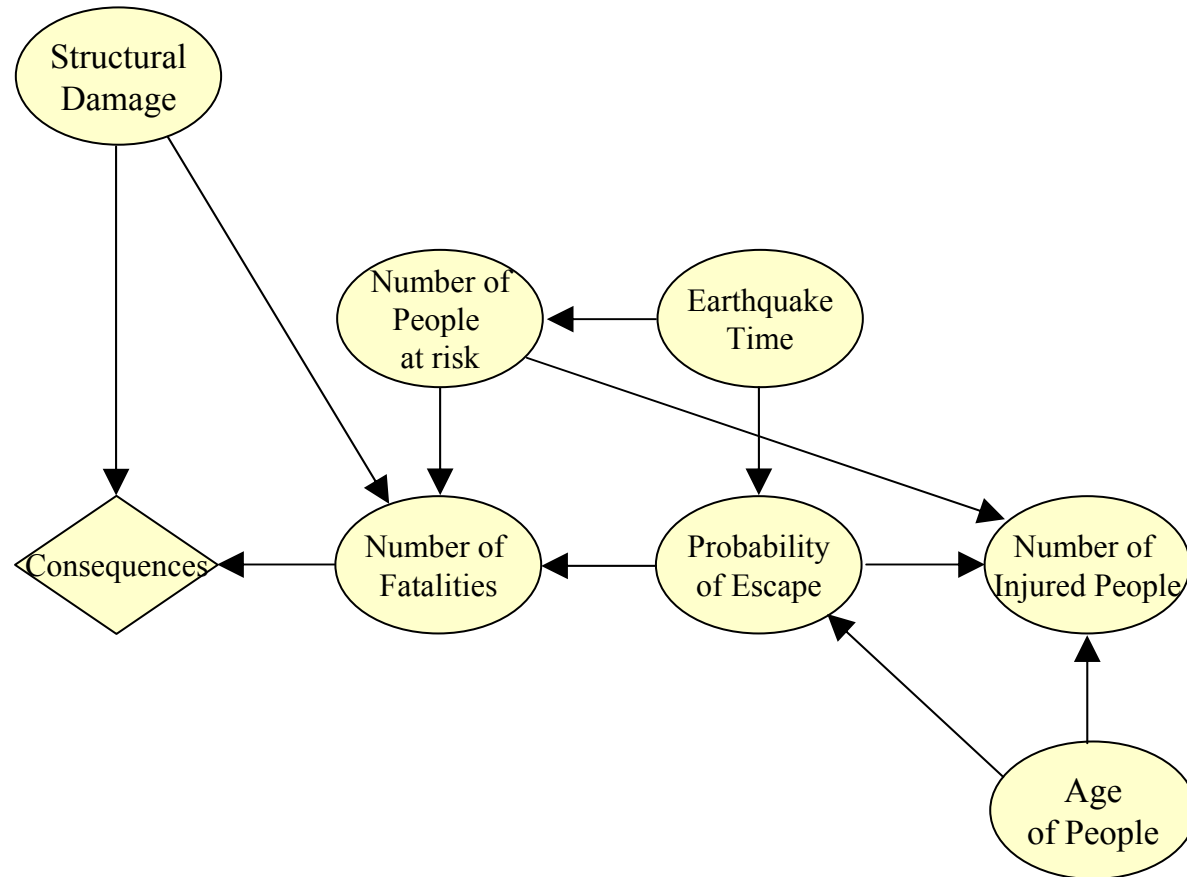
- No fatalities for the damage classes „No damage“, „slight damage“ und „moderate damage“. For „heavy damage“ and „totale damage“ a distribution is assumed.

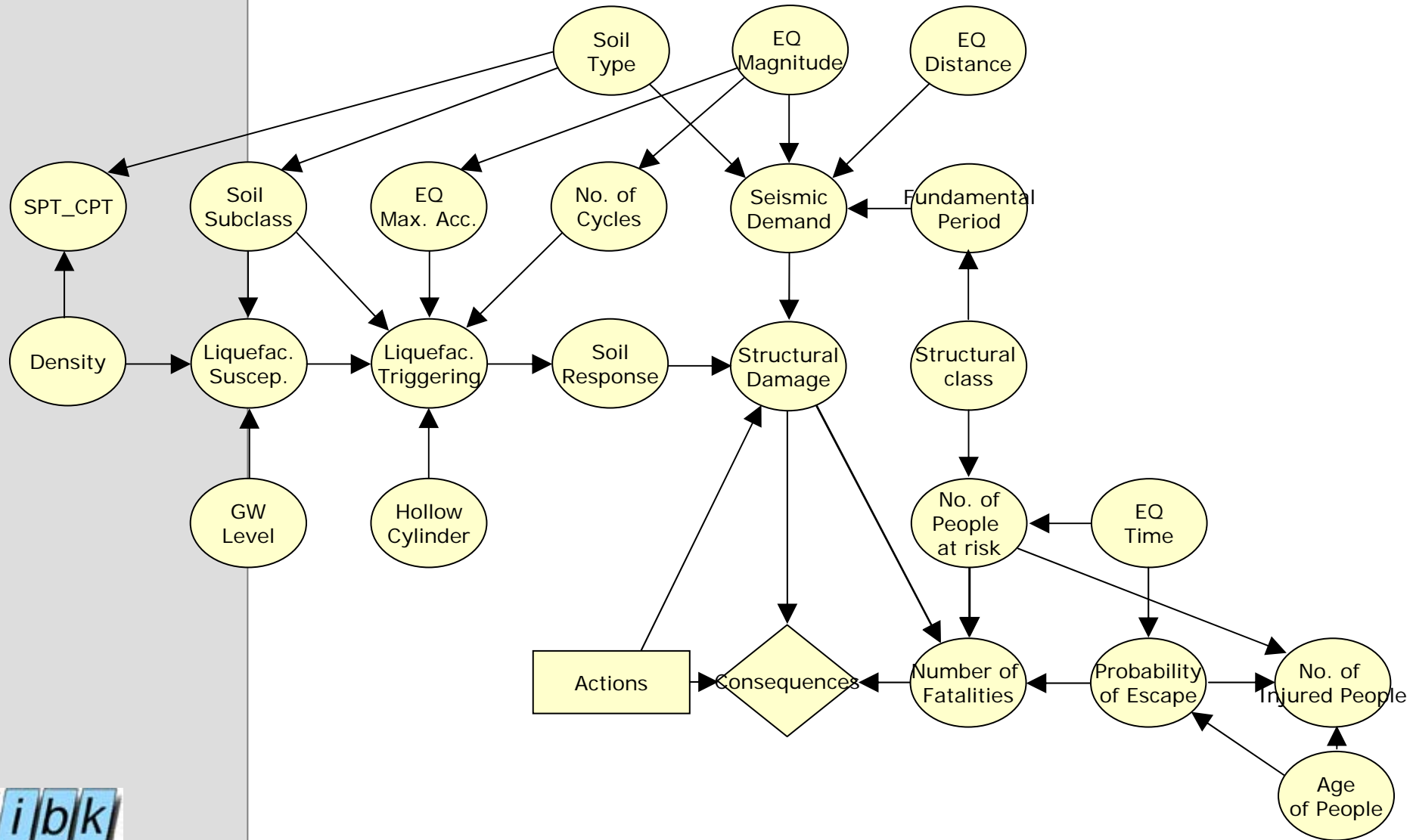


Example: Updating the Network in the „During“ phase









- A systematic approach is suggested by formulating decision problems for three cases in terms of characteristic descriptors (condition indicators), which can be observed and/or measured.
- The Bayesian decision theory provides the mathematical framework for the consistent treatment of uncertainties and consequences.
- Bayesian Probabilistic Networks are utilized for the consistent consideration of causal dependencies and uncertainties prevailing the identified decision problem.
- The modular approach enables the utilisation of different models with varying levels of details.