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# Learning from failure: Research initiatives towards improving safety and reliability of the Swedish railway system

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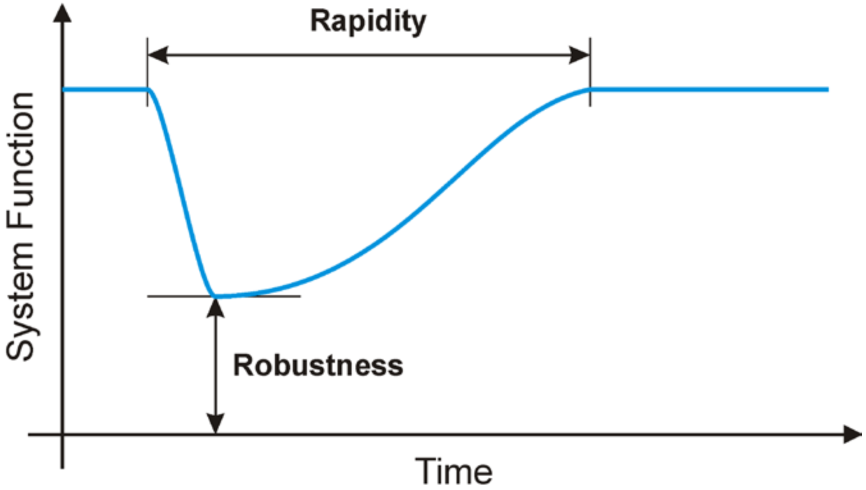
# Introduction

- Overview of ongoing research activities aiming at improving safety and reliability of the Swedish railway system
- 3 case studies will be briefly presented
- Research question forming the starting point for all of the research activities:
  - What can we learn from failures in the railway system?

# Case study 1: Introduction

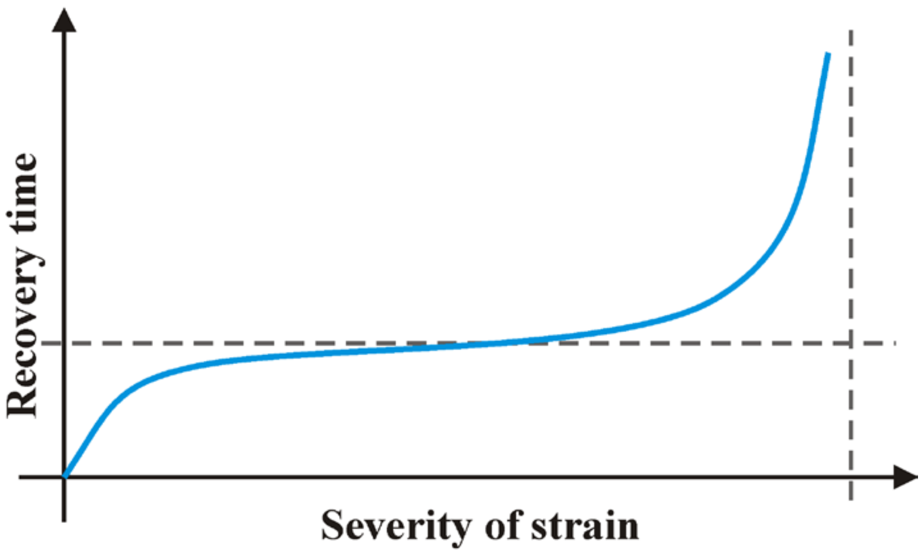
- The first of the three research activities is concerned with the ability to recover from failures affecting the railway system
- Two important aspects for describing a system's resilience (i.e. ability to "bounce back" after failures) are its
  - Robustness
  - Rapidity




- Focus of this case study is on the system's ability to return to normal operation after (large) failures, i.e. the rapidity aspect

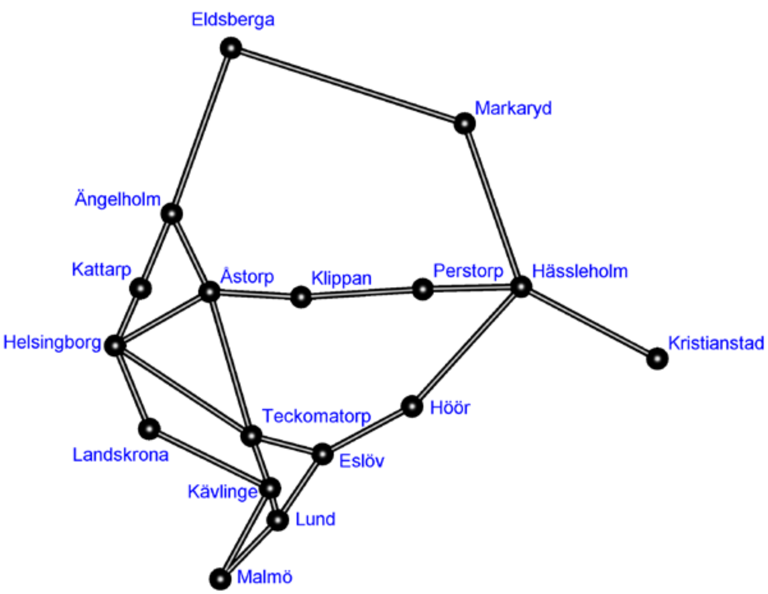
# Case study 1: Response curves

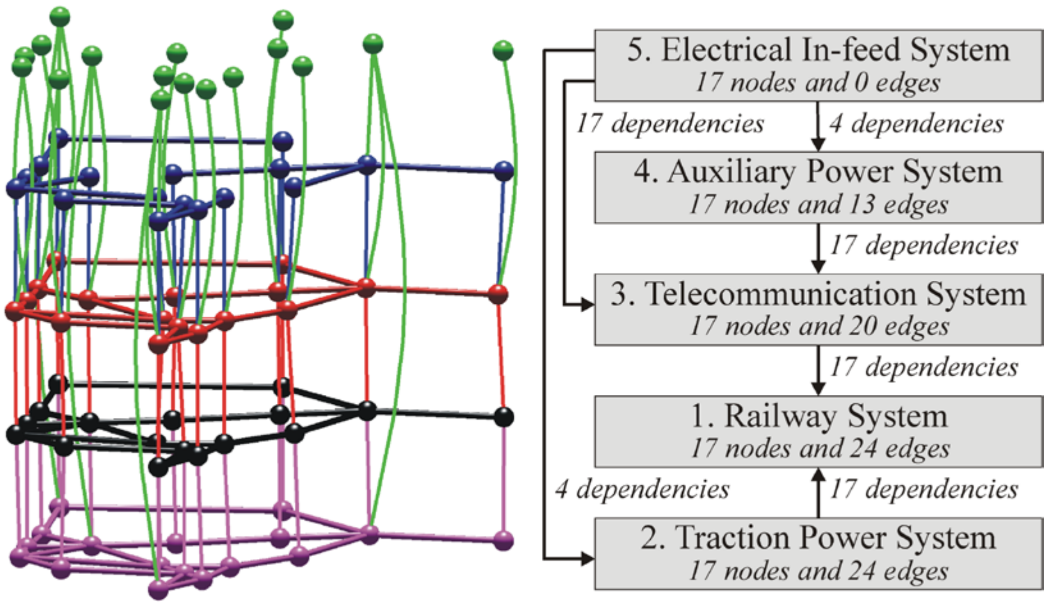
- Particular focus on large failures where knowledge regarding available capacity is limited
- Previous failures (incidents and accidents) are used as a starting point
- By using so-called counterfactual scenarios in table-top exercises the aim is to gain knowledge of the capacity for handling (large) failures
- A workshop with employees from the Swedish Rail Administration has resulted in so-called response curves illustrating the recovery time with respect to the severity of strain
- The shape of the response curve reveal a number of interesting characteristics



# Case study 1: Vulnerability analysis

- The results from the present study are used as a starting point for vulnerability studies of the technical systems
- In this type of study, the use of recovery times are important in order to achieve realistic measure of the system’s overall vulnerability



# Case study 1: Discussion

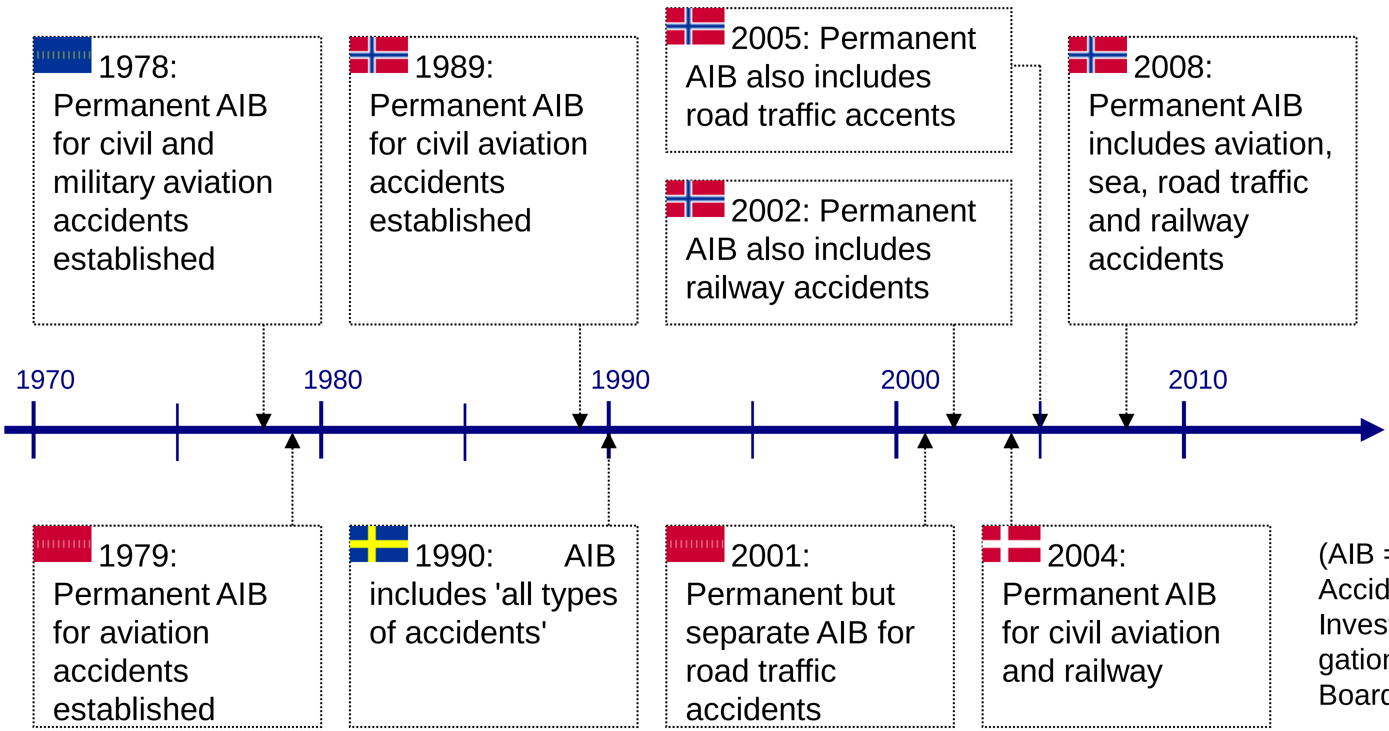
- This case study contribute to improved knowledge regarding the capacity to restore the railway system after failures
- In particular, increased knowledge regarding the maximum capacity for handling failures can be gained
- The results are valuable for the assessment of the railway system's overall vulnerability, e.g. for vulnerability analyses
- This information can be used as a basis for decision making regarding adequate resources in the face of future failures

# Case study 2: Introduction

- Case study 2 also use previous failures as a starting point
- However, in this study emphasis is on *why* these incidents and accidents happen
- The aim is to study how learning from previous failures can be used for avoiding failures in the future
- We should not only aim at avoiding the exact same accident, but to generally improve safety
- Accident investigations constitute an important tool for learning from accidents and incidents
- Case study 2 includes a comparison between the approach for investigating accidents and incidents in Sweden, Norway and Denmark
- Although the societies in general have a number of similarities, the investigation boards differ in some aspects between these countries
- What obstacles to learning from accidents can be identified, stemming from these differences?

# Case study 2: Initial studies

An initial comparison between the accident investigation boards in Sweden, Norway and Denmark show some differences in terms of structure and responsibility




(AIB = Accident Investi-gation Board)

# Case study 2: Preliminary results

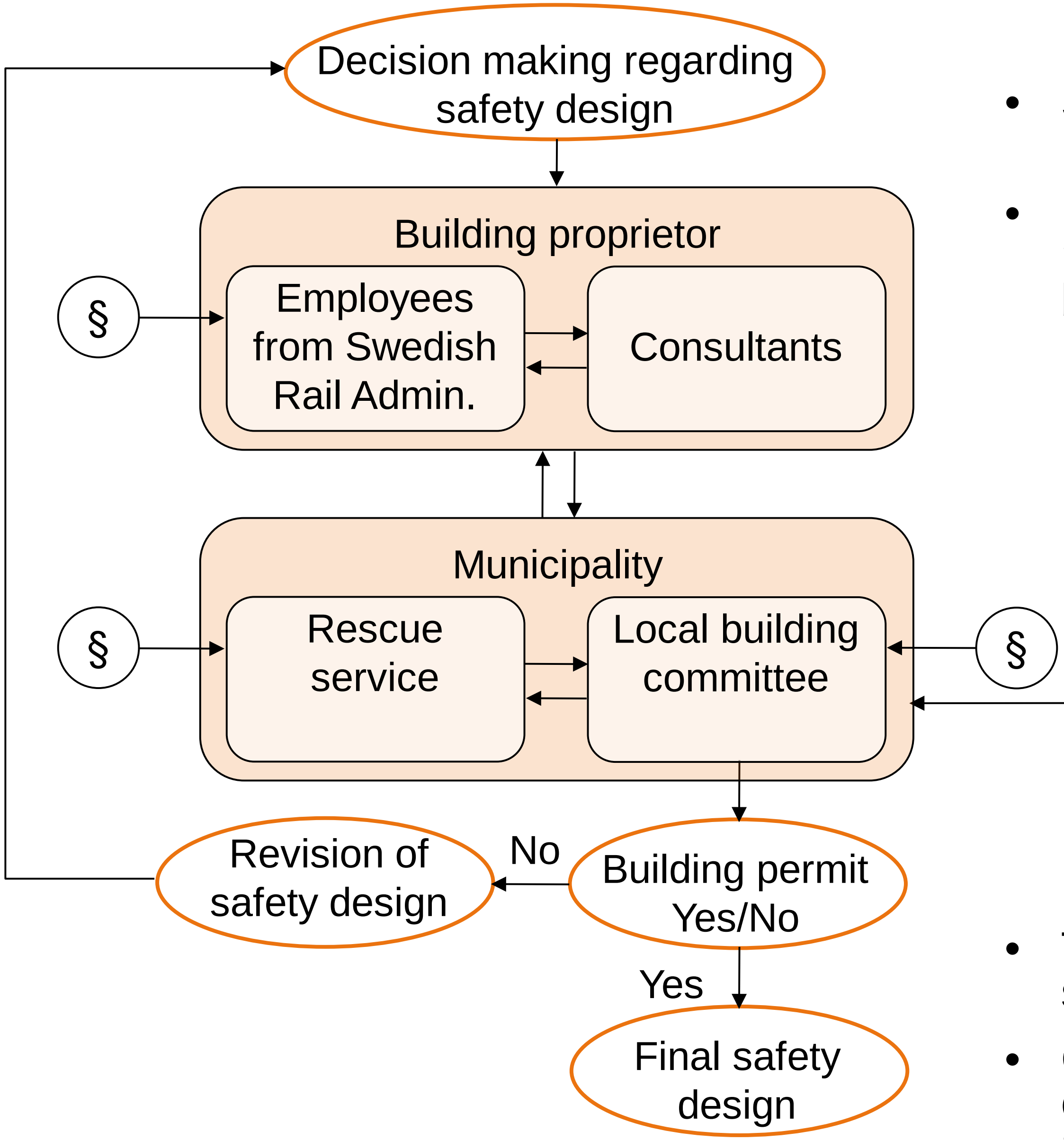
- The preliminary results from this study indicate that some of the factors that influence the ability to learn from accidents include:
  - The structure of the accident investigation board, i.e. the number of investigators, their level and span of skills and competences
  - The mandate of the investigation board, i.e. ability to influence the implementation of recommendations and follow-up activities
  - The investigation method used by the investigators, i.e. what causes that are emphasized, the formulation of recommendations
  - The processing of information between involved actors, i.e. the way that findings in the investigation is conveyed
- Future work include analysis of a number of accident investigation reports issued by the accident investigation boards

# Case study 3: Introduction

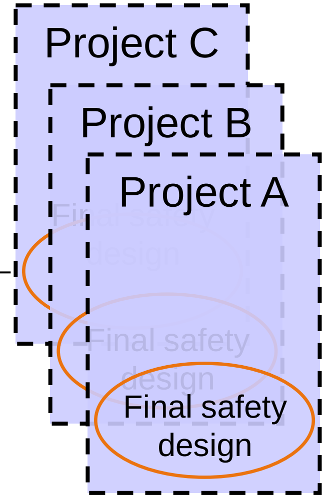
- Case study 3 is focusing on safety investments in railway tunnel projects
- Several sets of guidelines and legislations are applicable for the safety design of railway tunnels in Sweden
- This has resulted in disagreements between different actors involved in the process, due to incompatibility of these legislations
- Attempts to solve disagreements and different views among authorities involved in tunnel projects have not been successful
- The aim of this study is to investigate;
  - how the decision making process and the outcome regarding safety investments is affected by these incompatible legislations, and
  - what bases for decision making that are used in practice

# Case study 3: Method and results

- The study is based on interviews and document studies including six railway tunnel projects in Sweden, consisting of a total of 28 tunnels
- 11 interviews have been carried out with a total of 18 persons
- The results from the interviews show that there has been a substantial focus on safety considerations from an early stage in all studied projects
- Disagreements become evident during the approval of building permit, which is required in order to build tunnels in Sweden




- Several applicable legislations
- Decentralised decision making involving local building committee and local rescue service




- The role of the rescue service
- Comparisons with the outcome from other projects ("precedents")

# Case study 3: Discussion

- Decentralised decision making in questions that are considered to be of national interest put a lot of pressure on local decision makers
- A detailed comparison of the different safety measures in each project shows that no major differences can be identified
- This can be explained by a substantial influence from comparisons with other projects ("precedents")
- Suggestions on different ways of solving the identified problems have been put forward, e.g.:
  - excluding tunnels from the requirement for building permit
  - new attempts for achieving consensus or coordination between authorities
  - clarifying the role of the rescue service

# Conclusions

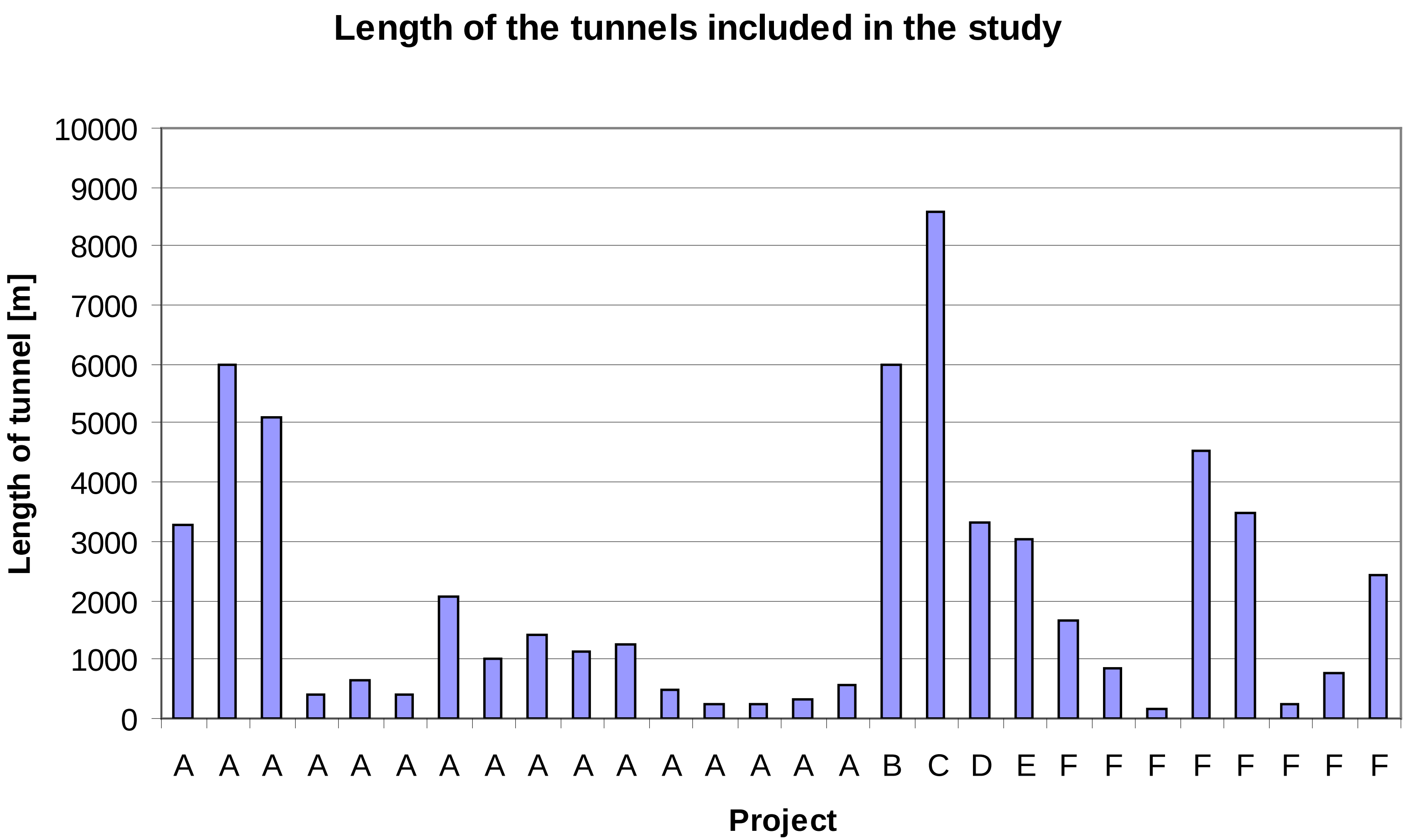
- Several processes that together influence the ability to improve safety and reliability of the Swedish railway system have been identified
- Learning from previous failures is a valuable starting point, both in order to gain knowledge of existing capacity and to make improvements
- The ability for generalization of the results needs to be further addressed
- Although further and more detailed studies are necessary, the different case studies provide valuable input in order to improve the safety and reliability of the Swedish railway system

# Finally…

Thank you for your attention!

Questions or comments?

# Case study 3: Description of studied projects



# Case study 3: Description of studied projects

| Project | Trafic flow per day | Tunnel type | Geographic posistion |
|---|---|---|---|
| **A** | 28 passenger trains and 20 freight trains | Single-track tunnel | Rural area |
| **B** | 420 passenger trains | Two single-track tunnels | City area |
| **C** | 104 passenger trains and 35 freight trains | Two single-track tunnels | Rural area |
| **D** | 8 passenger trains and 24 freight trains | Single-track tunnel | Rural area |
| **E** | 120 passenger trains and 50 freight trains | Double-track tunnel | Rural area |
| **F** | 31 passenger trains and 21 freight trains | Single-track tunnel | Rural area |

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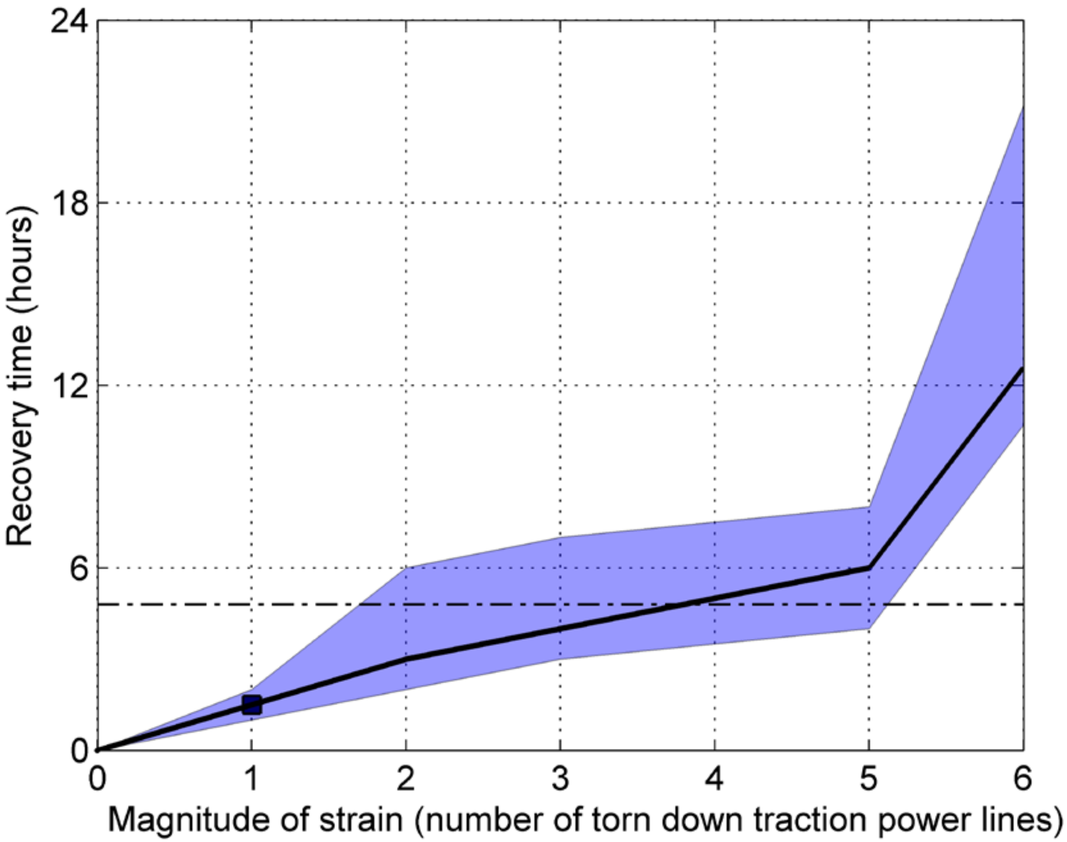
# Case study 1: Empirical study




Blue shadowed field:
estimated minimum and
maximum recovery time

Black line:
estimated most likely
recovery time