Railway robustness in critical situations

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Problem and purpose

The project addresses new demands on Sweden to ensure functioning transports in critical situations (e.g. military mobilization, accidents, extreme weather). The focus is on ensuring railway operations under such conditions when (short-term) capacity is critical.

The project examines

- how capacity has been and may be affected in critical situations
- potential countermeasures to enhance robustness and/or restore capacity
- research needed to enhance capabilities

The project is aimed to show potential and influence policy development regarding transport robustness in critical situations.

Proactive path to robustness

A flowchart for improving robustness. Category examples are used to clarify the category, not to indicated prioritized areas or preferred actions.

Identify key critical situations

Chart potential causes for disruptions
natural (e.g. snowstorm)
provoked (e.g. sabotage)

Estimate probability
natural disturbances: use historical data
provoked: estimate from efforts required to cause disruption

Estimate consequences
case-by-case since dependent on event, severity, location, time

Prepare to reduce impact of critical situations

Prevent
redesign to reduce/eliminate risk (e.g. improved wheel design)

Increase redundancy
alternative in case of component failure (e.g. brake systems)

Increase robustness
decrease risk of component failure (e.g. decreased load)

Increase resilience
component recovery from failure (e.g. temporary repair)

Evaluate operational limits
under which conditions can traffic progress in critical situations

Plan for disruptions in critical situations

Establish action plans in case of disruption
general for component type (e.g. clamp switch)
specific for individual asset (e.g. use alternative route)

Establish recovery plans
general for disruption type (e.g. derailment procedures)
specific (e.g. 3D-printing of replacement part)

Act in case of critical situation

Detect (potential) cause(s) for disruption before major consequences occur (e.g. wheel load detectors)

Decide which risk and disruption levels are permissible, and how do we achieve these (e.g. reduced speed operations)

Activate suitable action and recovery plan(s) including traffic arrangements and communication

Results

Knowledge and tools to aid in the different steps of the flowchart e.g. by predicting effects of different actions have been developed. Some examples of research results are given in the references, which are all partly funded within the project.

Case studies

Real life examples of critical conditions. Examples of recent actual challenges and potential improved proactive measures are indicated

Derailment

CHALLENGE: no alternative route, rapid restoration needed
PROACTIVE: design and maintenance actions, derailment sensors, storage of replacement track components, restoration plans etc

Track bed collapse

CHALLENGE: alternative route with limitations
PROACTIVE: improved drainage, pre-evaluate alternative routes for increased operational demands under severe and unusual conditions

Massive snowfall

CHALLENGE: widespread disturbances e.g. due to clogged switches
PROACTIVE: plan snow removal, identify key switches etc, plan for operations with limited flexibility (e.g. clamped switches)

Storms

CHALLENGE: current practice closes traffic on unsecured lines
PROACTIVE: increase removal of trees close to track, carry out detailed risk analyses also comparing to risks of alternate traffic

Risks of forest fires

CHALLENGE: recent action with speed reductions in northern Sweden
PROACTIVE: remove vegetation close to track, identify malfunctioning brakes, evaluate actions that will reduce risks of malfunctioning brakes

Figure 2: Derailment on the Iron Ore line 2023. Embankment collapse 1918. Undercarriage and brake on Iron Ore loco covered with ice.

References

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