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Climate Change Adaptation for GeoRisks Mitigation of Railway Turnout Systems

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Abstract

To enhance rail operational flexibility, railway turnouts are special track systems, which are designed to divert or change a train from a particular direction or a particular track onto other directions or other tracks. In reality, the railway turnout is commonly built on complex track geometry and graded terrain, which makes it one of the most unique and critical railway infrastructures. The physical constraints and complexity of turnout systems cause various risks and uncertainty in rail operations. This study critically analyses emerging geotechnical risks on turnout systems considering all aspects that can potentially result in impaired reliability, availability, maintainability and safety (RAMS) of the turnout systems. The annual derailment incidents have been evaluated to identify emerging risk factors. Not only do these incidents yield operational downtime and financial losses, but they also give rise to the casualties and sometimes the loss of lives across the world. In particular, the climate change risks on geotechnical aspects of the turnout systems have been highlighted. This paper thus presents how turnout components work as a system, the diversity of emerging risks considering natural hazards and global warming potential to the system. In addition, it highlights the climate change adaptation strategies for georisk mitigation of the railway turnout systems in order to improve RAMS of the railway turnouts and crossings, focusing on trackbed failures on the systems.

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Keywords: natural hazards; bayesian network; railway turnout; switch and crossing; trackbed failures.

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1. Introduction

As a key asset of railway infrastructure, turnouts represent the junctions in trackwork where lines diverge or converge. These infrastructures are constructed to enable a rolling stock to divert one track to another. A turnout consists of a number of mechanical parts, electric or hydraulic installments, concrete or wooden ties and trackbeds. In order to ensure a smooth turnout operation, all turnouts should be working in harmony in various operational conditions, yielding both complexity and variable risks for railway operators.

Turnouts were revealed to be systems vulnerable to the environment; thus, the diversity of emerging risks associated with natural hazards and global warming requires investigation [1]. The environmental impact varies from one part of the system to another [2]. In other words, the question regarding to what extent the vulnerability of a system's parts can be influenced through environmental impact should be clarified in order to maximise operational productivity and smoothness of railway turnout operation.

One of these vulnerable systems is the trackbed. In this paper, trackbed failures of turnouts were observed at various sites wherein different climate patterns are summarised and revealed. To determine the solid relation between environmental patterns and railway turnout trackbed, all derailment cases suspected as being caused by poor trackbed and reported as derailment caused by climate/weather are investigated. The results of investigation—causal relations—are presented through this paper. Thus, this study allows such relations to be modelled and predicted by numerous risk analysis techniques, each of which helps to minimize the risk in a particular part of turnouts [3]. The paper concludes with an analysis of possible scenarios and suggestions for countries with different climate patterns to reveal geo-risks by which challenges can be countered.

2. Railway turnouts

The word "turnout" in this paper refers to all track formations enabling rolling stocks to be guided from one track to another at a railway junction so as to avoid "switches" or "points", both of which terms in literature might sometimes be confusing. There is a large variant of railway turnout design.

2.1. Turnout types

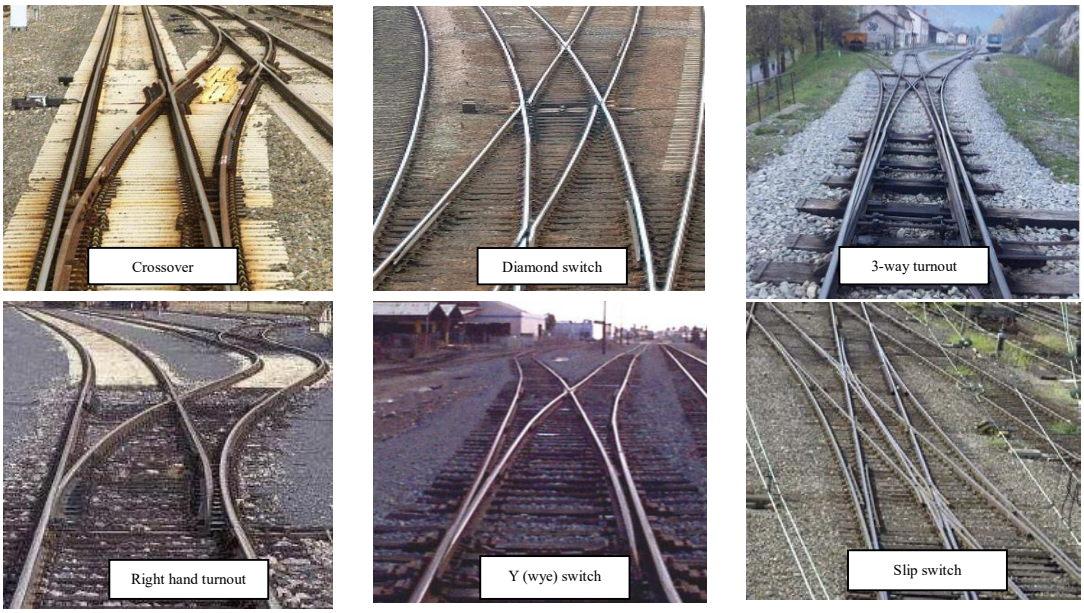

Fig. 1 Common types of turnouts, the most used in railway operation.