MODELS AND COMPUTATIONAL ALGORITHMS FOR RAILWAY TRACK GEOMETRY

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Abstract

The implication of train derailment is enormous including loss of life, economic loss, damage to property and environmental impact, rail transport asset management and safety is an interesting area for stakeholders and present ample opportunity for researchers. This research presents a thorough review of studies on railway track degradation, causes of a derailment, maintenance strategy and a discussion of different models and computation algorithms.

1. Introduction

The railway is one of the important means of transportation for cargo and passengers in the society due to its cost, relative safety, and carbon emission reduction potential. The railway system is a complex one consisting of track, safety, telecommunication and power distribution. The expansion of economic activities has placed unprecedented demand on the railway industry that requires increased capacity in terms of tonnage and speed which has led to a higher degradation rate and maintenance costs for railway assets. Over the years new technologies and improved safety standards are continuously being introduced, but the accident still occurs. According to Selig and Waters, (1994), one of the criteria to ensure the safety of the railway and acceptable railway service is to maintain a high quality of railway track geometry.

Jovanovic (2004) pointed out that the railway track geometry is a significant part of railway construction due to the following reasons:

- Railway track geometry is generally used to set off the maintenance and renewal of the track.
- The deterioration of other track elements directly related to the condition of the railway track geometry.

2. Objectives

- Carry out a detailed literature review of proceedings and journal articles on the model and computational algorithm for railway track degradation and maintenance.
- Identify and classify the models and computational techniques used in the literature.
- Suggest future research opportunities that can be explored based on the literature review.

3. Structure of the railway track

The structure of a typical railway track consists of different components as shown in figure 1 below, the interaction of these components is dynamic and complex playing a critical role in the safety and performance of the railway infrastructure.

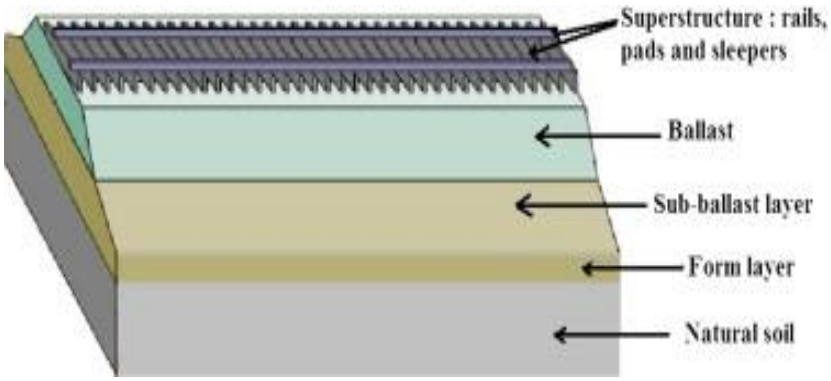

Figure 1: Structure of the railway track. Source: [Rhayma et.al 2013]

One of the important components of the railway track structure is the railway track geometry; the three-dimensional layout on which the train travels. The railway track geometry deteriorates over time mainly due to the effect of dynamic loads exerted by the train, the governing mechanism of this phenomenon is complex. Jovanovic et.al (2004) observed that the complexity arises from the fact that different heterogeneous factors such as soil type, track slope e.t.c affecting Railway track geometry degradation might change over track length. Poor quality of railway track geometry may result in speed reduction, higher maintenance cost and higher degradation rate of the other railway components.

Two approaches have been used to model the deterioration of the railway track geometry: mechanistic or statistical approach. In a statistical approach, the theory of statistics and probability is used to model railway track deterioration, this approach requires ample track geometry data, it can cope with several descriptive factors, also the stochasticity in railway track degradation can be considered under this approach although the physical information of the railway track cannot be incorporated. While mechanistic approach considers the mechanical responses in the track that leads to deterioration, it is based on the physical information of the railway track, requires few geometrical data but it is not able to cope with the innate uncertainty of the track geometry behavior.

Robust rail maintenance is a major concern for rail industry policymakers all over the world. This major mode of transportation has long life span as one of its important characteristics; however, its useful life is greatly dependent on the maintenance and renewal approach adopted during its life cycle. According to R.B Faiz (2010), rail maintenance actions are reactive i.e maintenance actions are carried out after a defect has been identified, this type of strategy is costly and could also lead to safety concerns, but this challenge can be overcome through the use of an accurate railway track geometry reliability prediciton model.

4. Lessons Learned

After carrying out a detailed review, we have observed the following:

- Finding a proper track geometry quality indicator is a challenge.
- Few studies have been done to develop an integrated railway track geometry model that combines the mechanistic and statistical approach.

- An acceptable railway track geometry degradation model needs to be developed. This model should consider the innate uncertainties of railway track geometry behavior
- The mode of recovery of railway track geometry after maintenance action has been carried out should be studied and modeled.
- There is a need to develop a composite index in which the defects associated with railway structures and railway track geometry are considered together.

5. References

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