Proceedings IRF2018: 6th International Conference Integrity-Reliability-Failure
Lisbon/Portugal 22-26 July 2018. Editors J.F. Silva Gomes and S.A. Meguid
Publ. INEGI/FEUP (2018); ISBN: 978-989-20-8313-1

PAPER REF: 7218

EVALUATION OF DYNAMIC WHEEL LOAD CONSIDERING BALLAST FOULING DURING TRAIN PASSAGE

Chayut Ngamkhanong[1,2(*)], Keiichi Goto[3], Sakdirat Kaewunruen[1,2]

[1]Department of Civil Engineering, The University of Birmingham, U.K.
[2]Birmingham Centre for Railway Research and Education, The University of Birmingham, U.K.
[3]Railway Dynamics Division, Railway Technical Research Institute, Japan
[(*)]*Email:* cxn649@student.bham.ac.uk

ABSTRACT

Dynamic wheel load, which has a large magnitude in short duration, can be induced by the wheel/rail irregularities. Due to the increase of traffic and load demands, these can accelerate the deterioration of railway track. In addition, ballast fouling, which is a serious concern in the railway system, may increase the dynamic wheel load due to the reduction of ballast modulus. This paper demonstrates the effects of fouled ballast in both dry and wet condition on the dynamic wheel load generated by train. It is noted that the ballast is assumed as dry and wet fouled conditions by different values of ballast modulus.

Keywords: dynamic wheel load, impact load, fouled ballast, ballast fouling, wet ballast.

INTRODUCTION

At present, railway track structures often experience harsh environments and dynamic loading conditions due to wheel/rail interactions associated with abnormalities in either a wheel or a rail (Remennikov, 2008). Due to the increased traffic and load demands, train speed also plays a significant role in the increase of impact load along the rails. The higher impact load can induce track deterioration. The most significant track deterioration is located on ballast (Ngamkhanong, 2017). Ballast deterioration and fouling are serious concerns in the railway system and can be caused by repeated dynamic loadings from train, which lead to crushing ballast that is in contact with sleepers. The water is retained in the ballast layer as the percentage of ballast fouling increases.

Based on the relevant literature, non-invasive measuring technique has been used to estimate the ballast and sub-ballast modulus using seismic Raleigh waves (Stark, 2016). It was found that the ballast modulus can be reduced significantly when the fouled ballast was in wet condition. This paper presents the effects of fouled ballast in dry and wet conditions on the dynamic wheel load generated by high speed trains. Moreover, wheel irregularities, which induce high impact load, are considered. DTRACK software is used for simulating the wheel dynamic load with a half of single bogie with two wheels running on coupled model with different speeds (Cai, 2006). Dynamic track responses, impact load and displacement, considering fouled dry and wet ballasts are presented and compared.

RESULTS AND CONCLUSIONS

The study results exhibit that the fouled ballast in wet condition has a significant effect on the increase of wheel impact load. Moreover, the increase of train speed can also cause the higher

wheel load. This leads to the higher track settlement and deterioration. The understanding from this paper will help improve the practical maintenance issues and enable predictive track maintenance regime in railway industry.

ACKNOWLEDGMENTS

The authors are sincerely grateful to the European Commission for the financial sponsorship of the H2020-RISE Project No. 691135 "RISEN: Rail Infrastructure Systems Engineering Network", which enables a global research network that tackles the grand challenge of railway infrastructure resilience and advanced sensing in extreme environments (www.risen2rail.eu).

REFERENCES

[1] Cai Z. DTRACK V2.0.5081. Dynamic analysis of rail track structures. Rail CRC, Central Queenland University, Building 30, Bruce Highway, Australia, 2006.

[2] Ngamkhanong C, Kaewunruen S, Baniotopoulos C. A review on modelling and monitoring of railway ballast. Structural Monitoring and Maintenance, 2017, 4(3), pp. 195-220.

[3] Remennikov AM, Kaewunruen S. A review on loading conditions for railway track structures due to wheel and rail vertical interactions. Structural Control and Health Monitoring, 2008, 15(2), pp. 207-234.

[4] Stark TD, Wilk ST, Thompson HB, Sussmann TR, Baker M, Ho CL. Evaluating Fouled Ballast Using Seismic Surface Waves. In Proceedings of the 2016 Joint Rail Conference, Columbia, SC, USA, 12-15 April 2016; American Society of Mechanical Engineers: New York, NY, USA, 2016.