Design of Advance Compacting Tool for Railway Track: A Review

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Abstract— Maintenance has long been an important part of rail roading. Under repeated loading from traffic the track progressively moves, causing deviations from the desired vertical and horizontal alignment. Compacting is the process to restore the geometry and rearrange the ballast under the sleeper to keep the track in position and provide it with a homogenous ballast bed. The track geometry should be measured regularly or at least the track should be compacted at regular intervals to ensure that trains are able to travel safely at the normal speed of line. This paper deals with the design modification of the compacting tool used in compacting machine to restore geometry and rearrange the ballast. In this project we will be creating CAD model of the existing compacting tool and determine the stresses and failures occurring in tool. After detailed study and analysis on existing tool we will modify and perform analysis for the improvement of the compacting tool for minimum stresses and failures. Thus comparing the results for the both modified and the existing tool, the tool with the minimum stresses will be taken into consideration.

Key words: Tamping Tool Failure, Tamping Process

I. Introduction

Railway sleepers (Track) are generally laid on a sub-structure that consists of two or more layers of different materials. The top layer (below the sleepers) is a layer of railway ballast.

Railway ballast is one of the most important components in a rail track. It is a crushed granular material that supports the rails and sleeper. Various types of materials are used as ballast such as granite, limestone, or basalt. The chosen type of ballast material usually depends on the local availability.

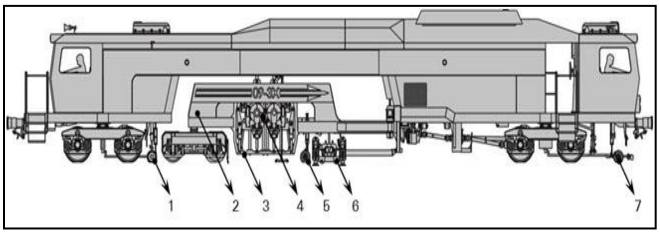
Under repeated loading from traffic the track progressively moves, causing deviations from the desired vertical and horizontal alignment.

The track geometry must be measured frequently or at least, the track should be compacted at frequent intervals to ensure that trains are able to travel safely at the normal speed of the line.

When using inferior machines or other manual Compaction methods, geometry is corrected using track jacks and the visual judgement of the Track Master. These methods are unable to provide the high quality or durability required for a modern railway line.

On any modern railway today, ballast settling machines with automated lifting, lining and synchronised compaction on open track, turnouts, checked rail sections, splice joints etc. is essential for maintaining the track at the required standards.

II. Compaction Unit Components



The most important working components of a ballast settling machine are shown in figure.

1) Rear Measuring Trolley
2) Satellite (Continuous Action)
3) Compaction Unit Frame
4) Compacting Unit/s
5) Centre Measuring Trolley
6) Lifting and Lining Unit
7) Front Measuring Trolley

III. Literature Review

Parametric Analysis of New Tamping Device Based on the Mathematic Modeling [1] The requirements of higher train speed, safety and more smooth and comfortable travelling are increasing strongly. This leads the need of predictive maintenance. Tamping machines have been used for this purpose. Tamping machines on the market are mostly mechanically driven. A new hydraulically driven tamping device is proposed to overcome the limitations of mechanically driven machines. The results show that new tamper can meet the design requirement and the flexible adjustment of amplitude and frequency is realized.

In this article, a new type of rotary valve is designed to improve the control of oscillating tamping cylinder. Parametric analysis is carried out by establishing mathematic model.

Railway track settlements, Tore Dahlberg [2] This review deals with railway ballast and railway track settlements. This article presents some mathematical and numerical methods dealing with the static and dynamic loading of the track due to interaction of train, track, and sub-structure. The report has been synthesized for the Brite Euram project SUPERTRACK (Sustained performance of railway tracks). One aim of the SUPERTRACK project is to contribute to the understanding of the fundamental physical behaviour of railway ballast when used in track sub-structure.

Ballast tamping tool for attachment to a reciprocating tamping drive of a ballast tamping machine [3] Ballast tamping machine comprises a shaft having an axis and an upper end affixed to the tamping drive, a tamping blade detachably mounted on a lower end of the shaft, the tamping blade having a ballast tamping front surface, an opposite rear surface and an upper edge between the surfaces, and a plug-in, formatting connection for detachably connecting the tamping blade to a lower end of the shaft and defying a recess. The plug-in connection comprises a plug projecting from the lower shaft end and a connecting part at the rear tamping blade surface form fittingly connecting the tamping blade to the plug.

The present invention relates to a ballast tamping tool for attachment to a reciprocating tamping drive of a ballast tamping machine.

Discrete Element Method Simulation of Railway Ballast Compactness During Tamping Process [4] In this paper, based on analysis of tamping principle, the discrete element analysis model of railway ballast is created using the discrete element method, numerical simulations are performed to study the change of railway ballast compactness during tamping process. This paper presents the motion trend of stone ballasts as the change trend of railway ballast compactness in qualitative analysis, and the distance between stone ballast and sleeper as the change index of railway ballast compactness in quantitative analysis. By comparing simulation data of different vibration frequencies, an optimal vibration frequency is obtained. The simulation results accord with the actual industrial tamping operation, which verifies that the discrete element method is an effective method to evaluate the change of railway ballast compactness during tamping process.

Current practice in ballast maintenance & ballast maintenance & renewal [5] In this paper they have described the whole introduction of ballast , constituents of ballast , failure of ballast material , reasons for failure of ballast material , is discussed . They have also described about the current methods and traditional methods adopted for its maintenance, Current ballast renewal methods and substantial challenges faced.

IV. Identified Gaps in the Literature

Many researchers have presented their work on development and optimization of Tamping machine considering limited parameters, calculations on mechanism, and methods of failure was also observed during our study. Very limited and small amount of work for design and analysis has been observed and there is still a need for further work. Understanding the problems this work is mainly focused on design and analysis of Tamping tool.

V. Problem Formulation

The compaction arm is connected to the main body using a sleeve and a pin. This joint is a pivot point. The upper end of the arm is connected with hydraulic cylinder and the lower end is connected with compacting tool. During the working of ballast settling machine, the compacting Unit due to its self-weight penetrates through the ballast bed to the desired depth, after which the hydraulic cylinder moves outwards causing the compaction arm to move inwards. This inward movement of arm squeezes the ballast and fills the void beneath the sleeper. Due to reactions from the self-weight and Hydraulic force, the compacting tool fails under the repeated cyclic loads prematurely. There is a need to replace the complete compacting tool in very short intervals. The cost of replacing the tool is high due to frequent downtime on railway line.

VI. Research Methodology

The design and analysis of Tamping tool which is used for tamping process with tamping assembly machine is failing premature prior to its working life. For design modification, in this work all the essential Data will be accumulated, CAD model of the existing and modified design will be generated. FEA analysis and calculations will be performed. After that results of both designs will be discussed and design will be finalized. The design of Tamping tool is based on the specification and data provided by the company.

VII. Conclusion

Our project involves the design and analysis of the Tamping tool. The detailed study of tamping tool from the sources available has help us to gain deeper knowledge of affecting parameters, mechanism and its working principle etc . By performing design and analysis company will be directly benefited with improved tamping tool design in their products.

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