Chapter 1

Background and Introduction

This chapter provides background information on the research that was conducted throughout the course of this study. An introduction is given on the objectives of this research and its importance. Additionally, an overview of the study that was conducted and its presentation are provided.

1.1 Introduction

Rail vehicles have played an important role in the development of the United States and many other countries of the world. As a result, railways penetrate virtually every corner of the Earth. Railways continue to be immensely important to the world commerce and development. It is therefore essential that rail vehicle dynamics be further understood and improved. The research presented in this thesis represents an effort to relate rail vehicle dynamics to track irregularities.

Currently, railway tracks are grouped into several classes based on specific track properties, ranging from class 1 to class 6. The class designation indicates the degree to which the tolerances are held for each characteristic, and the speed limit for that track. Experience has shown that this method of track classification is successful in minimizing the risk of a derailment. This method, however, does have its limitations. In particular, this method of classification does not establish a direct correlation between the dynamics of a vehicle and the track on which the vehicle runs.

Without such a correlation, vehicles that have the capability to run at higher speeds are limited to the speed limit that is "safe" for vehicles that do not have the same characteristics. Therefore, there are no advantages to designing or building a vehicle that can achieve a higher safe speed than the speed limit that is assigned to a specific track. Additionally, the lack of a direct correlation between vehicle dynamics and rail characteristics presents a problem with establishing the tolerances necessary for safe operation of all vehicles that travel on a specific track. One vehicle's dynamic reaction to a section of the track may vary greatly from another vehicle's reaction to the same section of the track. With the current method of track classification, either the vehicle speed is limited to what is deemed to be a safe limit, or the tolerances for all of the track parameters are held to pre-determined limits in order to insure safe operation of all traffic on the track.

In addition, the empirical tolerances that establish the class and therefore the speed limit for a section of track do not account for how the different track parameters collectively affect a vehicle's performance. If a certain track parameter degrades to a point beyond its specified tolerance, it may not be an unsafe condition unless another parameter has also degraded to a certain level. The current Federal Railway Administration (FRA), however, requires that the track be reclassified to a lower class, and thus a slower speed limit, until the track parameter has been maintained. As a result, the track is maintained even when there may not be a real need, causing U.S. railroads lost time and revenue.

If a section of track were maintained based on the effect that it produces in a vehicle, maintenance expenses would be reduced without adversely affecting the integrity of the track. As mentioned earlier, the relationships between the track condition and the vehicle reactions can be used to reduce track downtime, improve vehicle dynamics, reduce maintenance costs, decrease travel time, and increase productivity for the railroad industry. The determination of these relationships, however, is not a trivial task and will require a significant amount of research. The research presented in this study includes only the initial steps necessary to fully understand some of the dynamic interactions that exist between the track and rail vehicles.

1.2 Research Objectives

The primary goals of this research are to:

1. Analyze the data collected by Transportation Technology Center, Inc., (TTCI) over the past ten years on the High Tonnage Loop at Pueblo, Colorado,
2. Determine the trends related to the degree of curvature and subgrade stiffness present in the track geometry and wheel load measurements,
3. Determine to what degree and how the wheel loads and track parameters are related, and
4. Establish the limitation of the data collection techniques currently used and suggest recommendations for future data collections.

1.3 Outline

Chapter 2 provides the results of a literature search on similar previous studies. Chapter 3 describes the equipment employed for the tests, the High Tonnage Loop where the data was collected, the basic bogie design on which the tests were conducted, and the signal conditioning that took place during the data collection. Chapter 4 describes the results from analyzing the vertical and lateral wheel loads of the rail vehicle in the time and frequency domain for various degrees of curvature, subgrade stiffness, and truck design. Chapter 5 details the results obtained from analyzing the track geometry parameters in the time and frequency domains for various degrees of curvature and subgrade stiffness. Chapter 6 explains the analysis performed for establishing the relationship between the track geometry and wheel load measurements. It also presents the limitations of the data for the purpose of correlating the track and wheel measurements. Finally, Chapter 7 presents the conclusion of the research and recommendations for future field measurements and data analysis.