Chapter 1

Introduction

1.1 The Role of the Primary Suspension
The perceived comfort level and ride stability of a vehicle are two of the most important factors in a vehicle’s subjective evaluation. There are many aspects of a vehicle that influence these two properties, most importantly the primary suspension components, which isolate the frame of the vehicle from the axle and wheel assemblies. In the design of a conventional primary suspension system there is a trade off between the two quantities of ride comfort and vehicle stability. If a primary suspension is designed to optimize the handling and stability of the vehicle, the operator often perceives the ride to be rough and uncomfortable. On the other hand, if the primary suspension is designed to be, the vehicle will be comfortable, but may not be too stable during vehicle maneuvers. As such, the performance of primary suspensions is always limited by the compromise between ride and handling. A primary suspension can only optimized to a point. To achieve a better performance, it is necessary to investigate different, non-conventional types of suspension systems.

1.2 Focus
Though conventional primary suspension systems are passive in nature, there are other alternatives available to suspension designers. The different types of primary suspensions that can be implemented in a vehicle include passive, adjustable, semiactive, active, and adaptively controlled suspensions. Each of these types of suspensions has different advantages and disadvantages. This study focuses on studying the benefits of using semiactive primary suspensions on a heavy truck.

The semiactive suspension system used consists of a passive spring element and a controllable variable damping element. To achieve variable levels of damping, the damping element uses a magnetorheological fluid. The fluid’s magnetorheological property allows the effective viscosity of the working fluid inside of the damper to be
altered by the application of a magnetic field. The level of damping present in the system is determined and adjusted by an electronic controller during the operation of the vehicle. In this study the effect of this type of suspension on a heavy truck was investigated experimentally, and compared to data taken on the same truck equipped with a conventional passive suspension system.

1.3 Approach
The starting point of this study was the design and fabrication of the hardware necessary to equip a heavy truck with a semiactive suspension system. A large truck requires suspension components of size and strength suitable to the large motions and forces that occur during operation. The adjustable dampers that were designed for this application needed to be capable of exerting damping forces both greater and less than those exerted by the stock dampers. Magnetorheological technology was used for the adjustable dampers. This allowed the level of damping present to be controlled by varying the current supplied to a simple electromagnetic coil inside of the variable dampers.

The controllable dampers were then implemented on the Volvo VN heavy truck shown in Figure 1.1.

![Volvo VN Heavy Truck Test Vehicle](image)

Figure 1.1. Volvo VN Heavy Truck Test Vehicle

They were controlled electronically by a real-time embedded controller that independently varied the level of damping in each of four dampers. The truck was road tested with both
the prototype semiactive suspension system as well as the original passive system under the same conditions. For each system, a series of data was collected and analyzed. The data consisted of acceleration time traces of eleven points on the truck. This data was used to judge the effectiveness of the application of the semiactive suspensions.

1.4 Outline
This report is broken into five chapters. Chapter 2 presents the background information relating to vehicle suspensions. It gives the reader basic information on different types of suspension systems, and relates some of the advantages and disadvantages of each. Chapter 2 also discusses some of the background information necessary to understand the function that a damper has in a suspension system. The last part of chapter 2 gives information on controllable fluids and controllable fluid devices. Chapter 3 discusses the design, fabrication, and characterization of the dampers used in this study. It details the basic function and design of the different components of the dampers. The damper characterization methods used in this study are also discussed, along with the force-velocity damper test results. Chapter 4 deals with the field testing of the dampers that were presented in Chapter 3. It starts with a description of the test vehicle and describes the implementation of the dampers onto the test vehicle along with the addition of the necessary sensors and data acquisition systems. A description of the field tests performed is given and the results are discussed. This discussion includes the data acquired during the field tests, the processing of the data, and a review of the results of the field test data. Finally, Chapter 5 summarizes the study, the significant findings, and provides recommendations for future studies in this area.