A LIFE CYCLE COST ANALYSIS OF THE GAUTENG TO DURBAN FREIGHT CORRIDOR: INTRODUCTION TO STUDY

Bruce S. Morton[1], Alex T. Visser[2] and Emile Horak[3]

[1]Associate, Ninham Shand Consulting Engineers/Senior Lecturer, Department of Civil and Biosystems Engineering, School of Engineering, Faculty of Engineering, Built Environment and Information Technology, University of Pretoria, Private Bag X136, Centurion 0046, Tel: +27 12 643 9000. Fax: +27 12 663 6238. E-mail: bruce.morton@shands.co.za / bruce.morton@up.ac.za (corresponding author)
[2]Professor, Department of Civil and Biosystems Engineering, School of Engineering, Faculty of Engineering, Built Environment and Information Technology, University of Pretoria, Pretoria. Tel: +27 12 420-3168. E-mail: alex.visser@up.ac.za
[3]Professor, Head of Department of Civil and Biosystems Engineering, School of Engineering, Faculty of Engineering, Built Environment and Information Technology, University of Pretoria, Pretoria. Tel: +27 12 420-3168. E-mail: emile.horak@up.ac.za

ABSTRACT

Freight transport in South Africa is dominated by two modes, namely road transport and rail transport. The current dominance of road is not only linked to high value commodities, perishables or short transport distances, but has recently been extended to include freight transport of bulk low value goods such as coal and iron ore, previously the domain of rail transport. The condition of the rural road network is deteriorating rapidly as traffic volumes and axle loads increase on an ageing network. The primary road network is in most instances completed, with maintenance and rehabilitation taking precedence over capacity enhancements, albeit of a limited extent when compared to actual requirements. The rail system has been described as being in a near state of collapse due to enormous underinvestment since road replaced rail as the dominant freight transport mode from the mid 1980s.

Numerous studies have been undertaken both locally and internationally to ascertain the most cost effective and beneficial form of freight transport, but in a number of instances these studies ignore certain basic externalities that require consideration and analysis to provide a meaningful and representative outcome. Only once all costs have been fully internalised can the performance of freight transport be accurately computed and investment in freight transport infrastructure satisfactorily justified.

The aim of this paper is firstly to present the framework of a study designed to evaluate through a holistic systems approach the total costs of the primary modes (road and rail) of freight transport along the Gauteng to Durban Freight Corridor, taking into account all significant internal and external costs associated with such modes of freight transport. A preliminary program and the provisional list of role-players currently providing assistance and co-operation will be presented. Furthermore the paper will provide an overview of the respective road and rail corridors with respect to the basic infrastructure of the systems, the current trafficking levels and anticipated capacity of the systems under current infrastructure conditions.

1. INTRODUCTION

1.1 Background

The role of an efficient and well-developed transportation system as a necessity in a prosperous economic environment is not a new philosophy. John F Kennedy stated in one of his numerous public appearances that, “It is not wealth that creates roads, but roads that create wealth.” The motto of the South African Road Federation, “Good Roads Lead to Prosperity," illustrates that the importance of transportation to a country’s economic well-being is as evident today as it was four decades ago. In the current environment, roads, railways, marine and air transport all contribute to the “Prosperity” of a nation.

Freight transport in South Africa is dominated by two modes, namely road transport and rail transport. In the last two decades road transport has gained precedence over rail transport as the primary provider of freight transport with the abolishment of regulations on the distance road freight could be transported and that government relaxed certain size and axle load configurations that had been the norm in the past. The ‘dominance’ of road is not linked only to high value commodities, perishables or short transport distances, but has recently been extended to include freight transport of bulk low-value goods such as coal and iron ore, previously the domain of rail transport.

1.2 Problem Statement

The country’s transportation infrastructure stands at a cross road. The condition of the rural road network is deteriorating rapidly as traffic volumes and axle loads increase on an ageing network. The primary road network is in most instances completed, with maintenance and rehabilitation taking precedence over capacity enhancements. The result is an ageing road network trying desperately to maintain an efficient level of service under high loading conditions for which it was not originally designed in terms of loading and design life. The rail system has been described as being in a near state of collapse due to enormous underinvestment since road replaced rail as the dominant freight transport mode from the mid 1980s. Certain core lines are exhibiting good returns but overall the rail industry is in a state of decline. As is the case with the road network, the South African rail rolling stock is at the point where refurbishment is essential to ensure the continued adequate supply of service.

On a national level sustainable economic growth can only be achieved in South Africa through increased local investment and a supply side export boom. Without an adequate, cost effective and efficient freight transport system neither of these objectives can be readily met. Government has identified this need for maintaining and improving the current freight transport infrastructure, but uncertainty exists as to the best course of action regarding reapportionment of investment in transportation infrastructure. This uncertainty is compounded by the mutual dependence of the freight and personal transport fields on the same infrastructure. Changes in investment in rail and road could be beneficial to the freight industry in isolation but may adversely affect the level of service of personal transport that also plays an integral, if not more important role in the economy of the country.

Significant uncertainty exists pertaining to the actual costs of transport, particularly total freight transport costs. This is primarily due to the exclusion of certain externalities from the cost calculations of all freight transport modes. The inclusion of externalities has been identified as a primary requirement in the implementation of the user pays principle. The result is that the true cost and sustainability of freight transport is currently not quantified to a satisfactory level to provide adequate guidance in the provision of transport infrastructure. Only once all costs have been fully internalised can the performance of

freight transport be accurately computed and investment in freight transport infrastructure fully justified.

1.3 Aim of Paper

The aim of this paper is to present the framework of the Gauteng to Durban Freight Corridor Study designed to evaluate through a holistic systems approach the total costs of the primary modes (road and rail) of freight transport, taking into account all significant internal and external costs associated with such modes of freight transport. A preliminary program and the provisional list of role-players currently providing assistance and co-operation will be presented. A secondary aim of the paper is to provide an overview of the respective road and rail corridors in terms of the basic infrastructure of the two systems, the current trafficking levels and anticipated capacity of the systems under current infrastructure conditions.

1.4 Scope of Paper

The paper will present the structure of the Gauteng to Durban Freight Corridor study and the proposed deliverables of the study. A preliminary programme will be presented indicating the key tasks and subtasks of the study and proposed milestones for presented of the findings of research tasks. The paper will furthermore provide an introduction of the Gauteng to Durban Freight Corridor in terms of the infrastructure of the two main modes of freight transport, their current freight haulage estimates and predictions of the capacity of the corridor within each freight mode under current infrastructure conditions.

2. OVERVIEW OF GAUTENG TO DURBAN FREIGHT CORRIDOR STUDY

2.1 Introduction

The study was originally initiated through discussions between the RailRoad Federation (RRA) and the University of Pretoria's Chairs in Transport Engineering and Railway Engineering to focus on the actual costs of road and rail freight transport within South Africa taking into consideration externalities such as environmental, safety and cross subsidisation. Originally packaged as a Doctoral Study of limited scope, a preliminary scope of works or the study was drawn up at which time the extent of the study was re-evaluated to focus on the Gauteng to Durban Freight Corridor and expanded to include additional research capacity through the inclusion of post-graduate assistance and aligned research initiatives.

Through a number of subsequent discussions with the RRA, the Department of Transport, Spoornet and the Road Freight Association the study goals, activities and proposed deliverables were contextualised and refined to their current state.

2.2 Study Goal

The primary goal of Gauteng to Durban Freight Corridor Study is as follows:

- **"Evaluate through a holistic systems approach the total costs of the primary modes (road and rail) of freight transport in South Africa along the Gauteng to Durban Corridor, taking into account all internal and external costs associated with such modes of freight transport."**

A secondary related goal is to quantify each mode's respective roles in providing the most cost effective and efficient freight transport system to the country as a whole.

The study will focus on rail and road freight transport as the primary modes of freight transport within South Africa. Although maritime (including ports), pipeline, air freight and

various other forms of freight transport are not the primary focus of the study their role in providing a seamless freight transport system will need to be addressed with respect to freight transport, particularly along corridors where these 'minor' fright transport modes play a significant role such as the pipelines from Gauteng to Durban.

The study will be aligned with the requirements of the national freight logistics strategy (DOT, 2004) and provide recommendations relating to the costs of the various freight transport modes.

2.3 Study Tasks

The following tasks have been identified for the purpose of achieving the stated goal of the study. This list is not all encompassing but should be viewed as a proposed set of tasks and related objectives for further discussion with role players and incorporation within the scope if deemed pertinent. The extent of involvement of all affected parties is critical to the achievement of a number of these tasks' objectives.

- Initial infrastructure costs;
- Maintenance costs of infrastructure;
- Freight product study;
- Operational costs;
- Environmental;
- Safety;
- User pays principle;
- Customer service qualities;
- Internalisation of external costs;
- Review of tasks and collaboration of findings;
- Life cycle cost analysis; and
- Final reporting.

The tasks are illustrated schematically in Figure 1. Although these tasks are being undertaken as separate entities of research, the authors are fully aware of the mutual interdependency of certain of the tasks, and therefore a review and collaboration task has been included prior to the life cycle cost analysis to ensure that these interrelationships are adequately defined and that the findings of each task are accurate and relevant.

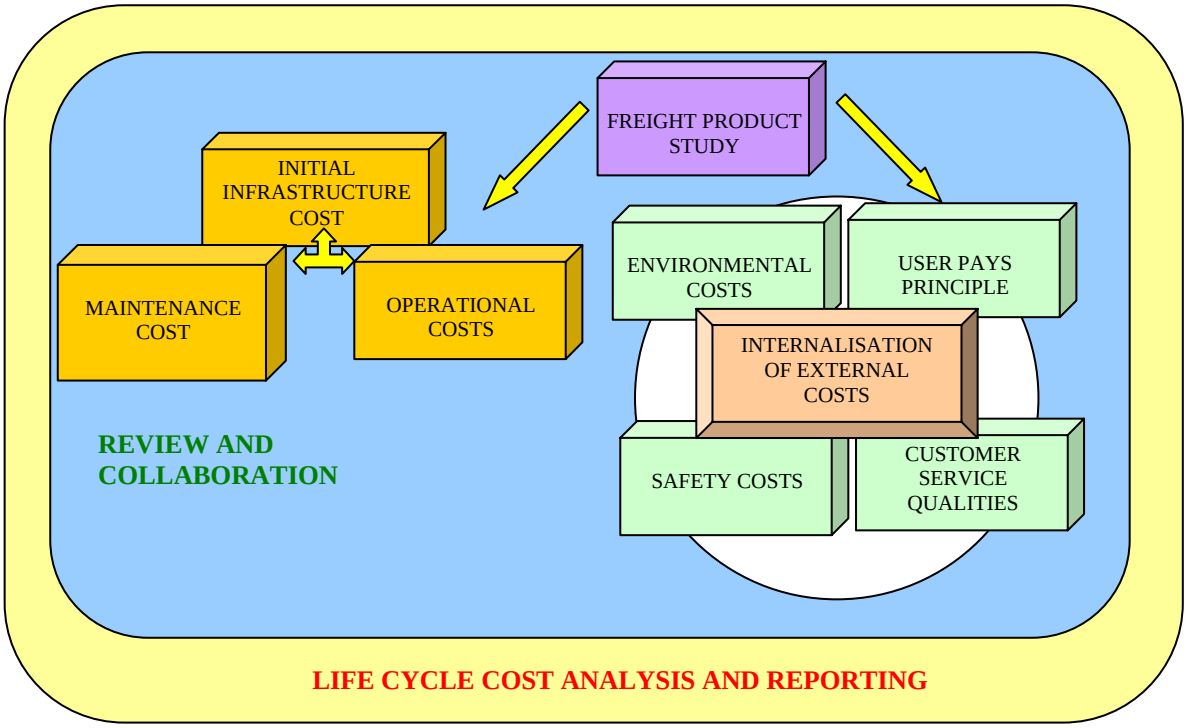

Figure 1. Schematic representation of study tasks.

2.3.1 Quantify Initial Infrastructure Costs

Initial infrastructure cost plays a significant, if not the primary, role in the cost analysis of various alternatives. This task is aimed at providing an accurate estimate of the replacement construction cost of the existing infrastructure along both the road and the rail transport corridors in present day Rand value. Primary factors considered include land use cost, basic cost of rail infrastructure and basic cost of road infrastructure. The costs relating to the port terminal and associated infrastructure requirements will also be taken into consideration on a tonnage basis for each mode.

2.3.2 Quantify Maintenance Costs of Infrastructure

The quantification of maintenance costs of freight transport between each mode along the Gauteng to Durban Corridor will be based on historical data available from the key stakeholders, namely Spoornet and the N3 Toll Concessionaire (N3TC). In addition to the information available the dynamics of motor vehicles and railway rolling stock, and their respective effects on deterioration of infrastructure and the quantification of effect of climate, axle loading, stress conditions, repetitive loading and abnormally heavy loads on deterioration of infrastructure will also be assessed. Predictions will be made of the respective maintenance costs resulting from these factors.

2.3.3 Freight product study

It is evident from the traffic distribution and type of freight transport vehicle currently utilising the Gauteng to Durban Road Corridor that the freight product distribution between rail and road is undergoing continual change. Iron ore, coal and other so-called “low unit value” products are increasing utilising road transport as the preferable mode of freight transport.

An inherent relationship exists between the costs of freight transport and the value of goods being transported. Current road data only accurately predicts the traffic loading along the road corridor and differentiates between the types of vehicles undertaking the haulage. It does not however differentiate between types of goods transported, as in the case of railway.

2.3.4 Quantify operational costs
The operational cost of freight transport is perceived by many within the transport industry as the main area where substantial savings can be brought about. This task will deal with logistical aspects such as loads and goods monitoring in additional to assessing associated infrastructure related costs with respect to sidings and storage facilities, intermodal facilities, and road usage.

2.3.5 Environmental Costs
Environmental costs will focus on noise and emissions relating to freight transport by various modes. Additional long terms environmental costs will also be evaluated. This task will rely heavily on the significant investigations and research initiatives conducted internationally with regards to the environmental effects of freight transport.

2.3.6 Safety costs
Safety costs will focus primarily on the costs associated with policing, accidents and regulations regarding the various modes of freight transport.

2.3.7 User pays principle
The user pays principle will focus on two key aspects namely the recuperation of costs and the time related cost of each mode. The recuperation of costs will place emphasis on the topics of fuel tax, tolls and public/private investment and infrastructure liabilities link to the various modes. Other methods of cost recuperation will also be researched.

2.3.8 Customer service qualities
Customer service quality will deal with speed, reliability, efficiency and cost of freight transport.

2.3.9 Internalisation of external costs
External costs to be analysed include environmental costs, cross-subsidisation, user costs and safety related costs of the various freight transport modes.

2.4 Study Parameters
The study will focus on the Gauteng to Durban freight transport corridor initially and be expanded dependent on national needs. The Gauteng to Durban corridor has been identified in the freight logistics strategy as one of the primary freight transport corridors in southern Africa and would presumably form the basis of any pilot project established to implement the proposed national freight logistics strategy (DOT, 2005). Additionally the role of the Durban Port in the holistic analysis of freight transport will be taken into consideration in the analysis focussing on the cost and efficiency of required intermodal facilities for each freight mode.

The role of secondary and other strategic routes will be the focus of further studies incorporated into the project based on the requirements of the role players.

2.5 Funding and Assistance
Funding is currently being provided by the DOT, the RRA and the Chair in Railway Engineering (CRE), funded by Spoornet. Additional assistance for the study is being provided by the Road Freight Association and the N3 Toll Concession.

2.6 Programme and Study Time Frame

The preliminary programme is illustrated in Figure 2. It is anticipated that the study will be undertaken within a 3-year period with draft documentation available by end 2008. Although a time frame of 36 months is proposed, progressive reports and findings will be published throughout the research project period and a steering group, with representation from the key stake holders, will be instituted to monitor the progress of the research project.

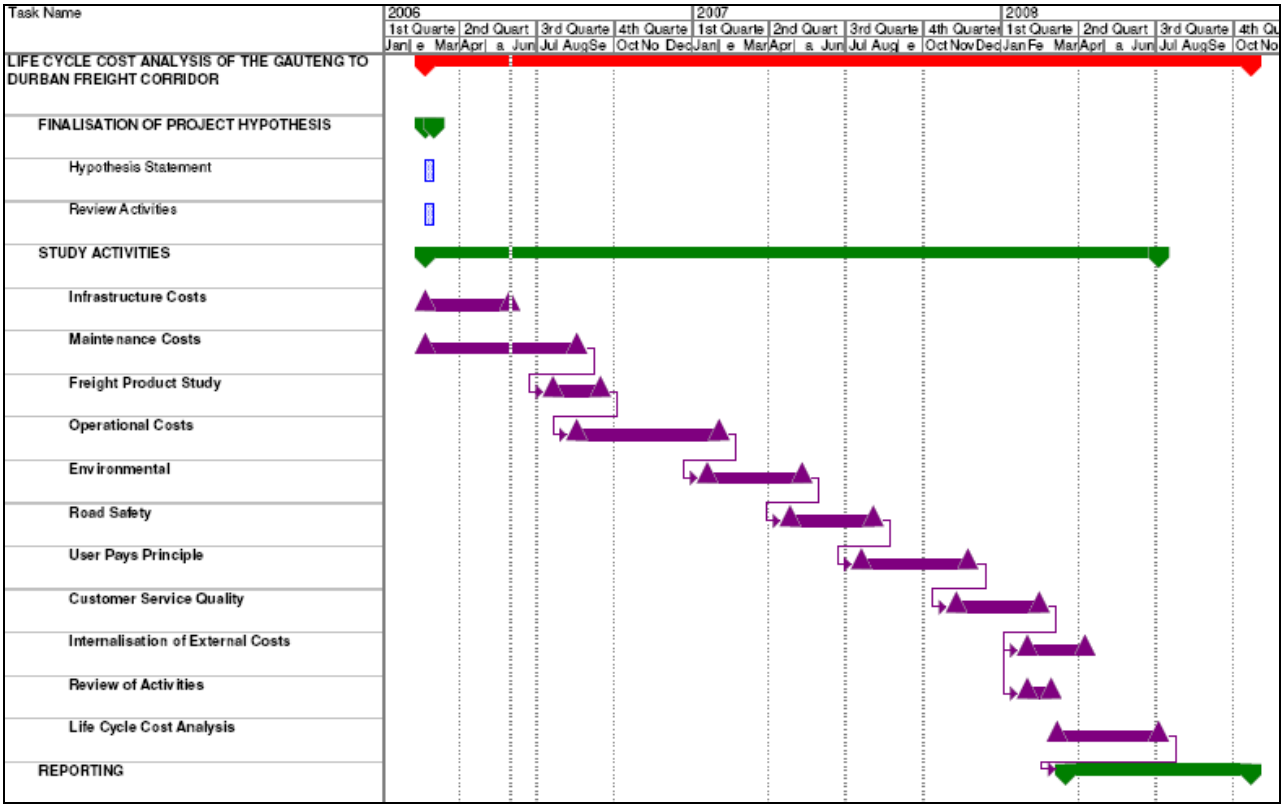

Figure 2. Proposed programme.

3. OVERVIEW OF BASIC INFRASTRUCTURE

3.1 Introduction

This section provides general information relating to the basic infrastructure provided along the Gauteng to Durban Freight Corridor for both the road and rail. Aspects discussed include length of the freight corridor, general track and road layout and geometry, maximum permissible travel speed, and an assessment of the possible maximum capacity in terms of freight transport under current infrastructure conditions.

3.2 Corridor Length and General Layout and Geometry

The Gauteng to Durban Freight Corridor is defined as the corridor extending from central Johannesburg, in the vicinity of Newtown to the port in Durban. Figure 3 illustrates the road and rail corridors.

The road corridor extends over a distance of approximately 580 km dependent on the route taken within the Johannesburg region. The corridor is illustrated in Figure 3 and consists primarily of the N3 National Road between Gauteng and Durban of which in excess of 75% is toll road. The geometric layout of the corridor consists generally of a 4-lane dual or single carriageway road consisting of flexible and rigid pavement sections. In certain areas the road consists of 6 lanes incorporating additional slow climbing lanes and crawler truck traffic lanes in the vicinity of Pietermaritzburg and Durban.

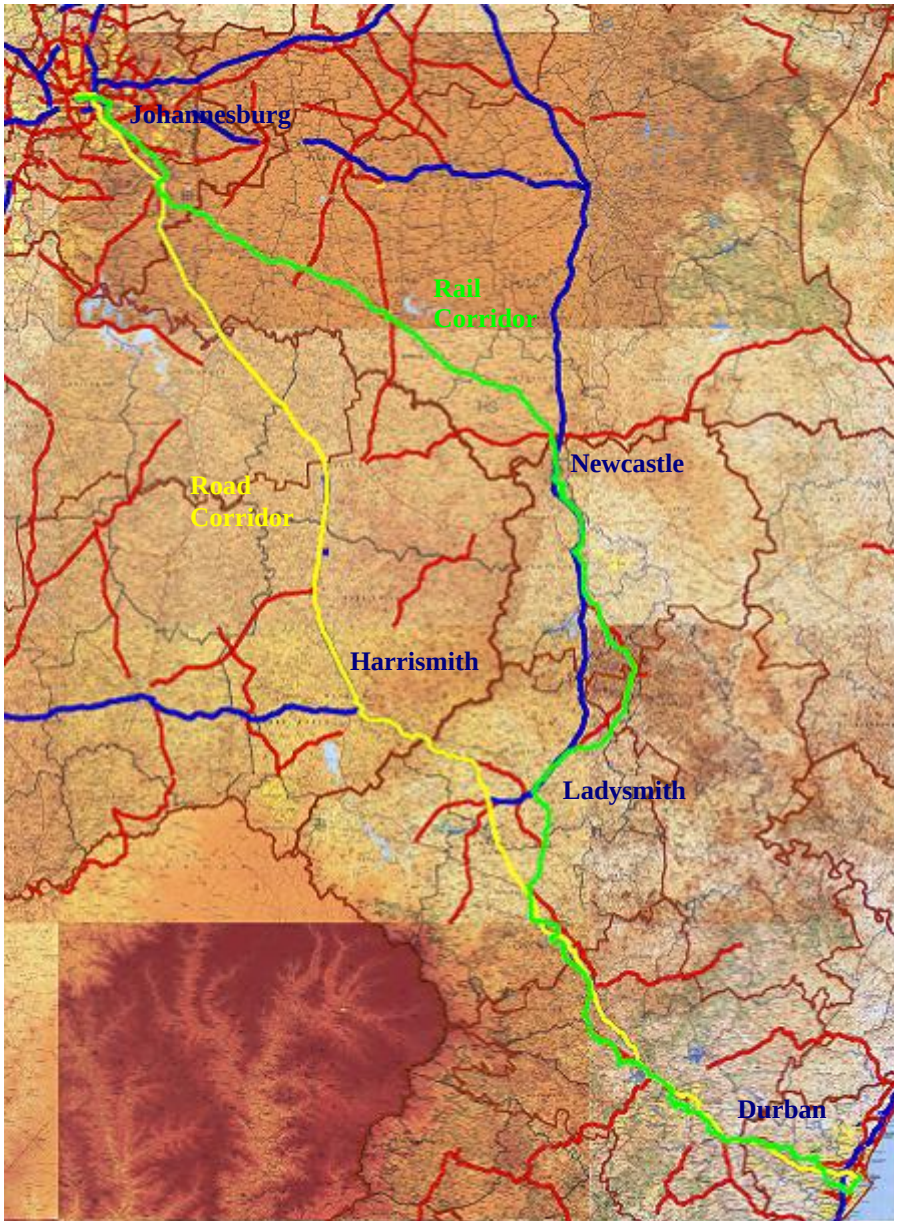

Figure 3. Gauteng to Durban freight corridors for road and rail freight transport.

The Gauteng to Durban rail corridor extends over a distance of 688 km and deviates significantly from the road corridor via Volksrust, Newcastle and Ladysmith. Thus the rail corridor is approximately 20% longer than the road corridor. The corridor consists of a double line over its entire length with numerous branch lines.

3.3 Travel Speed

The permissible maximum travel speeds over the corridors vary dependent on the geometric layout and additional constraints.

The general speed limit along the road corridor is 120 km/h. In certain instances the travel speed is decreased to 80 km/h along sections of Van Reenan's Pass and 100 km/h over sections of the route in the vicinity of Pietermaritburg and Durban. As stated previously dedicated crawler lanes are provided that significantly curtail travel speed to less than 40 km/h. Trucks are legally restricted to a maximum speed of 80 km/h, but appears not to actively be enforced.

The rail travel speed varies dependent on the type of train and type of braking system employed. Passenger train's speed limit is generally 100 km/h while freight train speeds vary from 80 km/h to 60 km/h for airbrake and vacuum brake freight trains, respectively.

3.4 Estimated Maximum Freight Capacity

The capacity of the road corridor under current infrastructure conditions is heavily dependent on the distribution of traffic between passenger and freight transport vehicles. Current traffic data indicates that the current average daily traffic varies from 10 000 to almost 30 000 vehicles/day. The percentage heavy vehicles vary from 17% to 27% with E80/HV (equivalent 8 ton axle loads/heavy vehicle) varying in the range of 2.63 to 3.25 (N3TC, 2006).

As with any corridor the maximum capacity is defined as the maximum capacity of the most constrained sections of the entire corridor. Taking the trigger for the construction of De Beers Pass along the N3 Toll Road as the basis of the constraint and assuming 33% heavy vehicles and an E80/HV factor of 3.5 the maximum E80/day value is approximately 15 000. Considering the ratio between truck weight and freight weight for large trucks (6 - 7 axle configurations), this equates to approximately 30 000 tons of freight per day in the northbound direction (almost 22 million tons of freight per year in both directions).

Spoornet undertook a capacity analysis of the rail corridor in 2004. As with the road corridor the capacity of the freight corridor is constrained by the section of track with the lowest capacity. From this analysis it was concluded that the capacity of the rail corridor, under current infrastructure provision is approximately 147 million tons, with a 50/50 split per direction. This capacity figure is based upon the following assumptions regarding operation and train size and type distribution:

- Airbrake train = 50 wagons (1741 tons per train);
- Vacuum train = 40 wagons (1393 tons per train);
- 50/50 distribution of air/vacuum brake trains; and
- Operational 360 days/year (Spoornet, 2004).

3.5 Capacity Utilisation

Current traffic statistics indicate that the Average Annual Daily Traffic (AADT) over Van Reenans Pass is approximately 9 000. Assuming that the proposed heavy vehicle distribution increases over this section to 33% as a maximum capacity, the current utilisation of the Durban to Gauteng Road Freight Corridor is estimated at 42% (N3TC, 2006). This prediction relates only to the northbound direction of the road freight corridor. However, taking into consideration the constraints resulting from crawler lanes and urban area congestion this estimate of utilisation is considered applicable to both the northbound and southbound direction (N3TC, 2005).

A detailed capacity analysis was conducted by Spoornet in 2004 of all major freight lines within South Africa. Considering 2004 as the base year and increasing traffic by 10% it is estimated that the capacity utilisation of the rail corridor is approximately 18%. This is significantly less than the road corridor utilisation.

4. CONCLUSIONS

This paper provides a detailed overview of the Gauteng to Durban Freight Corridor Study.

The study aim is to evaluate through a holistic systems approach the total costs of the primary modes (road and rail) of freight transport in South Africa along the Gauteng to

Durban Corridor, taking into account all internal and external costs associated with such modes of freight transport.

The study will focus on the Gauteng to Durban Freight Corridor initially and be expanded dependent on national needs.

The proposed time frame for the study is three years, however findings from the various tasks identified for research will be published on a regular basis once available.

The current freight capacity of the road corridor utilising existing infrastructure and conditions equates to approximately 22 million tons. In comparison, the capacity of the rail corridor is approximated at 147 million tons.

A rudimentary analysis of the percentage utilisation of the road corridor indicates a 42% utilisation in comparison to 19% utilisation along the rail corridor. This shows that there is significant capacity particularly along the rail corridor.

5. ACKNOWLEDGMENTS

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