IMPACT OF OVERLOADING ON OPERATIONAL PAVEMENT LIFE IN FLEXIBLE PAVEMENT

By

Eng. Amr Muhammad Mahmoud Fathy

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List of Abbreviations

AASHTO American Association of State Highway Transportation Officials
CBR California Bearing Ratio
GARBLT General Authority of Roads, Bridges and Land Transport
WB World Bank
JICA Japan International Cooperation Agency

Abstract

The main objective that motivated this study is to assess the impact of overloading on operational pavement life in flexible pavement. This research includes two roads, Cairo Suez road with weighbridge and Zagazig Bilbis road without weighbridge. There are three objectives required to achieve the main object. First, calculating the reduction in the pavement operational life due to trucks overloading under various cases of loading, truck type and annual growth rate. Second, operational life comparison between Cairo Suez road with weighbridge and Zagazig Bilbis road without weighbridge. Third, comparison between income from overloading fines according to GARBLT method due to excess load and reduction in operational pavement life cost.

The AASHTO method is applied to calculate the reduction in the pavement operational life on the two roads under various cases of loading, truck type and annual growth rate. The results for the two roads have been analyzed and operational life comparisons between the two roads have been held. Also, comparisons between expected income from overloading fines according to GARBLT method due to excess load and reduction in operational pavement life cost have been held.

Conclusions can be summarized in the following:

1. Traffic composition is the most effective element in the reduction of pavement life due to overloading which Egyptian traditional method only co-relates with the excess load without knowing the other elements of roads.
2. The impact of overloading of 2 axles trucks will be almost equal or less than overloading all trucks types.
3. In case of overloading on 2 axles trucks by max. available load 10 tons the reduction in operational lifetime will be from 5 to 9 years at various values of annual growth rate.
4. The Egyptian overload fine pricing method does not represent the real impact of overloading on the operational pavement life on roads.
5. Cairo Suez road with weighbridges and Zagazig Bilbis road without weighbridges have similar behavior under different overloading conditions which mean that both roads must have weighbridges.
6. Income from overloading fines due to excess load according to GARBLT method covers the cost of additional asphalt layer due to overloading and maintenance required along road pavement life.

The following recommendations can be derived based on the study as follows:

1. A new study must be conducted for the relation between overloading and material properties and climate conditions.
2. Economic study should be conducted to compare between the Egyptian overload fine pricing method and AASHTO design method.
3. Many alternatives must be achieved by other researches to knowing the impact of axle truck percentage on pavement design life.
4. New truck roads should be added to Egyptian road network which can allow maximum overloading and accident decreasing.

Chapter 1 : Introduction

1.1. General

Roads and streets are the most important transport communication medium in the country and are used by almost everyone on a daily basis. Besides the fact that roads are provided for the benefit of the road user, they also play a significant role in promoting economic growth and the living standards of the population. By means of roads, people have access to markets, places of work, clinics and hospitals, educational institutions, places for sport and leisure activities and vacations. The structural design of roads is a very important issue. A 20-year pavement life represents the total anticipated load applications the pavement will be subjected to over a 20-year period. For the purpose of thickness design, the total number of load applications is the defining parameter. Trucks are considered the most determining type of vehicles in the structural design of roads. Overloading in Egypt not only causes considerable damage to the road network, but also contributes to serious road safety problems. Furthermore, heavy vehicle operators that do not overload are placed at a disadvantage, as they cannot compete fairly with unscrupulous operators that follow a policy of deliberate overloading. A fine must be imposed against overloading trucks but the Egyptian overload fine pricing method used by GARBLT does not represent the real effect of overloading on the operational lifetime of road.

The Egyptian payment method based on experience of specialists in this domain regarding the resulted performance concerning the defects occurs at the road. In the past, there was no easy way to analyze the reduction in the operational lifetime that may occur, but now using computer programs, the proposed pricing method became easier to be implemented.

This study aims to evaluating the effect of overloading on pavement operational lifetime.

1.2. Problem Statement

The absence of evaluation of the impact of overloading on the operational pavement life of road, and whether the Egyptian pricing method represents the impact of overloading on the operational pavement life of road. Egyptian roads network is very huge on which safety some roads have weighbridges and some others with similar conditions not.

The effect of overloading extends to include reduction in the operational pavement life and the result is very big losses in the budget of the road owners represented in the government. The traditional payment method based on experience of specialists in this domain regarding the resulted performance concerning the defects occurs at the road.

1.3. Research Objectives

Calculating the reduction in the pavement operational life due to trucks overloading under various cases of loading , truck type and annual growth rate, consequently holding operational life comparison between Cairo Suez road with weighbridge and Zagazig Bilbis road without weighbridge and comparison between Income from overloading fines due to excess load and reduction in operational pavement life cost.

1.4. Research Methodology and Tasks

To achieve these objectives the following steps have been performed:

1- Traffic data and road pavement characteristics for Cairo-Suez road with weighbridges and Zagazig-Bilbis road without weighbridges has been used to calculate number of ESALs application over design period.
2- Ten annual growth rate values have been assumed.
3- For each annual growth rate value, ten values have been assumed for the excess load which are from 1 ton to 10 tons.
4- For each value of excess load, six cases of the excess load application are assumed.
   - First case: the excess load is applied on 2-axles trucks only.
   - Second case: the excess load is applied on 3-axles trucks only.
   - Third case: the excess load is applied on 4-axles trucks only.
   - Fourth case: the excess load is applied on 5-axles trucks only.
   - Fifth case: the excess load is applied on 6-axles trucks only.
   - Sixth case: the excess load is applied on all types of trucks.
5- Operational pavement life is calculated under the previous conditions.

Chapter 2 : Literature Review

2.1. General

Trucks are considered the most determining type of vehicles in the structural design of roads. The concerning authorities in many countries including Egypt attempt to control overloading. Overloading in Egypt not only causes considerable damage to the road network, but also contributes to serious road safety problems.

2.1.1 Overloading effect on roads

Overloading has harmful effect on road pavement. It can causes some pavement distresses such as rutting, shoaving, corrugation, depression, cracks, and etc. Figure 2.1 shows some examples of overloading effect on roads.

Figure 2.1 : Examples of overloading effect on roads (3)

2.1.2 Allowable axle loads around the world

Concerning authorities in most countries have put limits of axle load to reduce overloading harmful effect on road network. Figure 2.2 shows allowable axle loads in some countries including Egypt, USA, and some Asian and European countries.

Tandem load							Single load (4 tires)
المزدوج (الترادفي)							الحمل المفرد (٤ عجلة)
						United Nations*	8
						الأمم المتحدة	
						14.5	
						United States	9.1
						الولايات المتحدة	
						15.5	
	Japan	Switzerland	Germany	United Kingdom	Sweden	Netherland	10
	اليابان	سويسرا	ألمانيا	المملكة المتحدة	السويد	هولندا	
	_	14	16	20	16	18	
						Italy	12
						إيطاليا	
						19	
Espane	France	Belgium	ESCWA members	Yemen	Jordon	Egypt	13
أسبانيا	فرنسا	بلجيكا	اتفاقية الأسكوا	اليمن	المملكة الأردنية الهاشمية	مصر	
14.7	21	20	20	21	20	20	

Figure 2.2 : Allowable axle loads in some countries (3)

2.2. The 1993 AASHTO Guide

The 1993 AASHTO Guide is the latest version of the AASHTO Interim Pavement Design Guide, originally released in 1961. The evolution of the AASHTO Guide is outlined, followed by a description of the current design equation and input variables. At the end of this section, a summary of recent evaluation studies of the AASHTO guide is also presented.

2.2.1 AASHO Road Test and Early Versions of the Guide

After two successful road projects, the Road Test One-MD and the WASHO Road Test (Western Association of State Highway Officials), in 1955 the Highway Research Board (HRB) approved the construction of a new test track project located in Ottawa, Illinois. This test facility was opened to traffic in 1958. Traffic operated on the pavement sections until November, 1960, and a little more than 1 million axle loads were applied to the pavement and bridges. (HRB, 1961) The main objective of the AASHO Road Test was to determine the relation between the number of repetitions of specified axle loads (different magnitudes and arrangements) and the performance of different flexible and rigid pavement structures.

The test track consisted of 6 loops, each with a segment of four-lane divided highway (two lanes per direction) whose parallel roadways were connected with a turnaround at both ends. Five loops were trafficked and loop 1 received no traffic during the entire experiment. Test sections were located only on tangents separated by short transition lengths. The inner and outer lanes had identical pavement sections. Each lane had its own