Sudan University of Science and Technology

College of Graduate Studies

"Analysis and Evaluation of Axle Loads on Khartoum-Portsudan Road"

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Dedication

This research is dedicated to my wife and her parents:

Dr. Ghazi M. Al Hachim and Mrs. Nawal H. Ahmed

With my great respect

Abstract

The deterioration, potholes, ruts, cracks and undulations that are evident on the Sudan roads press the importance of investigating the reasons of these defects and then offering a solution to eliminate them.

It is found that axle loading is the main factor affecting road deterioration. Hence, it influences design and maintenance.

The overall objective of this project is to evaluate the extent and hence the damaging effect of the level of axle loading on Khartoum – Portsudan Road being the most important case of all roads in Sudan. In addition the research provides a critical review the controlling systems that exist in Sudan highways and their ability to control the load on each axle.

Data related to this subject is collected from many sources namely:

- The previous traffic surveys from National Highway Authority,
- Statistic Section, Ministry of Finance,
- Land Transportation Unit, Ministry of Roads and Bridges,
- The National Chamber for Heavy Trucks,
- The National Chamber for transport Liquids and Petroleum products,
- Private Companies such as Al Muntalaq and Ur Transportation Cos. A three days visit to Suakin Weighbridge Station.

Chapter one is concerned with Sudan location, topography and climate. It covers also all sections of the project area (Khartoum – Portsudan Road). Transportation modes such as Highway, Railway, pipeline and river modes are discussed. The highway network in Sudan including the existing paved those under construction and those awaiting funds are studied. The identified highway network is about 22,000 km mainly in the South.

Chapter two is the theoretical background and literature review which consists of axle load surveying method, traffic counting and axle load studies in African Countries such as Malawi, Ghana, Kenya and Tanzania. Finally the previous axle load studies in Sudan such as highway organization and investment study (HOIS), Axle load control study (ALCS), Pavement Management system (PMS) and Axle load control study for Western Salvation Road.

Chapter three is about data collection and analysis. It consists of:

Traffic volume for all sections of Khartoum-Portsudan Road, data of overloading from private companies and data from Suakin weighbridge station which was represented by 805 records of vehicles crossing the weighbridge and about 100 records of vehicle that the load on each axle was taken.

Chapter four covers axle load analysis and axle load forecasting up to year 2025 applying regression analysis and Gross Domestic Product growth rate.

Chapter five includes the findings, conclusions and recommendations. It was found that the average Equivalent Standard Axle (ESA) for Heavy Vehicle is equal to 39, while the average for all vehicles is equal to 14. The ESA for 100 commercial axles is equal to 654. The ESA per ton is equal to 0.52.

When comparing the levels of ESA in Sudan with the other industrial countries, it is found that the ESA per 100 commercial axles in Sudan is greater than that in United Kingdom and France by (14) to (7) times respectively.

Axle overloading has direct effect on roads age and maintenance. The cumulative equivalent standard axle is expected to increase due to the investment expansion in the country. It is expected to pass the level of 47,000,000 ESA for PortSudan-Khartoum at the end of year 2025 which is classified as very heavy traffic.

The National Highway Authority is expected to implement the right polices to control and eliminate the overloading equivalent standard axles.

تجـــــــــريـد

من ظواهر تضرر الطـرق المشـاهدة فـي السـودان : التشـققات الطوليـة والعرضية، الحفر الموضعية، التعرجات والتموجات, اضافة الى التفتت.....
هناك عوامل عده مسببة لهذه الظواهرالسلبية أهمها وأكثرها تأثيرا علـى طبقـات الطريق هو الحمل المحوري الزائد المسلط على الطريق من قبل وسـائل النقـل المختلفة

- الهدف العام من هذا البحث هوتقييم الأثر الذي تحـدثه المسـتويات العاليـة لأحمال الشاحنات على الطـرق خصوصـا طريـق الخرطـوم – بورسـودان . كذلك يرمـي هـذا البحـث الـى تقييـم أنظمـة المـوازين المعمـول بهـا فـي السودان وقابليتها على مراقبة الأحمال المارة .
- البيانـات المتعلقـة بهـذا الموضـوع جمعـت مـن عـدة مصـادر مـن هيئـات ومنظمات وشركات ومؤسسات ذات صـلة بهـذا المجـال كمـا جمعـت مـن مصادر رئيسية بذهاب الباحث شخصيا الى محطـة ميـزان سـواكن وقيـامه لفترة ثلاثة أيام متواصلة بجمع بيانات العربات المـارة علـى الميـزان ووزن أحمالها على كل محور بمساعدة مشغل الميزان .
- يتكون البحث من خمسة فصول ، الفصل الاول عبارة عن مقدمـة لتوضـيح الموضوع وهـدف البحـث والافتراضـات والاثباتـات والمشـاكل والمعوقـات الـتي واجهـت البـاحث كـذلك بتحـدث عـن السـودان مـن حيـث الموقـع والطوبغرافية والمناخ ويخص بالذكر منطقـة الدراسـة(طريـق الخرطـوم-بورسودان) بمقاطعه المختلفة مع وصف مختصر لكل قطاع.
- الفصل الثاني عبارة عن الأساس النظري للبحث وقراءة لمـا تـمّ فـي هـذا المجـال سـواء فـي السـودان أو فـي بعـض الـدول الأخـرى فـي القـارة الأفريقية.
- الفصـل الثـالث تنـاول البيانـات وتصـنيفها وتحليلهـا –هـذه البيانـات تشـمل الحجم المروري والوزن العام للعربة(GVW)والمتحصل عليها من شركات خاصة وكذلك من محطة ميزان سواكن بالاضافة الى عملية وزن ما يقارب من(100) عربة بمحاورها .
- الفصل الرابع تناول تحليل البيانات المتعلقة بالحمـل المحـوري والمتحصـل عليها من ميزان سواكن وكذلك محاولة تقـدير الحمـل المحـوري المـوازي لهذا الطريق بعد 25 عاماً .
- الفصل الخامس تناول ما حصل عليه الباحث وما استنتجه والتوصيات .

- ان الاحمال المحورية للشـاحنات تقـارن بالحمـل المحـوري القياسـي (8.16 طـن) لكـل محـور , لقـد ظهـر مـن خلال البحـث ان معـدل الحمـل المحوري لكل شاحنة ثقيلة يعادل 39 حمل محوري قياسـي . بمعنـى اخـر ان مرور شاحنة ثقيلة يعـادل مـرور شـاحنة افتراضـية ذات 39 محـور كـل محور محمل ب 8.16 طن . اما اذا ادخلنـا الانـواع الاخـرى مـن المركبـات كالباصات السفرية والشاحنات المتوسطة الحمولـة فـان المعـدل ينخفـض الى 14 حمل محوري قياسي.

- لمعرفة تاثير زيادة الحمولات على الطرق فقـد وجـد البـاحث ان كـل طـن حمولـة يعـادل 0.52 حمـل محـوري قياسـي اي انـه لـو ان الـوزن الكلـي لشاحنة هو 50 طن فان مرور هذه الشاحنة يعادل مرور 25 حمـل محوري قياسي.
- ان هذه الارقام توضح الحمولات العالية المسلطة على الطرق حيث تـبين عند مقارنتها بمثيلاتها من الدول المتقدمة ان الاثر الذي تحـدثه الشـاحنات المارة على الطرق في السودا ن تعادل 14 اربعة عشر ضعف تلك المـارة علـى الطـرق فـي بريطانيـا و تعـادل 7 سـبعة اضـعاف الاثـر الـذي تحـدثه الشاحنات المارة على الطرق فـي فرنسـا . كـذلك وجـد البـاحث ان الاثـر الذي تحدثه الشاحنات على الطرق في السودان يعادل ثلاثة اضـعاف الاثـر الذي تحثه الشاحنات المارة على الطرق في كينيا.

لذلك يرى الباحث أنـه علـى الهيئـات المسـؤلة عـن المحافظـة علـى الطـرق بتحسين سياسات السيطرة على هذه الحمـولات بتحديـدها ومراقبتهـا وجعلهـا ضمن المستويات القياسية وذلك للمحافظة على سلامةالطرق في السودان.

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Abbreviations and Acronyms	
Abbreviation	**Description**
AASHTO	American Association Of State Highways And Transportation Officials
ADT	Average Daily Traffic
ALCS	Axle Load Control Study
CBR	California Bearing Ratio
CSIR	Councilor for Scientific and Industrial Research
DBST	Double Bituminous Surface Treatment
ESA	Equivalent Standard Axle
GDP	Gross Domestic Product
GVW	Gross Vehicle Weight
HDM	Highway Design And Maintenance Standards Model
HOIS	Highway Organization And Investment Study
km	Kilometer
NA	Not Available
NHA	National Highway Authority
PMS	Pavement Management System
PTA	Preferential Trade Area
RBPC	Roads And Bridges Public Corporation
SDD	Single, Double, Double axles as 1.22-22
SDT	Single, Double, Triple axles as 1.22-222
SE	Super Elevation

T	Ton
TRL	Transport Research Laboratory
WIM	Weigh In Motion
WSR	Western Salvation Road

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