

Sudan University of Science & Technology
College of Graduate Studies & Scientific Research

**Application of UK DCP 3.1 Software on Evaluation of
Structural Capacity and Design of Existing Gravel Roads in
Sudan**

Case Study ALDAMAZEEN -ALKOURMUK Road

**تطبيقات برنامج إختبار الاختراق المخروطي البريطاني (3.1) علي تقييم السعة
الانشائية وتصميم طرق حصوية في السودان
دراسة حالة طريق الدمازين الكرمك**

**A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS OF THE
DEGREE OF MASTER OF SCIENCE IN CIVIL ENGINEERING (ROAD ENGINEERING)**

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بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

قال تعالى : (يَرْفَعُ اللَّهُ الَّذِينَ آمَنُوا مِنْكُمْ وَالَّذِينَ أُوتُوا الْعِلْمَ دَرَجَاتٍ وَاللَّهُ بِمَا تَعْمَلُونَ خَبِيرٌ)

صدق الله العظيم

سورة المجادلة الآية (11)

Dedication

To my wife, family, and friends

Acknowledgments

I thank Allah the most merciful for all I have achieved throughout my life and I pray to Prophet Mohamed (peace be upon him) the ultimate teacher of humanity.

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Mohammed Alfadil

Abstract

Dynamic Cone Penetrometer (DCP) is an instrument designed for the rapid in-situ measurement of the structural properties of existing pavements with unbound granular materials. Correlations to CBR, structural Capacity (SN), resilient modulus, and its use in performance evaluation of pavement layers make it an attractive alternative to more expensive and time consuming instruments. Other possible applications of DCP such as its use in the quality control of compaction of fill.

The main objectives of the study is to analyze the DCP test data using UK DCP 3.1 software to predict in-situ soil strength in terms of CBR value, and to obtain the structural number (SN) in order to estimate the structural Capacity to upgrade Existing low volume Gravel Roads.

In this study a 20 km road section from DAMAZEN ALKORMOOK Road (total length 90 KM) DCP test data had been analyzed (as a case study) using UK DCP 3.1 software to evaluate unbound layers strength, and to determine their thicknesses.

The study results shows that the road section(20 km) should be upgraded by adding 20 cm sub base layer with 30% CBR value, 20 cm base layer with 80% CBR value, double surface treatment for the carriage way, and single surface treatment for shoulder. It is also recommended to complete the old width road to become 7.0m, with 2.5m shoulders, and to rehabilitate the drainage facilities.

We recommend introducing DCP instrument as rapid in situ measurement of the structural properties of existing pavements with unbound granular materials.

مستخلص

يعتبر جهاز الإختراق المخروطي الديناميكي من الأجهزة المصممة لقياس الخواص الإنشائية لطبقات الرصف للطرق الحصوية القائمة. العلاقات التي يتيحها البرنامج علاقات بين كل من نسبة تحميل كلفورنيا، السعة الإنشائية ومعامل الرجوعية، وكذلك إستخدامه الجهاز في تقييم اداء طبقات الرصف جعلت منه خيارا جذاباً مقارنة بالأجهزة الأخرى التي تعد أكثر تكلفةً وهدراً للوقت. كما وأن من الإستخدامات التي يتيحها الجهاز ضبط جودة دمك طبقات الردم.

الغرض الرئيسي من هذه الدراسة هو تحليل بيانات إختبار الإختراق المخروطي الديناميكي بإستخدام برنامج جهاز الإختراق المخروطي الديناميكي البريطاني (3.1)، ومن ثم التنبؤ بقيمة مقاومة التربة بالموقع بدلالة نسبة تحميل كلفورنيا (CBR) وكذلك تقدير الرقم الإنشائي (SN) المستخدم في حساب السعة الإنشائية بغرض رفع مستوى الطرق الحصوية قليلة حجم المرور.

في هذه الدراسة تم تحليل بيانات إختبار الإختراق المخروطي الديناميكي لقطاع بطول 20 كلم (دراسة حالة) من طريق الدمازين-الكرمك (الطول الكلي للطريق 90 كلم) بإستخدام برنامج جهاز الإختراق المخروطي الديناميكي البريطاني (3.1) لتقييم مقاومة الطبقات الحصوية، وتحديد سماكاتها. أشارت نتائج الدراسة الى أن يتم رفع مستوى قطاع الطريق (20 كلم) وذلك بإضافة طبقة أساس مساعد بسمك 20 سم ونسبة تحميل كلفورنيا (CBR) 30 %، وطبقة أساس بسمك 20 سم ونسبة تحميل كلفورنيا (CBR) 80 %، وعمل طبقة معالجة مزدوجة لمسار الطريق، وطبقة معالجة فردية للأكتاف. وكذلك اكمال عرض الطريق الموجود ليصير بعرض 7.0م وأكتاف بعرض 2.5م، وتأهيل منشآت التصريف.

ويوصى البحث بإستحداث إستخدام جهاز الإختراق الديناميكي (DCP) في تقييم الخواص الإنشائية للطرق الحصوية القائمة.

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LIST OF ABBREVIATIONS

Abbreviation	Description
AASHTO	American Association of State Highway & Transportation officials
ASTM	American Society for Testing Material
A.S.	Australian Standard
B.S.	British Standard
CBR	California Bearing Ratio
CSIR	Council for Scientific and Industrial Research, South Africa
DCP	Dynamic Cone Penetrometer
Mn/DOT	Minnesota Department of Transportation
NCHRP	National Cooperative Highway Research Program
TRL	Transport & Research Laboratory
T.R.R.L	Transport & Road Research Laboratory
USCS	Unified Soil Classification System
DFID	Department For International Development
UK	United kingdom
UE	Un engineered Earth
EE	Engineered Earth
EG	Engineered Gravel
C	Cut
F	Fill
C&F	Cut and Fill
S	Sidelong Ground
N	None or unknown