ASSOCIATION OF SOUTHERN AFRICAN NATIONAL ROAD AGENCIES (ASANRA)

ADDITIONAL ROAD TECHNOLOGY DATA REPORTING FORM - BOTSWANA

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TYPE OF ROAD TECHNOLOGY DISCUSSED 1-procedure 2-software 3-equipment 4-materials 5-other	All procedures.
Constraints in promoting innovations in road technologies	1. The lack of local expertise. 2. No proper monitoring of implementation of the guidelines. 3.
List of validated technologies	All validated.

Abstracts for road technologies earmarked for full submission (If long can be submitted separately)

1. **The guideline on the designs, construction and maintenance of Otta seals.**

Dwindling resources for the provision of low volume roads in many developing and industrialised countries have prompted road engineers to search for and develop innovative methods of road design and construction in order to reduce costs and at the same time not impair the quality of the end product. Very often, consideration has to be given to the use of local materials, which may be non-standard or of marginal quality, in situations where the use of conventional materials could be prohibitively expensive. One type of such cost effective in road surfacing is the Otta Seal using graded aggregate.

An Otta Seal is a particular type of bituminous surfacing that was originally developed in the early 1960's by the Norwegian Road Research Laboratory.It derives its name from the location in Norway where it was first used – the Otta Valley. Although originally intended to serve as a temporary surfacing for newly constructed gravel roads, its good performance has led to its adoption as a permanent single or double seal surfacing for both new and existing roads
Otta Seals consist essentially of a 16 - 32 mm thick bituminous surfacing constituted of an admixture of graded aggregates ranging from natural gravel to crushed rock in combination with relatively soft (low viscosity) binders, with or without a sand seal cover. This type of surfacing contrasts with the single sized crushed aggregate and relatively hard (high viscosity) binders used in conventional surface dressings e.g. Chip Seals.

The use of Otta Seals in Botswana dates back to 1978 when this type of surfacing was first used on the Oodi - Modipane road under the Rural Roads Project. Single and double layers were constructed, both on primed and unprimed base courses.
The main purpose of this Guideline is to provide practical guidance on the design, construction and maintenance of Otta Seals. In so doing, the intention is to improve the understanding of this type of road surfacing and to promote its use, not only in Botswana, but also elsewhere in Southern Africa and other countries where optimum use has to be made of the limited funds available for road

construction and maintenance. The Guideline is intended for use by the various organisations associated with the design, construction and maintenance of Otta Seals.

2. The guideline on use of Silcrete and Other Marginal Materials for Road Surfacing

The development, maintenance, and upgrading of the Botswana road network requires, the use of large quantities of road construction materials and aggregates. The properties of many of the local materials that are available fall outside the traditional specifications and can be considered to be of marginal quality. Experience in Botswana, in the sub-region and elsewhere in the world has shown that under certain circumstances, these aggregates can be successfully used as surfacing stone with significant cost savings to the project.

Silcrete, which probably makes up the predominant potential surfacing aggregate in the Kgalagadi (Kalahari desert) is often classified as marginal material.Calcrete is probably the most important pedocrete in Botswana however, generally too soft for use as surfacing aggregate. It is usually being used in combination with silcrete when the silcrete predominates. However,where the normal surfacing aggregate requirements are satisfied, calcrete can be used as a surfacing aggregate up to high traffic levels (up to 3x106 E80s)39,40. Many calcretes are porous and highly absorbent requiring high binder contents. Silcrete is generally considerably harder than calcrete and, although there is often a calcrete component in the silcrete, it has been successfully used for surfacing aggregate on a number of projects. Kalahari Sands cover more than 60 per cent of the country's area and are therefore readily available. They have been used successfully on a number of projects as a sand cover seal with single Otta seals.

The guideline summarises methods for the selection, testing and acceptance of local materials for use in road surfacing and highlights some construction and maintenance aspects. The use of silcretes and other marginal materials obtained in close proximity to road projects generally results in significantly lower seal construction costs. If used correctly and constructed properly, their performance can equal that of conventional materials and their life cycle costs would thus be significantly lower.

3. The Guideline for the use of Kgalagadi Sands in Roads Construction.

There is a general scarcity of traditional road construction materials in Botswana, particularly in the western area of the country which is covered by the Kgalagadi Desert. In this areas the,Kgalagadi sands occur in abundance. However such sands would not normally be specified for use as a structural layer in a pavement as they do not comply with conversional specifications.

The use of Kgalagadi sands in road construction has often being based on the instinctive understanding of which materials can be used. They have been used as a fill material which and have a good bearing capacityprovided there is good drainage on the road. Not much use as sub base material due to the fact that it does not comply with the required specification. Similar sands have been successfully used in roads pavement layers in Australia and Brazil. In this guideline several tests were performed and trail section done using kgalagadi sands. The main aim of the guideline is customise a broad international classification of systems for sands in general in particular based on the a good understanding of the mineralogical and engineering characteristics and several behaviours of local sands.

4.The Guideline on Methods and Procedures for Prospecting for Road Construction Materials.

In order to maintain, construct, rehabilitate or upgrade any road network, large quantities of gravel are required. This Guideline gives advice on the methods and procedures that are appropriate in Botswana for the locationand proving of material sources for road construction.

Construction materials are a non-renewable resource and in view of the increasing importance attached to protecting the natural environment, it is important to make the best use of a source, once found. This implies mapping it and describing it accurately so that it can be correctly classified and therefore correctly applied to a specification. Ideally, a record of extraction should also be kept so that reserves can be utilised economically.Natural gravels are defined in this Guideline as rock products that have been partially broken down chemically and physically by weathering. Some of these products may have undergone transport and re-deposition, or reworking of their constituents by water movement and chemical processes within the soil profile.Gravels occur as relatively small localised deposits, scattered around the landscape and usually buried. The art of prospecting involves looking for clues to the occurrence of useful materials and then digging to see what may be there. Learning to identify features that indicate the presence of gravel from the interpretation of maps and other information is a central activity in prospecting. However, the most important parts are the desk study followed by the field survey and pit evaluation, the latter being a mechanical process that depends on the prospector's experience and the quality and thoroughness of preparatory work.

5.**Guideline on Axle Load Surveys**

During the last 20 years, Botswana has made tremendous efforts in developing and improving the road network to enable efficient development of the country infrastructure.In order to secure and preserve such valuable asset timely and appropriate maintenance/rehabilitation interventions must take place.Overloaded vehicles causes serious damage to all roads, however, the problem may be even more serious in Botswana as most of the country's first generation roads are reaching the end of their design life.Furthermore, overloaded vehicles also become a traffic hazard, especially regarding the heavy vehicles braking system and additional braking distance involved.

It is well known that pavement design and its performance are influenced by the traffic loading on the pavement. The same applies for bridges, although in a different manner. Light vehicles such as cars and delivery vans make a very small contribution to the structural damage of a pavement in comparison to the heavy vehicles. Heavy vehicle wheel load, tyre pressure, frequency and duration together with environmental factors are all important to the performance of the pavements. However, the most significant parameter is the axle load.

The main purpose of this guideline is to provide both a practical and a theoretical guidance on how to conduct an axle load survey and how to analyse and present the data in a professional manner. The Guideline also gives a brief understanding on how road pavements deteriorate under wheel loads and the environment.The axle load weighing described in this Guideline deals only with static weighing and does not deal with the weight of moving vehicles commonly termed Weigh - in - motion (WIM).

6.The Prevention and Repair of Salt Damage to Roads and Runways

The prevention of soluble salt damage to bituminous roads and runways plays a vital role in reducing the cost of both construction and maintenance of roads in Botswana. Without adequate prevention measures and monitoring of soluble salt during construction, the road may deteriorate and will often result in extensive rehabilitation. There is, therefore, a need to draw the attention of designers and engineers to the dangers of soluble salts in the early stages of road construction.Because of Botswana's environment, construction materials and construction water contain soluble salts which Because of Botswana's environment, construction materials and construction water contain soluble salts whichwhen used in construction has resulted in severe damage to roads and runway surfaces. These problems havebeen encountered in several projects including Sua Pan airstrip, Nata-Gweta road, Orapa-Mopipi-Rakops road,Selibe-Phikwe runway, the trans-Kgalagadi road and many others. It is exorbitantly expensive to avoid the use of saline materials and water by importing non-saline alternatives.

By providing guidelines for the use of available saline materials and water where technically feasible, significantcost savings can be achieved.The guidelines discuss the occurrences of salt damage in Botswana and elsewhere worldwide, detailed design andconstruction procedures are provided for the prevention of salt damage. Methods of testing and measurement of saltsare also given together with repair methods where damage has already occurred.The guideline will also be useful to those working in other semi-aid environments of the SADC region where muchof the available materials and contain soluble salts.

7.Technical Auditing of Road Projects

This guideline document on technical auditing of road projects is a step in the right direction towards ensuringthat the road projects undertaken in Botswana are appropriately designed and constructed.
Financial auditing of public funded projects are done but it is the technical audit which had not received anyattention in the past. The need for producing a guideline on such an important aspect arose from the fact thatvery recently, some of the road projects implemented in the country have either failed pre - maturely and/or arein the process of showing distress ultimately leading to failure in the near future. The irony is that it has notbeen possible to portion accountability to parties involved in the contract. It is my hope that Roads authorities,administrators and organizations will start thinking about carrying out Technical Audit of road projects in orderto ensure that the government and public in general get value for investment incurred.

The primary objective of this Guideline is to assist the Department and Consultants appointed to carry out Technical Audits with assessing the required scope of the audit and identification of the appropriate requirements and techniques to be employed for such audits. The guideline describes step by step procedures involved in a technical audit process and details the methodologyrequired to conduct a technical audit. This guideline will certainly go a long way in implementing roadprojects in the right manner and introduce accountability on the part of all Stakeholders, the Client, Consultantor the Contractor.The primary aim of these audits is to ensure that the road is constructed to the design specifications and that the Contractor is paid as per the contract conditions. Technical Audits that may include, destructive testing for all projects. It is essential that the correct degree of audit (neither too much nor too little) be carried out to minimise time and cost. The extent of the Post Construction Audit depends directly on the results of the Initial, Intermediate and Final Audits.

8. The guideline on Planning and Environmental Impact Assessment of Road Infrastructure

Under the policy direction of the Ministry of Works, Transport and Communications, Roads Department exists to provide and maintain adequate, safe, cost effective and efficient road infrastructure for Botswana and our neighbours in order to facilitate national development and intra-regional communications in an environmentally sustainable manner. Implied in these far-ranging responsibilities is the obligation to among others to ensure that existing roads are adequately maintained in an environmentally friendly way in order to provide appropriate level of service for road users.
standards
This guideline presents the methodology to be used for Planning and Environmental Impact Assessments of road projects. The objective of the guideline is to achieve a comprehensive technical basis for decision-making through integrating Environmental Impact Assessments into the planning process. Equally important is facilitating transparency for authorities and communities affected during the planning process. The term environment in this guideline encompasses the economic, ecological and social surroundings of man. Environmental Impact Assessment (EIA) is an evaluation of foreseeable impacts, both beneficial and adverse. It is intended to help reveal mitigating measures and alternatives to optimise positive impacts while reducing or limiting negative impacts. The end result of the EIA process should be a better understanding of the linkages between our society, our natural environment and the sustainable use of our inherited resources.

9.Traffic Data Collection and Analysis

Botswana with a population of 1.70 million in the year 2001 is projected to have a population of 2.25 million in 2016 and a projected annual traffic growth of 8%. With this scenario, it is expected that the total number of vehicles using the Public Highway Network (PHN) will increase substantially. The resulting vehicle fleet, is expected to be over 300 vehicles per 1,000 persons in the year 2016 from the current level (2002) of approximately 90 per 1,000 persons. This indicates a potential demand for investment in transport infrastructure. Proper utilisation of such huge investments necessitates systematic planning for need-based development. Such need-based developments include determination of the required capacity expansion, provision of additional road infrastructure, improvement of existing roads, prioritisation of different development phases and forecasting of which is possible upon collection of traffic data. This is done in order to eliminate bottlenecks in both international and local inter-urban road transport towards providing an efficient and effective road transportsystem.

In the past, routine collection of traffic data in this country was not considered important for the development and management of the road network. In the early 1970's it was realised that a wide variety of information is required in respect of traffic characteristics for proper maintenance, planning, design, maintenance and management of the national road network. This realisation emanated from concerns raised with regard to the amount of traffic (volume), the composition of the different types of vehicles, their speed, total gross weight, number of axles, axle loads and origin and destination of the journeys. Most of this information result in assessment of progressive or rapid deterioration of the road network towards estimating additional cost required to sustain it.As a result, attempts are now being made to adopt suitable road traffic methodologies for conducting road traffic surveys, which are both technically and scientifically sound, and operationally convenient to execute under the country's prevailing conditions. This includes the use of both manual and automatic traffic counters, together with computer analysis of the collected traffic data. During the planning, design, construction and maintenance period of the road network, traffic data becomes an essential element in decision-making, and therefore the format and the accuracy of data collection and analysis is critical. It is with this view that this guideline on traffic data collection and analysis has been prepared.

This guideline has therefore been prepared with the main aim being to provide basic information, concept and principles with respect to traffic data collection and analysis. There are various methods of data collection available and used by different organisations/institutions. This guideline, therefore, is only intended to provide guidance in respect of data collection and analysis, and allows for variation in the methodologies adopted by different users, planners, developers, funding authorities, etc.

10.Operating Procedures for Central Materials Laboratory

This document sets out quality management and operating procedures for the Government Central Materials Laboratory (CML) of the Materials and Research Division of Roads Department. Roads Department is responsible for the construction and maintenance of the primary and the secondary road network in Botswana. It also provides a demand led technical services to other Government Departments when permitted by available resources. The Materials and Research Division (MRD) is responsible for quality control of road projects and for materials related research. An important part of MRD's work is the testing of materials and this is undertaken by CML.

CML is the principal construction materials testing laboratory for Government in Botswana. The quality of services provided by CML has important influence on the quality of Botswana's road infrastructure. The laboratory could also be a standard bearer for the nation's commercial laboratories. This Guideline is intended for daily use of CML staff at all levels for managerial and operational functions including outline of test procedures. The primary aim is to maintain quality, consistency and standards.
The guideline covers the following: Organisation and Management where this part deals the laboratory management personnel whose responsibilities includethe setting up of and monitoring quality assurance procedures. The second part is the Laboratory Management Procedures where it deals with the human resources ,it describes the roles and responsibilities of each functional position in accordance with the schemes of service. The necessary equipment and physical resources are also documented. Thecare for and calibration of testing equipment is emphasised. Accepted quality procedures, which are adopted by the laboratory for procurement, maintenance,calibration and disposal of equipment, are described. The other part is the testing Procedures. The specific methodologies fortype of tests undertaken in the laboratory and in the field are described to ensure consistency and common standards. Many tests are standards or variations ofinternationally accepted methodology and as such are not repeated but merelyreferred to. Lastly the Laboratory Layout and Safetyissues affecting workers within the work place and this part is intended to impressupon the management and the employees in general at CML about the needfor safety in the work place and good housekeeping procedures.