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PERFORMANCE EVALUATION OF SOME NIGERIAN ROADS

NIGERIAN BUILDING AND ROAD
RESEARCH INSTITUTE

Foreword

This report describes the use of the Bump Integrator as a simple and powerful tool for economically evaluating the performance of individual roads and for prioritizing roads for mainentance schedules.

The Bump Integrator measures the road roughness which analysed with other parameters can provide performance criteria for the road. When this exercise is carried out at regular periodical intervals over a number of years, the peformance of any road can be better assessed and the maintenance needs highlighted.

In this report, three busy roads namely the Port- Harcourt-Enugu Expressway, the Ibadan — Lagos Expressway and the Benin — Asaba Highway are investigated. It is hoped that the results of this investigation will be of benefit to the various road maintenance organisations in Nigeria.

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1. INTRODUCTION

The general principle of any pavement surface is to maintain a true planar surface which is free from defect after construction. This principle is never completely achieved due to instability of the subgrade or the imposed layers which constitute the pavement thickness. Instability is a result of some microscopic deformations which occur in the subgrade or within the imposed layers and due to age and constant application of load, increased in magnitude to introduce distortions on the surface of the pavement, and in some cases lead to eventual structural collapse of the pavement. These distortions constitute the pavement surface roughness. The study of the interface between the pavement and the vehicle therefore is aimed at generating reliable data for highway maintenance programming and overall pavement performance evaluation. Road roughness measurements, is in effect, an integration of vehicle vibrations and shocks as the tyres roll over the pavement.

In technical terms, road roughness can be defined as the deviations of a pavement surface from a true planar surface with characteristic dimensions that affect vehicle dynamics, ride quality, dynamic pavement loads and pavement drainage. Road roughness is directly related to riding comfort and safety of vehicle operation particularly at high travel speeds (i.e. over 55 kph). It is common knowledge that on bumpy roads, drivers operating above advisory speeds stand the chance of losing control particularly at sharp curves. The tyre wears also depend on the roughness index of the pavement. It is apparent from the above discussion that road roughness index is the primary descriptor of the overall performance of the pavement. The above fact was recognised by the International Road Roughness Conference held in Brasilia in June 1982 (1). It was generally agreed by the conference participants that optimization of road transport efficiency involves balancing of high initial capital investments required for smooth roads with low maintenance against low capital investments with high maintenance and vehicle operating costs for rough roads. Hence, the road roughness index provdies quantitative criteria for:

(i) assessing riding surface quality of any road.
(ii) comparing the riding comfort of two or more roads.
(iii) assessing the need for renewal.
(iv) comparing the relationship between road user cost and road roughness.
(v) correlating road roughness and frequency of accidents in a particular roadway section.
(vi) determining the relationship between pavement roughness and skid resistance in rainy tropical roadway condition.
(vii) assessing the standard of work from various construction agents and hence creating competition among construction industries.

2. STATE-OF-THE-ART IN ROAD ROUGHNESS MEASUREMENTS

Road roughness can be measured by using any of the two methods:

(i) Visual surveillance and driver ridability rating.
(ii) Response-type equipments which measure surface roughness as a dynamic response of the measuring equipment to that roughness. A brief discussion of each type of equipment is important in order to highlight the output of each equipment and inherent advantages.

2.1 Visual Surveillance and Driver Ridability Rating

Driver ridability rating and overall visual surveillance of a highway is the traditional method of evaluating highway deformation and facility maintenance. It is usual to have two to four drivers drive along a section of a highway at a given speed after which they are required to complete questionnaires on the state of the roadway inventory. In some cases, similar questionnaires are distributed to randomly selected vehicle drivers for their response. In the above two survey methods, useful information can be generated from the questionnaires and photographs of road deformations. However, experience has shown that driver ridability ratings are in most cases subjective. The fact that a rural driver and urban driver have different conception of road roughness justifies the above statement. It is apparent that driver biases can be reflected in the ratings. This situation makes data analysis inconsistent.

From the above discussions, visual surveys and driver ratings are of limited use. There is a great need to adopt a more quantitative technique such as the use of a road roughness equipment. However, it can be used as a support or a check on other type of measurement.

2.2. Response-Type Road Roughness Measuring Systems

Two of the most commonly used roughness measuring systems are the Bump Integrator and the Maysmeter. The basic difference between the two types of instruments is that the former is equiped with a single testing wheel while the latter is equiped with two testing wheels that traverse the wheel tracks of vehicles during roughness measurement.

The equipment available at the Nigerian Building and Road Research Institute is the Bump Integrator. This consists essentially of a single wheeled trailer that is made up of a rectangular chassis within which a pneumatic-tyred wheel is mounted. The Integrator unit which is mounted on one side of the chassis measures the relative movements induced between the chassis and axle of the vehicle by the surface roughtness.Plate1 shows a sketch of the Bump Integrator. The main disadvantage in the Bump Interator system is that measurements are generally made at low speed of 32 ± 1 kph whereas advisory speed for vehicles is as high as 88kph. Also, when the equipment is deployed, the testing wheel runs between wheel tracks of motor vehicles. Thus the bumps recorded are the deformations between the tracks and not those on wheel tracks caused directly by motor wheel loads.

3. FIELD INVESTIGATION

3.1 Preamble

The Nigerian Building and Road Research Institute embarked on a study to evaluate the performance of some Nigerian roads with the aim of programming them for appropriate maintenance schedules. This study requires the continuous evaluation of the selected roads at regular intervals. The selected roads include in Enugu — Port Harcourt Expressway, the Lagos — Ibadan Expressway, and the Beinin — Asaba road. These are roads with heavy traffic in terms of volume and loading. The choice of the Kano — Zaria — Kaduna highway was sidelined pending the completion of the new Kano — Kaduna expressway. This in fact will be a model as the road performance will be monitored and evaluated right from the period the road is opened to traffic.

The scope of the study involves conducting

(i) road roughness measurements using the Bump Integrator

(ii) visual road condition survey, and

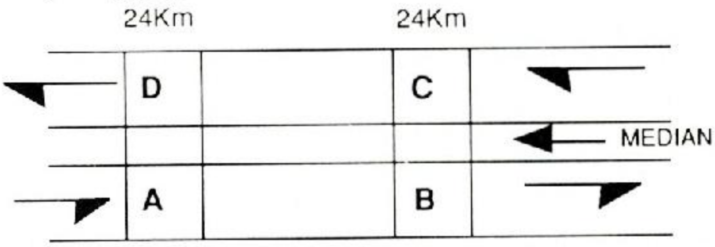
(iii) traffic survey.

The results generated are analysed to evolve some meaningful recommendations.

3.2 Road Roughness Measurements

The road roughness measurements were achieved by towing the Bump Integrator with a Landrover vehicle over the test lane at the required speed of 32.0 ± 1 km/h. On the expressways, the test lanes are restricted to the slow lane so as not to obstruct the flow of fast moving vehicles. For the 2-way Benin — Asaba highway, the Bump Integrator measurements were made on Saturday/Sunday mornings when the traffic volume was low.

In each of the three roads investigated, bump measurements were carried out on either direction of two test sections. Each test section is 24 km long. For the expressways, the test sections are designated as shown in the sketch below.



A, D — Test Section 1
B, C — Test Section 2

SCHEMATIC DIAGRAM SHOWING THE DESIGNATION OF TEST SECTIONS ALONG THE EXPRESSWAYS

The two test sections along the Enugu — Port Harcourt Expressway are the road stretches between Km200 - 177 and between Km 100 - 77 while those for the Lagos — Ibadan Expressway are the road stretches between Km 96 - 73 and Km 50 - 27. For the Benin — Asaba highway, the test sections are the road stretches between Km 96 - 73 and Km 46 — 23.

During the bump measurements, recordings of the integrator counter values, the number of tyre revolutions and the time are made. These are computed and analysed to obtain the Corrected Irregularity Indices along the test sections. Typical test data sheet is shown in Appendix 1, while the summary of the test results of the Corrected Irregularity indices are presented in Tables 1a, 1b, 2a, 2b, 3a and 3b. Figs 1, 2 and 3 show the plots of the corrected irregularity indices against the respective distances on either direction for the Enugu — Port Harcourt, Lagos — Ibadan and Benin — Asaba roads respectively.