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ORIGINAL ARTICLE

# Short term performance and effect of speed humps on pavement condition of Alexandria Governorate roads

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**Abstract** The road network in Alexandria Governorate includes approximately 3800 km of roads. In the recent years, it was observed that some of these roads failed prematurely within 3–5 years of construction. In addition, there has been an increased use of speed humps that were placed with obtaining proper permits and pavement distresses were observed near these humps.

A research study was initiated to evaluate the performance of pavements in Alexandria Governorate, to identify the main deterioration patterns on these pavements, and to investigate the possible effect of illegal speed humps on condition. The research methodology involved selecting a representative sample of the pavement projects and analyzing the pavement condition of these projects both at the network level and at the project level.

Some performance trends were observed and found to be statistically significant, including superior short-term performance of projects with good or average construction QC records when compared to poor construction QC records. Raveling was the most widely observed distress, while load-related distresses were not common. The analysis also showed that the presence of improper speed humps significantly affected the pavement condition, reducing the PCI of the pavement sections by up to 19 PCI points.



## 1. Introduction

Alexandria is the second largest city in Egypt, with a population of 4.1 million. It is located in Alexandria Governorate, which extends about 72 km along the coast of the Mediterranean Sea in northwestern Egypt. It is also the largest Egyptian city lying directly on the Mediterranean coast and the home of Egypt's largest seaport.

Based on 2011 statistics, the road network in Alexandria includes approximately 3800 km of roads, of which 78% are paved and 22% are unpaved [1]. These roads are maintained by the Roads and Transportation Directorate (RTD) in the Governorate of Alexandria. The total annual budget of pavement rehabilitation and construction projects is approximately

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50 million Egyptian pounds [2], although this budget can change from one year to the other.

In the recent years, some roads within the RTD jurisdiction failed prematurely within 3–5 years of construction. The failure was primarily a functional failure due to excessive roughness and/or raveling. These observed failures warranted a more in depth evaluation of the general pavement condition of the road network to identify critical distresses and possible causes of such premature failures.

Speed humps are raised pavements spanning across or partly across a roadway, thus; forcing drivers to reduce the speed of their vehicles. Speed humps are widely used on the streets of Alexandria Governorate for traffic calming in residential areas. Typically, speed humps are constructed by RTD based on a traffic warrants and according to the Egyptian Code of Practice specification [3]. However, there has been an increased use of speed humps that were placed without obtaining proper permits and did not meet the design specifications. Moreover, these speed humps are sometimes constructed in a manner that may cut the storm water drainage path causing surface water ponding over the pavement surface. These improper speed humps affect the pavement condition and might be a factor in reducing the pavement service life [4].

As a result, a research study was initiated with the objectives of evaluating the performance of typical flexible pavements in Alexandria Governorate, identifying the main deterioration patterns on these roads, and investigating the possible effect of improper speed humps on pavement condition.

The research study involved the selection of representative sample of the pavement projects, the evaluation of the pavement condition and quality control records of selected sections from these projects. The analysis of the pavement condition of these sections was carried-out both at the network level and at the project level.

## 2. RTD standard practices

RTD has a standard practice for new road construction and existing pavement rehabilitation. The standard pavement type used is flexible pavement, with rigid pavement used only in very special cases and on limited sections. For new construction, the typical pavement cross section is 40-mm of asphalt concrete surface course, 50-mm of asphalt concrete binder course, and 200-mm of aggregate base course over prepared subgrade soil. Existing pavement rehabilitation involves milling of the top 40-mm of existing pavement, using a leveling asphalt concrete course to adjust the grade, and adding 40-mm of asphalt concrete surface course. These standard practices are typically implemented, unless specific reasons are observed in the project under consideration, such as excessively weak subgrade soil or excessively high truck traffic volumes. All materials and pavement layers follow the guidelines of the Egyptian Code of Practice (ECP) for Road Works [3].

Quality Control (QC) during construction involves testing of aggregate layers and asphalt concrete mixes in accordance with the requirements of the standard test methods for the Egyptian Authority of Roads and Bridges [5]. If the constructed pavement did not meet the QC requirements, the contractor is penalized by deductions applied toward his payment in accordance with the ECP [3]. In addition, the contractor is required to provide a warranty on his work for a three years period, where he is required to repair any defects observed on the road that are related to defective materials or poor workmanship. Other surface defects, such as those resulting from utility cuts, poor surface drainage, etc., are not the responsibility of the contractor and they automatically annul the contractors' warranty.

## 3. Sections selection

In this research study, sections were selected from typical projects in Alexandria Governorate. These projects were selected such that they would represent the typical practices for RTD for both construction and rehabilitation projects. The selected projects were all constructed in the summer of 2009, such that at the time of this research, they would be at, or immediately after, the expiration of the projects standard warranty. The selected projects included rural and urban roads, reconstruction and rehabilitation projects, and were distributed over all seven administrative districts in Alexandria. In total, 24 projects were selected for this study. It is worth mentioning that these projects were constructed by different contractors, but subject to the supervision of the same team from RTD and the Consultant.

Each project was represented by three [3] pavement sections, with a total of seventy-two (72) sections considered in the research study. The sections were pre-selected prior to field data collection, such that each section was 150-m long along the travelled lane. The sections were selected in a manner to represent the entire project, where one section was selected near the start of the project, one section near the middle of the project, and one section near the end of the project. Table 1 shows the distribution of the projects over the districts in Alexandria and the number shown between brackets represents the total number of sections in all projects. As can be noted from the table, not all districts included all types of activities since no projects were carried-out during the selected study period to match the research requirements.

## 4. Data collection

For each project/section, field and office data were collected. Field data included the pavement condition survey, while office data included the project information and QC records for the Asphalt Concrete (AC) surface and binder layers.

### 4.1. Condition survey

The objective of the condition assessment was to assess the surface condition of the existing pavement after approximately four [4] years of service. Each pavement section was assessed through a visual distress survey, using a distress rating methodology according the ECP [3] and ASTM D6433-03 [6] distress rating methodologies, which are the standard local condition survey methodologies. The extent and severity of each distress type was measured and logged. All field data were entered on a data collection form, which was later entered into an MS EXCEL spreadsheet following a QA/QC review. The extent and severity levels for each distress type for asphalt concrete (AC) considered in the survey are shown in Table 2.

During data collection, the presence of speed humps within the section was also noted. The presence of these humps was