IDENTIFICATION OF PROBLEMS IN RIGID PAVEMENTS IN AMPARA DISTRICT AND PROPOSED SOLUTIONS

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ABSTRACT: Construction of rigid pavements is nowadays most widely used in road construction industry. Rigid pavements tend to fail with time due to many reasons. Although the reasons for the failures and the remedial measures are well documented in literature still the problems are common in the road construction industry of Sri Lanka. Hence, the aim of the present study is to shed some light on this issue. The objective of the present study is to identify the problems associated with rigid pavements and recommended solutions in Ampara district, Sri Lanka. Through literature survey, problems in rigid pavements and how to identify them were found. Then 108 randomly selected rigid pavements covering a total length of 98 km in Ampara district were examined by field survey to identify the problems present in recently constructed rigid pavements. The failure types were identified with the help of literature survey and the exerted reasons on the failures were studied. Altogether 10 types of various failures were identified in randomly selected all rigid pavements, and 5 major types of failures were focused and stated in this paper. Polished aggregate was the most common problem among the identified failures followed by scaling and transverse cracking. The reasons and solutions were given to those problems by observing those failures and discussing with the responsible road owning authorities. Some solutions were given in order to prevent failures of newly constructed rigid pavement in future.

Keywords: Rigid pavements, Failures of Rigid Pavements, Polished Aggregate

INTRODUCTION

Roadsare classified into two main categories based on their structures as rigid pavements and flexible pavements. Concrete is normally used to construct the wearing surface of a rigid pavement which acts like a slab over any irregularities in the underlying supporting material. Bituminous materials are used to construct the wearing surface of flexible pavements.

Attention should be taken to design and construct of subgrade and subbase since it is essential to ensure the structural capacity and ride quality of all types of pavements. Pavement performances with respect to bearing strength, consolidation and moisture susceptibility are strongly influenced bysubgrade and subbase (Delatte, 2008). For Rigid pavements, the requirements may vary considerably depending on subgrade soil type, environmental conditions, and amount of heavy truck traffic (ACPA, 1996).The terminologies such as subgrade and subbase were used in the 1993 AASHTO Design Guide to design the pavements(AASHTO, 1993).

During rainstormthe damage to bituminous surfaced roads are faster than concrete roads, while gravel roads become very dusty in dry weather condition causing safety and health problems. Problems of dust formation and wet weather damage to roads can be easily overcome by constructing concrete roads (ACPA, 2009).

Rigid pavements have a life span of more than 40 years compared to the bituminous which has 10 years life span (Smith and Maillard, 2007). In additionrigid pavements distribute loads much more widely than asphalt pavements; hence the pressures on the subbase and subgrade are less than the flexible pavement(Kohn and Tayabji, 2003).Furthermore, rigid pavements require little maintenance; whereas bituminous roads need frequent repairs due to damage occurred by traffic and weather, high surface resistant to automobile fuel spillage and environmental friendly since concrete is 100% recyclable(Rens, 2009).Construction of rigid pavement is also financially viable as rigid pavements require less thickness than the bituminous pavements when same and equal traffic load is applied to the pavement(Garber and Hoel, 1999).

The main disadvantage is rigid pavement requires a high initial cost for rectification compare to bitumen roads as the entire concrete slab needs to be replaced when it damages. In addition the rigid pavement tends to fail across the construction joints provided between the adjacent slab panels as it acts as a weak plane across the section. Furthermore there is a delaying for allowing normal traffic to newly constructed rigid pavements since concrete requires 28 days for achieving utmost compressive strength (Singh, 2008).

Since rigid pavements have more advantages than flexible pavements, construction of rigid pavements is nowadays widely used in road construction industry in Sri Lanka. Though different types of studies were carried out on failures of rigid pavements in some countries, not much effort were taken in east coast of Sri Lanka. This study was focused on problems in rigid pavement in Ampara district,Sri Lanka since 90% of low volume roads are rigid pavement and most of them failed within 5 years period of construction.

2. METHODOLOGY

This study based on the field surveys and questionnaire surveys of rigid pavements in Ampara district. 108 independently selected rigid pavements, which had a total length of 98 km in Ampara district, were covered. The main objective of the field surveys was to identify the failures occurred in recently constructed rigid pavements. The roads selected for this study were constructed in between 2008 to 2014.

The different types of problems found in these roads were identified by communicating people in relevant authorities such as Road Development Authority, Road Development Department, Urban Council, Municipal Council and Pradeshiya Sabha. In addition to that, some problems were identified from the literature review carried out on rigid pavements. Rectification methods were proposed to those failures found in rigid pavement from the discussion with Engineers and other technical people in aforementioned road governing bodies.

3. RESULTS AND DISCUSSION

Altogether 10different types of failures were identified in 108 roads from the field surveyand shown in Figure 1 below.

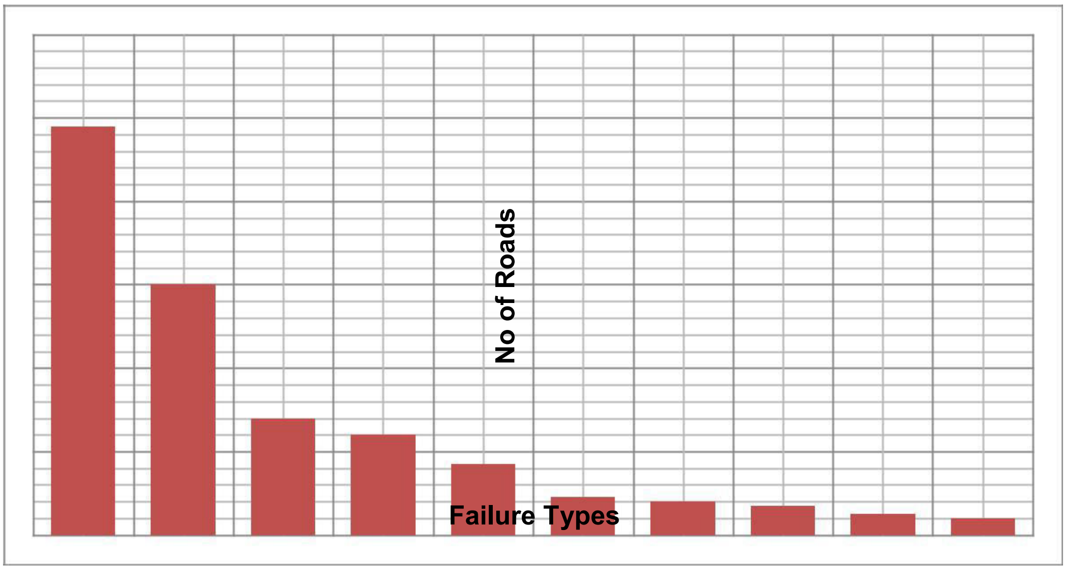

Figure1. Severity of different types of failure

The above bar chart illustrates the different types of failures found in rigid pavements in Ampara district. Polished Aggregates was the most severe failure type as it was identifiedin most number of roads. Map cracking was the less significant failure pattern as it was found in only 4 roads. Some of roads have multiple failures too.Among those failures first 5 types of failures shown in Figure 1 were reported as most significant,and were focused in this paper and discussed below with the causes, and proposed solutions.

a. Polished Aggregates

Figure2. Polished Aggregates

This is the most significant problemidentified in rigid pavements in Ampara district from the field survey. Almost 90% of roads have failed by the polished aggregates. When examining the failure surface shown in Figure 2, coarse aggregates exposed to environment as fine particles removed from the surface due to vehicle abrasion. The main causes areusage of poor quality cement which does not have good abrasion resistance and poor finishing. Based on the questionnaire survey it was revealed that most of the labourers were not trained well and poor supervision of construction activities particularlyin finishing during the construction. This problem can be rectified by overlaying asphalt layer over the existing concrete surface.

b. Scaling

Figure3. Scaling

This problem shown in Figure 3 was reported as the second major failure type followed by polished aggregates in rigid pavements in Ampara district. Almost this problem found in 60 roads. When observing the failure areas, they appeared like a pot holes of around 1m diameter, and without top concrete layer. Sub grade inside the failure areas exposed to the environment and it gradually weakened due to vehicular load. Main cause was identified from the field survey that is concrete which had not been air-entrained and poor quality materials were used during construction.This problem can be temporarily prevented by laying the asphalt over the failure surface.

c. Transverse Cracking

Figure4. Transverse Cracking

Crack patterns appeared in parallel to the transverse direction as shown in Figure 4 were found in 28 roads. When observing the failure no transverse joints were provided between adjacent slabs. Though design guidelines stated that the transverse joints should be placed in 6m intervals, transverse joints were found in 12m intervals in failed areas.This shows the ignorance of guidelines and poor construction practices of relevant agencies duringconstruction. Removing the portion of cracked slab andplacing transverse joints between two panels is the best rectify method for this problem.

d. Corner Breaks

Figure5. Corner Breaks

Corner breaks is the one of significant failure, and was identified in 24 roads. Portion of slab panel at the corner broke as shown in Figure 5 when it was observed during field survey. Main cause for this failure is high stresses acting at the corner of road due to trucks loaded heavily travelling on the edge of road. Furthermore, dowel and tie bars were not observed in the failure slab areas which are essential to connect the adjacent slabs. This shows the poor construction practices and lack of supervision during the construction. This problem can be rectified by providing dowels and tie bars through the cracked slab to adjacent slabs and concrete the failure portion again.

e. Erosion of Sub Base

Figure6. Erosion of Sub Base

This problem was identified in some part of the roads where the drainage facilities were not provided along the road as shown in Figure 6.Moreover some of failures were due to the improper embankment where road crosses the steep slope.Due to improper drainage flood water penetrates below the road surfaceand erodes the subgrade of road. This problem was identified in 17 roads. Constructing drainage network along the road is the one of the remedial action for this problem.

4. CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusions

In the present study, the problems associated with rigid pavements were identified from past literature. This study provided a valuable insight to identify different problems in rigid pavements in Ampara district. This was followed by field surveys in 108 concrete roads covering a total length of 98km.The following conclusions could be made on problems identified in rigid pavements in Ampara district:

- From the all observations it was concluded that main reason for all failures is poor construction practices during construction stage as design criteria and strength details of roads were checked with relevant authorities during field survey and was all satisfied with the required criteria.
- Usage of poor quality materials, inappropriate usage of machineries, involvement of unskilled laboursrsfor skill works and poor supervision were identified as the root causes for failures of rigid pavements
- Polished aggregates failure was found as the most common problem in Ampara district followed by scaling and transverse cracking.
- Best corrective actions to prevent this types of failures in future construction of roadsareproper construction and maintenance methods during pre and post construction. This should be confirmed and monitored by the road governing bodies.

4.2 Recommendations

In this study, field visit and questionnaire surveys were carriedout to identify the failures. Some experiments can be carried out to identify the propagation of each failure with loading and time howeverit involves the use of some equipment and testing (both are costly). If the facilities are available it may be better to carry out tests and do detailed studies to pinpoint the cause, failure propagation and the remedial measures. Also a check list can be prepared to improve the construction process. Effectiveness of the remedial measures also can be identified with such studies and a properly updated database.

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