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Factors Affecting The Sustainability Of The Asphalt Roads: A Case Study Of Irbid Inner Ring Road, Jordan

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ABSTRACT

This study discusses the impact of weather, road design and method of construction on the asphalt's sustainability in the Inner Ring Road, in Irbid, Jordan. At most importance and care should be given to these factors in order to give more durability for our asphalt. At the same time, these factors are have combined effects, for example, high moisture in the base, immediately below the asphalt, will cause a damage to the asphalt, even if the asphalt mixtures have been very good. The asphalt in this road was laid during the cold and rainy season and therefore the layers below the asphalt, especially the base and the sub base were not dry enough. The cold weather during and after laying also caused damage. There are other factors affecting the road, but in this study, the impact of weather alone is looked into. The study is on a road in the city of Irbid, North of Jordan, that has been found affected by the above mentioned factors.

Keywords : 1.Asphalt, longitudinal cracks, spider cracks

Introduction

This road is located in the eastern part of Irbid city, Northern Jordan. The owner and supervisor of this road is the Ministry of Public Works and Housing, Directorate of Works in Irbid Governorate. The construction of the road had been executed by a local company. The Road has been constructed in 2008-09. The area witnesses frequent rains fall during winter season, mild weather in summer and hot weather sometimes. As indicated in the tender file documents, the road bed soil has been improved with a 40cm rock fill layer, then several layers of sub-grade materials with 20cm thickness, followed by 20cm of sub base layer, and 20cm of base layer, crushed lime stone used for sub base and base layers. Thin layer of prime coat below the asphalt pavement consists of a single layer of wearing course with 7 cm thickness. A number of roads in very good situation were observed in Jordan during the study. But this particular road constructed in the winter season is in a very bad condition tempted to take up this study.

Existent situation

Based on the field visit to the site, review of the tender documents of the road and the laboratory tests related to all the components of the road, the following facts have been identified.

- The soil under the road consists of red clay with low capacity that is very sensitive to moisture. Since it has a high PI, the water has a major impact on this type of soil.
- The water collects on both sides of the road, and during some of the heavy rain days, it may accumulate up to the level of the asphalt layer; then the exposed components of the road below the asphalt will absorb water. The water will be absorbed into inside also, and the voids will be filled by the water, which later, when the weather become warm, will increase the moisture in the road layers below the asphalt.

- The slope of the road from the eastern side is sharp and not appropriate. In this case would be the flow of water quickly, and the sweep of the material from this slope, because it is already not protected, which will lead to weakness of this region, and resistance load in this region will be weak.

- There is no system to drain rainwater from the surface of the road, which led to the penetration of water into the layer of asphalt and then into the base layer sub base and even below, which caused a high level of humidity within these layers. This in due course will weaken the strength of these layers against the loads on the road,

- There is no protection for the slopes on both sides of the road to prevent the water from going through the component materials of the road by considering the absorption factor.

- The construction of the road took place during the rainy months.

- The asphalt laying was carried out at the beginning of April, 2009, the period during which the weather is wet. Therefore it could be inferred that in the rain season, all asphalt works should be stopped.

- The materials that do not comply with the required specifications have been remApparent defects on the road and causes

A. Presence of spider cracks accompanied by a settlement in multiple places in the asphalt wearing course layer [

Fig. 1 Spider cracks and settlement



The following causes have individually or severally caused the damage.

- The presence of high moisture content in that area of the base layer beneath the asphalt, due to the lack of protection for the shoulders and the slopes, and the lack of a system of drainage,
- As the wearing course layer has been done during the cold weather then there is a possibility that the asphalt has become cool, which leads to an increase in the air voids and a lack to obtain the required density; also the voids in the asphalt layer and in the below layers, will be filled of water, this also help to keep the moisture content high for more time.
- Pressure of vehicles on the asphalt layer with the presence of moisture in the layers of the base and below is also be the cause of these damage.

A. There is a large number of longitudinal cracks in the asphalt layer of the asphalted shoulder, and many of them are expanded and are very dangerous.

Fig.2 Longitudinal cracks



The following causes have individually or severally caused the damage.

- Lack of drainage system for the rain water both on the edge of the road and below the side slopes, these made the water coming into the component materials of the road and weaken.
- Lack of protection for the side slope of the road by such a technique as a concrete paving or by stones
- The erosion of the lower parts of the side slopes of the road due to the free flow of rain water
- Due to the high moisture content because of weather, the compaction will not be enough in the layer of base and the below layers on both sides of the road and at the shoulders
- It is noted that the width of the shoulder is not proportional to the differential level between the surface of the road and the natural neighboring area, can be noted by the Fig. the difference level, it is more than 2 m

Fig.3 Cracks seen on the roads Fig.4 Cracks seen on the roads



More width in the shoulder gives a strong support to the road from slipping, by its weight.

Where there is no difference between the top level and bottom level of the road, the vicinity land that is a part of the road, acts as a shoulder and absorbs the loads (n Fig. 4). Similar cracks are not seen in such areas.

A. Longitudinal miniature cracks in the asphalt layer on the carriageway of the road

The following causes have individually or severally caused the damage.

- These cracks are a continuation of the ones that are on the hard shoulder due to lack of protection of the road from water;

Fig. 5 Longitudinal miniature cracks



- The thickness of 7cm of one layer of asphalt wearing course pavement is not sufficient for such roads exposed to heavy traffic with various loads, and different climatic conditions ranging from cold in the winter to the semi-hot in the summer season. It is necessary to have at least one layer of asphalt base course, under the layer of wearing course so that the base course layer will distribute the wheel loads over the base, sub base and sub grade layers, load-associated cracking but the thickness well-supported pavements do not bend as much under loading as thin or poorly supported pavements do. Therefore, they have longer fatigue lives.

Conclusions

Through the study of the state of this particular road, it is noted that cracks will be dangerous in the near future if the necessary maintenance will not be done, the reasons of these cracks are fundamentals in road building. These causes are well known to everyone concerned, so it should be taken care of before the construction of the road.

- The road under study, including its asphalt layer, was constructed during winter, rainy and cold season. As a result, the layers of the road were not dry, especially the base and sub-base layers before laying the layers of prime coat and asphalt.

-The clay ground was not removed and replaced with the selected materials to the required depth, to improve the road base.

-There has been no provision for the much needed protection of the side slopes and the soft shoulders from water. Consequently water entered into the components of the road, and increased the weight of the road verges. The increased content of water has weakened the ability of the road to remain steadfast causing the danger of cracks which started from the shoulders.

-The side slope, especially the eastern side of the road, is sharp and without sufficient protection, and the shoulder width is not enough heavy to have the ability to form a suitable support to the road stability.

- Insufficient asphalt thickness, should be laid at least one layer of asphalt base course. - Asphalt laying was done during inappropriate climate, when it was wet and cold causing cracks and damage (Fig. 1).

All of the above makes the road vulnerable to such cracks and damage.

From this case study, it can be inferred that the road required urgent maintenance otherwise it will get more damage and maintenance and repair will be more difficult. First, the cracks should be sealed. The slopes of both sides of the road should be covered with a layer of concrete to protect them. The asphalt should be removed to dry the materials in the base and to be replaced by new asphalt (fig.1).

It is also necessary to lay a new layer of wearing course thickness (4-6 cm) on the existing layer.

It is a fact that the Directorate of Public Works in the province of Irbid, as the other departments of the Ministry of Public Works in Jordan, has a good team of engineering and technical specialists, working under the General Specifications issued by the Ministry, and also according to the American Society for Testing and Materials (ASTM) and British Standards (BS).

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