Mustansiriyah University / Faculty of Engineering

Highway &Transportation Engineering Department

Highway Maintenance Course

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Lecture One

General Introduction

1-1 Introduction

The maintenance of roads involves the coordination of a wide range of seemingly unrelated activities. In practice to achieve a good standard of effective maintenance it is essential that different aspects of the work should integrate smoothly. The task facing the engineer inroad Maintenance is to maintain a network of roads within available budgets. This is made difficult by the amounts of roads which are built to inadequate standards and the increase in both the volumes of trafficand in the axle loadings combined with decreasing budgets and the expectation of further cuts in public expenditure. This is noticeable both in rural areas where the intensification and diversification of agricultural production have resulted in minor roads of minimal pavement construction having to accommodate relatively largevolumes of traffic and more particularly commercial vehicles which on occasion can barely fit onto the road, and in urban areas where the growth of towns and cities has incorporated areas serviced by minor roads now carrying heavy volumes of traffic.

1-2 Maintenance of Road

The goal of maintenance is to preserve the asset, not to upgrade it, maintenance must be done regularly. Road maintenance comprises “activities to keep pavement, shoulders, slopes, drainage facilities and all other structures and property within the road margins as near as possible to their as-constructed or renewed condition” (PIARC 1994).

It includes minor repairs and improvements to eliminate the cause of defects and to avoid excessive repetition of maintenance efforts. For management and operational convenience, road maintenance is categorized as routine, periodic, and urgent.

1-2-1 Type of Maintenance

Road maintenance is a crucial aspect of ensuring the longevity and safety of our transportation infrastructure. It involves a range of activities aimed at preserving and improving the condition of roads, highways, and streets. There are various types of road maintenance techniques that are employed depending on the specific needs and conditions of the road. In this section, we will explore some of the common types of road maintenance

1- Routine Maintenance

Which comprises small-scale works conducted regularly, and aims "to ensure the daily pass ability and safety of existing roads in the short-run and to prevent premature deterioration of the roads" (PIARC 1994). Frequency of activities varies but is generally once or more a week or month. Typical activities include roadside verge clearing and grass cutting, cleaning of silted ditches and culverts, patching, and pothole repair. For gravel roads it may include regarding every six months. Routine maintenance also involves the inspection and repair of signs, markings, and traffic control devices. This type of maintenance is essential for ensuring the safety and functionality of the road network.

2- Periodic maintenance

Which covers activities on a section of road at regular and relatively long intervals, aims "to preserve the structural integrity of the road" (WB Maintenance website). These operations tend to be large

scale, requiring specialized equipment and skilled personnel. They cost

more than routine maintenance works and require specific identification and planning for implementation and often even design. Activities can be classified as preventive, resurfacing, overlay, and pavement reconstruction. Resealing and overlay works are generally undertaken in response to measured deterioration in road conditions. For a paved road repaving is needed about every eight years; for a gravel road re-graveling is needed about every three years.

3- Preventive Maintenance

Preventive maintenance aims to address potential issues before they become major problems. It involves proactive measures to preserve the structural integrity of the road and prevent deterioration. Some common preventive maintenance techniques include crack sealing, seal coating, and pavement rejuvenation. By applying protective treatments to the road surface, preventive maintenance helps to extend the lifespan of the pavement and reduce the need for costly repairs in the future.

4- Corrective Maintenance

Corrective maintenance is performed to address specific defects or failures in the road infrastructure. This type of maintenance is reactive in nature and focuses on repairing or replacing damaged components. Examples of corrective maintenance activities include pothole patching, pavement resurfacing, and bridge deck repairs. Corrective maintenance is crucial for maintaining the safety and functionality of the road network, especially in areas where significant damage has occurred.

5- Emergency Maintenance

Emergency maintenance is carried out in response to unforeseen events or emergencies that pose an immediate threat to road users. This type of maintenance is often required after natural disasters such as floods, earthquakes, or severe storms. Emergency maintenance activities may include debris removal, temporary repairs, and the restoration of damaged infrastructure. The primary goal of emergency maintenance is to restore the road network to a safe and passable condition as quickly as possible.

6. Rehabilitation and Reconstruction

Rehabilitation and reconstruction are more extensive forms of road maintenance that involve major repairs or upgrades to the road infrastructure. Rehabilitation typically involves restoring the pavement structure and improving its load-carrying capacity. This may include activities such as milling, overlaying, and full-depth reclamation. Reconstruction, on the other hand, involves the complete removal and replacement of the existing road. These types of maintenance are necessary when the road has reached the end of its service life or when significant improvements are required.

7. Seasonal Maintenance

Seasonal maintenance focuses on addressing the specific challenges posed by different weather conditions throughout the year. In regions with harsh winters, this may involve snow and ice control measures such as plowing, salting, and sanding. In areas prone to heavy rainfall, seasonal maintenance may include drainage system cleaning and repair to prevent flooding. By adapting maintenance activities to the changing seasons, road agencies can ensure the safety and usability of the road network year-round.

8. Environmental Maintenance

Environmental maintenance involves activities aimed at minimizing the impact of road infrastructure on the natural environment. This may include erosion control measures, vegetation management, and the implementation of sustainable drainage systems. Environmental maintenance is essential for

preserving the ecological balance and minimizing the negative effects of road construction and maintenance on surrounding ecosystems.

In conclusion, road maintenance encompasses a wide range of activities aimed at preserving and improving the condition of our transportation infrastructure. From routine maintenance to emergency repairs and environmental considerations, each type of maintenance plays a crucial role in ensuring the safety, functionality, and longevity of our roads. By implementing a comprehensive road maintenance program that incorporates these various types of maintenance, we can create a sustainable and efficient road network that meets the needs of road users for years to come.

1-2-2 WHY IS MAINTENANCE IMPORTANT?

Roads are among the most important public assets in many countries. Road improvements bring immediate and sometimes dramatic benefits to road users through improved access to hospitals, schools, and markets; improved comfort, speed, and safety; and lower vehicle operating costs. For these benefits to be sustained, road improvements must be followed by a well-planned program of maintenance. Without regular maintenance, roads can rapidly fall into disrepair,

Preventing realization of the longer term impacts of road improvements on development, such as increased agricultural production and growth in school enrollment.

Postponing road maintenance results in high direct and indirect costs. If road defects are repaired promptly, the cost is usually modest. If defects are neglected, an entire road section may fail completely, requiring full reconstruction at three times or more the cost, on average, of maintenance costs.

The repair costs rise to six times maintenance costs after three years of neglect and to 18 times after five years of neglect as seen in Figure 1.

To avoid such escalating costs, SANRAL first "allocate[s] its available funding resources to ideal maintenance actions (e.g., reseals and overlays), and thereafter to more extensive Maintenance actions (e.g., rehabilitation), and finally new construction.

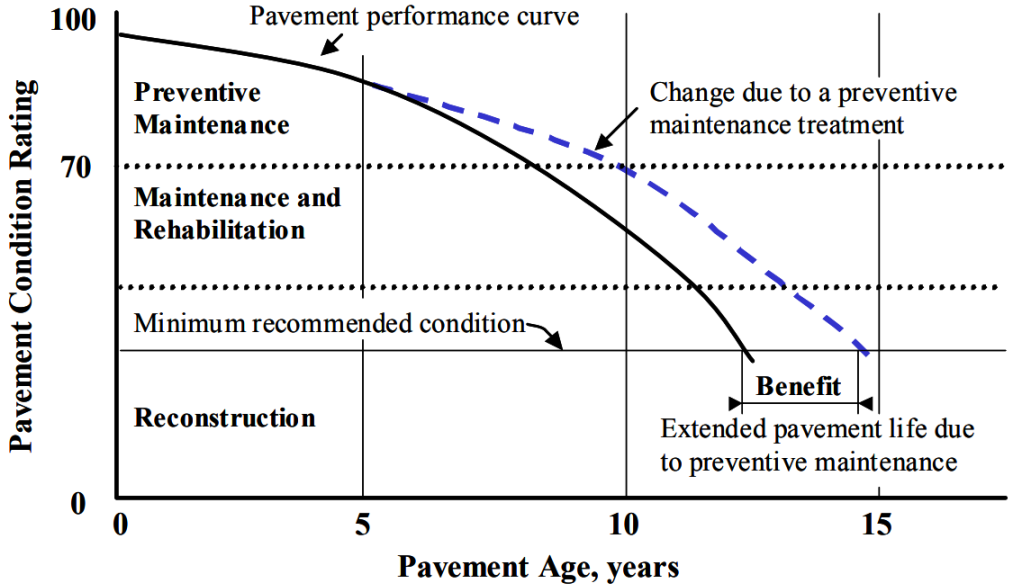
Delayed maintenance has indirect costs as well. Neglected roads steadily become more difficult to use, resulting in increased vehicle operating costs (more frequent repairs, more fuel use) and a reluctance by transport operators to use the roads. This imposes a heavy burden on the economy: as passenger and freight services are curtailed, there is a consequent loss of economic and socialdevelopment opportunities.

Countries need a core road network that carries about 80 percent of national traffic, including key roads in urban areas and roads providing sufficient access to rural areas.

Some part of the overall road budget thus has to be spent on construction and some part on maintaining the core network. But many countries have tended to favor new construction, rehabilitation, or reconstruction of roads over maintenance.

This has led to a steady increase in the backlog of road repairs and a loss of development impact. for every kilometer of road rehabilitated, an estimated three kilometers of road fall into disrepair, leading to a net deterioration in the total road network (World Bank 2003).

The situation is similar in many other developing country regions. Much of the capital cost of road construction is financed by donor funds, with low perceived cost tothe country but high real costs, while maintenance is funded locally, requiring difficult and unpopular tax mobilisation.


100
70
0
Pavement Condition Rating
Pavement performance curve
Preventive Maintenance
Change due to a preventive maintenance treatment
Maintenance and Rehabilitation
Minimum recommended condition
Benefit
Reconstruction
Extended pavement life due to preventive maintenance
0
5
10
15
Pavement Age, years

2-1 Road Failures

Roads are the basic needs of communications and it is most commonly used in our daily life for the travelling, transport andcarriage. Due to its importance we should pay special attention to its each step while making a road. If we do not follow the codes and safety measures given according to specification then we may face many problems about road failures. Generally the road failures occur due to potholes, alligator cracks, block cracks, rutting, raveling, slippage cracks, shoving/corrugation, longitudinal (linear) cracking, edge cracks, transverse cracking, depression, bleeding, swell.

2-1-1 Types of Failures

1- Potholes

Potholes are what most people think of when they think of pavement failures. These are usually non-functional pavement areas where the pavement has completely failed, exposing the base aggregate beneath it. Potholes usually pose liability issues such as causing vehicular suspension damage, or tripping hazards if they reside within pedestrian walkways.

Potholes are often the result of several years of failing pavement in areas of fatigue where pre-emptive repair was not done until the area has completely failed.

Potholes should be saw cut around the entire failing area, excavated, and base repaired using fresh ABC stone. Then proper placement of the asphalt design specification. The asphalt design specification varies from job to job. Typically the asphalt design will range from 3" of asphalt (2" of base asphalt, with 1" of surfacewear asphalt).

Figure (2) Severe Potholes on Road's Surface

2- Alligator Cracks

Fatigue is one of the most common types of failure that occurs in asphalt. Fatigue often presents a cracking pattern that slightly resembles the back of an alligator or a spider web, which is why these cracks are often referred to as alligator cracking or spider webbing.

These types of failures are often the result of insufficient support in the underlying base structure due to either insufficient design and construction or water penetration that has resulted in a weakened base.

In cases where the fatigue is considered non-severe and remains relatively stable, a thin coat of crack reflection treatment can be applied followed by an asphalt overlay of the fatigued area.

In the cases where the fatigue is more severe, exhibiting larger spaces between the pieces suggesting more movement, the area should be saw cut, excavated or milled. The base structure should be repaired and the asphalt should be replaced.

The overlay repair is the least costly, but tends not to last as long as the removal and replacement option.

Figure (3) Alligator Cracks on surface

3- Block Cracks

Block cracks, otherwise referred to as shrinkage cracks, present themselves as linear cracks several feet apart but often at different angles.

These types of cracks often appear in older asphalt that sees a light traffic loading. They are the result of the asphalt being allowed to shrink horizontally with little stress being applied vertically as the asphalt ages.

These typically should be filled with and sealed with a hot pour crack filler material to prevent water penetration.

Figure (4) Block Cracking

4- Rutting

Rutting involves depressions in the pavement that occur within the wheel tracks of vehicles. This is usually due to insufficient load-bearing capability of the asphalt/base design within that area.

It most often occurs in fatigued drive lanes, or close to stressed areas such as at stop signs, or in front of dumpster pads.

Figure (5) Rutting along the road

5- Raveling

Raveling occurs when the stone aggregate that was originally part of the pavement begins to break free from its bonds with theasphalt. Typically this tends to occur on older pavements that have already oxidized.

Over time as more and more aggregate breaks free from the asphalt, the asphalt loses significant load-bearing capability and will begin to prematurely fail in the areas that have exhibited the most raveling and bears the most traffic-loading.

The typical repair for this type of situation is to overlay the raveling asphalt with a new layer of fresh asphalt. Typically 1.5" to2" of new asphalt is recommended.

Figure (6) Raveling on the surface

6- Slippage Cracks

These types of cracks develop as a result of an overlay layer "slipping" across the underlying asphalt, resulting in cracks that resemble a smudge. The most frequent cause of these types of cracks is usually insufficient tack coat on the underlying pavement prior to the surface asphalt being applied.

These cracks often reveal themselves in stressed areas where trafficloading is increased due to either turning or stopping. The most common repair for these issues is full-depth asphalt replacement.

Figure (7) Slippage Cracks

7- Shoving / Corrugation

These types of failures present bumps or corrugations where the surface asphalt has been "shoved" or bunched up. This is most often the result of extreme horizontal stress caused where heavy traffic loads typically stop or start.

The most common repair for these areas is to perform full-depth repair. This exposes the base, allowing for any base weaknesses to be repaired.

Figure (8) Shoving / Corrugation

8- Longitudinal (Linear) Cracking

Longitudinal cracking are cracks that are parallel to the pavements centerline or laydown direction. These can be a result of bothpavement fatigue, reflective cracking, and/or poor joint construction. Joints are generally the least dense areas of a pavement.

FIX: Less severe cracks measuring 1/2 inch or less can be sealed to prevent water from entering into the sub grade. More severe cracks should be fixed by removing the cracked pavement layer and replacing it with an overlay.

Figure (9) Longitudinal Cracking

9- Edge Cracks

Edge Cracks travel along the inside edge of a pavement surface within one or two feet. The most common cause for this type of crack is poor drainage conditions and lack of support at the pavement edge. As a result underlying base materials settle and become weakened. Heavy vegetation along the pavement edge and heavy traffic can also be the instigator of edge cracking.

FIX: The first step is correcting the problem is to remove any existing vegetation close to the edge of the pavement and fix any drainage problems. Crack seal/fill the cracks to prevent further

deterioration or remove and reconstruct to full depth fixing any support issues.

Figure (10) Edge Cracks

10- Transverse Cracking

Transverse cracks are single cracks perpendicular to the pavement's centerline or lay down direction. Transverse cracks can be caused by reflective cracks from an underlying layer, daily temperature cycles, and poor construction due to improper operation of the paver.

FIX: Less severe cracks measuring 1/2 inch or less can be sealed to prevent water from entering into the sub grade. More severe cracks should be fixed by removing the cracked pavement layer and replacing it with an overlay

Figure (11) Transverse Cracking

11- Depressions

Depressions are localized pavement surface areas with slightly lower elevations than the surrounding pavement. Depressions are very noticeable after a rain when they fill with water.

FIX: Depending on the severity of the depression the asphalt may have to be removed and replaced (severe). Less severe depressions can be fixed by applying a thin surface patch or infrared patch.

Figure (2-12) Depression

12- Bleeding

Bleeding occurs when the asphalt contains too much asphalt cement relative to the aggregate. In these cases, the asphalt cement tends to "bleed" thorough the surface.

These types of issues are typically still functional but present an unsightly appearance to the pavement. Typical repairs for these areas are to either apply a chip seal application using absorbent aggregate or to mill off the top layer of asphalt and apply a new course of hot mix asphalt that contains a lower asphalt cement content.

Figure (13) Bleeding seen through a road

13-Swell

A swell is a localized upward bulge on the pavement surface. Swells are caused by an expansion of the supporting layers beneath the surface course or the subgrade. The expansion is typically caused by frost heaving or by water. Subgrades with highly plastic clays can swell in a manner similar to frost heaves (but usually in warmer months). Repair swells by excavating the inferior subgrade material and rebuilding the removed area. Reconstruction may be required for extensive swelling.

Figure (14) swell