International Journal of Innovative Research in Engineering & Management (IJIREM)
ISSN(Online): 2350-0557, Volume-10, Issue-3, June 2023
https://doi.org/10.55524/ijirem.2023.10.3.6
Article ID IJIR2375, Pages 29-37
www.ijirem.org

# Identification of Problems Faced in Road Maintenance

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**ABSTRACT-** A country's need for well-maintained road networks and appropriate road maintenance procedures is crucial for facilitating socioeconomic progress. However, the majority of federal highways are not in excellent shape, and more than one-third of them are in extremely poor or poor condition, which makes them unsafe for driving. The focus of this study was on identifying the current issues with road maintenance and evaluating the overall consequences of inadequate road maintenance on road function. The preservation of the investment made in the highway system as well as the comfort and safety of the road user were found to depend heavily on the proper design, routine inspection, and maintenance of the drainage system.. All different kinds of distresses have been categorized. For varying degrees of each suffering, there are several causes and treatments. It is crucial to recognize and fix the flaws in the current highway maintenance procedures and system. In this study, impacting factors such as cracks and cracking patterns, roughness, rut depth, potholes, and deflections were taken into account. The severity levels of the aforementioned factors have been used to categorize them. Therefore, it is advised that when doing any road maintenance, all concerned parties pay full attention to the most severe (acknowledged) issues in order to address the issues and lessen their impacts.

**KEYWORDS-** Road development plans, Effects, Problems, Road Maintenance.

## I. INTRODUCTION

One of the most crucial requirements for the economic growth of any nation, especially emerging nations, is the road network system. As a result, many developing nations spend a lot of money building roads while also understanding the importance of making significant investments in the capitalization of the road network. Few of them give road maintenance the respect it deserves. Although it is far more spectacular to start fresh construction than to maintain what currently exists, the pavement structure might be completely ruined by water infiltration in just one season. Repeat operations could be necessary periodically throughout the year, although the frequency varies according to traffic, topography, weather, the kind of road, and maintenance and rut repair on paved roads.. They consist of crack sealing as shown in figure 1 , surface patching, pothole repairs, and road surface marking. The viability of a nation's transportation network reveals the level of its social and economic advancement. The fact that this nation must offer road connection for both significant portions of villages and designated centers is the most difficult.[1]

Roads and vehicle transportation now predominate the system of transportation among other modes. Flexibility, door-to-door service, dependability, and speed are factors that have helped in this approach. Compared to the rise of road traffic, which includes both freight and passengers, rail traffic has grown by around 4% annually.. Between 1951 and 1992, the percentage of right-of-way traffic on roads increased from 11% to around 60%, and for passenger traffic, it increased from 26% to 80%. Table1 displays the development of India's highway system according to 20-year projections.[2]

Table 1: Road Development Plans: Targets and Achievements

| | Nagpur Plan 1941-1961 | Bombay Plan 1961-1981 | Lucknow Plan 1981-2001 | 1981-1990 |
|---|---|---|---|---|
| | Targets/(Achievements) | Targets/(Achievements) | Targets | Achievements |
| National Highways | 26715(22636) | 51500 (31737) | 66000 | 33600 |
| State Highways | 86825(62052) | 112650(95491) | 145000 | 130000 |
| Major District Roads | 80145(113483) | 241400(153000) | 300000 | 220000 |
| Other District Roads and Village Roads | 332335(500802) | 651780(912684) | 221000 | 1346000 |
| TOTAL | 532700(698973) | 1057330(1192912) | 2721000 | 1729600 |

India is going through an urbanization process that is significantly affecting urban transportation. Another area that frequently lacks proper attention is the upkeep of city roadways. Many roads lack the requisite surface thickness for the loads they support as well as the appropriate width for the amounts of mixed traffic necessitating separate lanes for bicycles, pedestrians, etc. The requirements of mixed traffic, subterranean water and wastewater pipelines, subsurface and above-ground utility networks,

walkways, correct drainage, and multiple crossroads with interlaced traffic must all be taken into account while maintaining urban highways.

The responsibility of safeguarding and maintaining our roadway infrastructure grows more challenging as traffic numbers rise and financing becomes scarcer.[3] The primary road network's bad state will result in yearly losses of about Rs. 12,000 crore (US$4 billion).

An engineer uses existing resources and the forces of nature for the good of humanity. The highway engineer is asked to bring the best to maintain the wheels smooth since he or she is unable to withstand the interaction of so many variable circumstances.. Therefore, the road is built and developed to accommodate road users' demands for a comfortable and secure ride at the intended pace. This must be continuously assured, which calls for an efficient maintenance program that is effectively carried out.[4]

### *A. Problem Identification*

The phenomenal growth in automobile traffic (measured by the axle load of commercial vehicles), the rapid expansion of the road system, the lack of suitable machinery, materials, equipment, skilled labor, and the inefficient use of resources have all added to the complexity of the problem of road maintenance. The upkeep of current roadways frequently suffers in favor of new development and financial restrictions. The various types of problems faced during maintenance of roads in general have been discussed in brief below:

*1) Problem of drainage system*

Any highway system or road network must have effective drainage, especially in hilly and low-lying locations where there is a lot of rainfall; all drainage structures must be carefully built and properly maintained [5].

*2) Geological problem*

In India, shifting sand dunes in the western desert pose a significant challenge to highway engineers, as do the regular landslides, flash folds, etc. that occur in the country's mountainous regions [6]. Field engineers face a difficult challenge while clearing snow and maintaining roads in high-altitude snowbound locations because of the harsh and unfavorable climatic conditions.

A lack of contemporary technology, competent workers, and the absence of rules and guidelines for road maintenance that are up to date. Water seepage into the subgrade has caused damage to it. Poor quality control during the original building phase, insufficient pavement thickness, high loads, and a lack of effective advertisements all contribute to issues with maintenance enforcement [7].

Under unfavorable moisture circumstances, frost action, and temperature change, players' stability is reduced. It is not always possible to make arrangements for traffic to be diverted to an alternate route when a road needs maintenance.

## II. LITERATURE REVIEW

The responsibility of safeguarding and maintaining our roadway infrastructure grows more challenging as traffic numbers rise and financing becomes scarcer. The primary road network's bad state will result in yearly losses of about Rs. 12,000 crore (US$4 billion) [8].

The network might degenerate to the point that repair or reconstruction would be extremely expensive due to historical maintenance negligence, necessitating an immediate burden. A World Bank report from 1987 claims that road degradation has cost developing nations, including India, billions of dollars' worth of infrastructure [9]. The price of repairing these roads will be three to five times more than it would have been if timely and efficient maintenance had been performed. In just one year, the overall economic return on the expense of road maintenance and upgrading would be between 50 and 60 percent. This is shown in Figure 2

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## III. OBJECTIVES

- To pinpoint the issues in maintaining roads.
- To conduct a critical analysis of the current rules and regulations employed in India to maintain the highway system.
- To determine the factors affecting the upkeep of flexible pavements.
- To categorize and classify typical flaws in flexible pavements.
- To pinpoint the root causes of these flaws and recommend solutions.
- To pinpoint the shortcomings in the current pavement maintenance procedures.

## IV. METHODOLOGY

Identification of defects, planning, programming, and scheduling for actual execution in the field, as well as monitoring, are all part of the maintenance of a road network. Maintaining the road surface and its accessories in excellent condition and extending the life of the road assets to their intended life should be the main goals. In general, the tasks involve identifying faults and any potential causes behind them, choosing appropriate corrective actions, putting them into action on the ground, and keeping an eye on the outcomes. This will need the management of all subsystems related to identification, evaluation, planning, scheduling, and the control of people, resources, and equipment, as well as performance evaluation [10].

### *A. Classification of Defects with Causes And Treatment*

On the test portions with varied severity levels, the numerous pavement distresses have also been photographed. All of the distresses have been broadly discussed. The definition of the distress measurement unit has been given. As previously said, the intensity of the flaws or distresses have been categorized as low, moderate, and severe. These frequent defects' causes have been

discussed [11]. Only after a thorough assessment at the scene have the appropriate remedies for any discomfort been addressed in detail. After determining the primary reason for the failure, a solution has been recommended. However, a concerted effort has been undertaken to outline certain broad principles for performing efficient repairs and maintenance.

### *B. Types of Defects*

The following sequence is addressed for the classification of the faults (as shown in images), along with their causes and remedies.

- Cracks:
- Cracks Classification
- Alligator Cracking
- Longitudinal Cracking
- Block Cracking
- Edge Cracking
- Centre Cracking
- Rutting and Shoving
- Rutting Classification
- Shoving
- Potholes and
- Patching:
- Potholes
- Patch Deterioration and Repairs
- Bleeding, Reveling and Weathering
- Bleeding
- Reveling and Weathering
- Miscellaneous Type of Defects
- Polished Aggregates
- Corrugations

#### *1) Classification of cracks*

The classification of cracks was carried out in accordance with the protocol established by the UK's TRRL (Transport and Road Research Laboratory). The images numbered 1 through 5 detail the categories of the crack index and degree of cracking. Any form of crack detail, such as an alligator, longitudinal crack, a block crack, etc., may be seen in the images..

#### *2) Alligator cracking*

*a) General Description*

These are the interconnected cracks which resemble the skin of an alligator shown in Figure 6 to 8. The above have been identified as follows: -

- Series of interconnected cracks.
- Many sided,
- Sharp angled,
- Usually, longest side < 1 feet.
- Initially appears a longitudinal crack.

*b) Unit of Measurement*

surface area in square meters at various degrees of severity. Anytime there are varying severity levels, rate the entire region at that level..

*c) Severity level / Classification*

Additionally, the categorization was completed using TRRL's (Transport and Road Research Laboratory) m/sqm standard. Below are the severity levels that have been assigned.:

*Low*– longitudinal hairline cracks that are not spalled and run parallel to one another. Typically, width is 3mm or less. The riding quality is still quite decent on the surface.
*Moderate* – . Lightly written cracks create a pattern of articulated fragments. There are cracks between 3mm and 6mm in width.
*High* – Significant cracks that are broader than 6mm. These have very poor riding qualities and are easily seen while driving on the road.

### *C. Causes*

The causes of the above cracking are as follows:

- Ageing of binder or initial over heating leads to brittleness of binder.
- Inadequate pavement thickness or excessive overloading or both [12].
- Unstable sub-grade or lower layers, leading to excessive deflection of the surface particularly in the wheel tracks. Unstable conditions in sub-grade or lower layers of the pavement might arise from saturation due to poor drainage conditions

*a) Treatment*

The treatment of the alligator cracking is discussed as follows: -
Whether a pavement is fundamentally sound or whether it has been warped or unsound will determine how to fix any sort of fracture. Cracks in pavement should be filled with a low viscosity binder if the pavement is structurally sound. To cover large fractures, slurry seal or sand-bituminous premix patching might be employed.
The pavement will become structurally unsafe as a result of the severe alligator cracking along the wheel path, which will cause rutting. It will be necessary to fortify or treat the unstable, cracked pavements.

*1) Longitudinal Cracking*

*b) General Description*

These fissures, which are often parallel to the center line of the pavement, may be seen at the intersection of two paving lanes or at the junction between the pavement and the shoulder. [13].

*c) Units of Measurement*

Linear, meters at each severity level.

*d) Severity Level or Classification*

*Low:* cracks with a width of less than 3 mm and sound material
*Moderate* –. The sealant material has cracks that range in width from 3 to 6 mm and show random cracking along the longitudinal fracture.
*High:*. significant cracking along the crack and cracks wider than 6mm. commonly present while traveling or otherwise, and is visible while driving [3].

*e) Causes*

The causes of the above cracking have been summarized as below

- Alternate wetting and drying beneath the shoulder surface owing to poor drainage and also due to variation in temperature.
- A week joint between adjoining spreads in the layers of the pavement gives rise to lane joint cracks

- Different frost has condition.

*f) Treatment*

The type of treatment depends on whether the pavement is still structurally sound; if so, it can be carried out as follows.

- Fill cracks with bituminous binder.
- A slurry seal or sand bituminous premix patching for wide cracks.
- A fog-seal if the cracks are fine and extended over large area.

*2) Block Cracking*

*a) General Description*

On the pavement surface, these fissures appear as interconnecting blocks of square or rectangular forms. Block cracking can range in size from 1 square foot to 10 square feet, or 1000 sq cm to 10000 sq cm.

*b) Units of Measurement*

Surface area in square feet or square meters for each degree of severity.

*c) Severity Level or Classification*

*Low* Unsealed fissures with a mean width of 3 mm and sound sealant are characteristics of blocks. The chunks are often bigger when the severity level is low.
*Moderate* Moderately spelled cracks and mean width between 3 to 6mm.
*High* Blocks with clearly discernible cracks that have a mean width of more than 6 mm. Compared to low and moderate severity levels, the block size is smaller.

*d) Causes*

The possible causes are summarized as below

- Inadequate pavement thickness and unstable condition of sub-grade and lower layers.
- Shrinkage of bituminous layer itself with age.
- Ageing and brittleness of binder.

*e) Treatment*

By first applying an interface treatment and then applying a surface layer in accordance with the original surface, the block cracking should be fixed.

*3) Edge Cracking*

*f) General Description*

These reasonably consistent cracks are often up to 0.5m from the pavement's edge and run parallel to it. Edge cracks that are not fixed in a timely manner result in edge breaking, lane to shoulder dropoff, and separation [7] .

*g) Units of Measurement*

Linear measurement at each severity level.

*h) Classification or Severity Level*

These verity levels have been classified as below
*Low* Cracks with a mean width of up to 3 mm but no break-up or raveling
*Moderate*– Cracks with some break-up or raveling and mean width between 3mm to 6mm.
*High*– Cracks with considerable break-up or raveling along edge and the width is more than 6mm.

*i) Causes*

The causes are summarized as below

- Lack of lateral support from shoulder.
- Poor drainage and frost heavy condition.
- Inadequate pavement width forcing traffic to move too close to the edge of the pavement.
- Settlement or yielding of the under lying materials.
- Non-provision of extra width of pavement on curves.

*j) Treatment*

The possible treatment has been summarized below

- Improve the shoulder condition and give lateral support to pavement.
- Seal the cracks with either of these depending on severity level and width of cracks as follows:
- Fog seal.

*4) Centre Cracking*

*k) General Description*

The pavement's middle line is completely covered with the cracking pattern. These are uncommon and resemble longitudinal cracks. Photographs 18 to 20 depict the center breaking.

*l) Unit of Measurement*

Length in meters as per each severity level.

*m) Classification or Severity Levels*

The classification is as under

*Low* Cracks with seal ant material in good condition and mean width up to 3mm.
*Moderate* Cracks with some break-up or raveling and mean width between 3mm to 6mm.
*High* Cracks with considerable break-up or raveling along center line of the pavement and width is more than 6mm. It can be easily noticed while driving on the road.

*n) Causes*

The root cause for center line cracking is summarized as below

- Improper or weak joint between adjoining, spreads all along the center line of the pavement.
- Different moisture conditions on both sides of the pavement.
- Different frost heave conditions along the center line.
- Improper design of pavement with reference to camber.

*o) Treatment*

It is best to take all necessary measures when building pavement. It is also possible to apply the previously described universal crack treatment procedure. Depending on the width of the cracks, this can be fixed by sealing them using slurry seal or fog seal.

*5) Rutting and Shoving*

*a) General Description*

A longitudinal surface depression or groove in the wheel path is referred to as rusting. Rutting that is accompanied by nearby bulging might be an indication of sub-grade movement. When there is considerable channelized traffic

or when the pavement thickness is insufficient, this problem occurs.

*b) Unit of Measurement*

The rut depth can be measured in mm and width of rutting can be measure dimeters.

- Materials that disintegrate locally.
- A weak link between the base course and the surface course.
- Localized regions with lower bitumen composition or very thin bituminous surfaces

*c) Causes*

The causes are as under

- Weak pavement and heavy channelized traffic.
- Improper mix design and lack of stability.
- Inadequate compaction of the mix at the surface or in the underlying layers during construction.
- Intrusion sub-grade clay into base course.

*d) Treatment*

After applying the attack coat, fill with the pre-mixed open/dense graded material and compress to the specified levels.
If sub-grade failure is the cause of the rutting, the sub-grade must be excavated and corrected.

*6) Shoving*

*e) General Description*

It is a type of plastic movement that causes small-scale surface bulging. Shoving typically happens at intersections where traffic begins or ends or at abrupt bends..

*f) Unit of Measurement*

It really cannot be measured in facts and figures, but the effect can be seen or riding quality.

*g) Classification or Severity Levels*

*Low*– When effect on riding quality is quite low.

*Moderate*– When it is possible to drive at low speed only.

*High*– When riding quality is very bad and extensive bumpy ride is experienced.

*h) Causes*

- Lack of stability in mix (excessive binder, high proportion of fines, too soft binder) of surface or base course.
- Pushing action by wheels of heavy traffic at time of acceleration and de-acceleration.
- Lack of bond between bituminous surface and underlying layers

*i) Treatment*

After putting an appropriate tack coat or removing the material in the afflicted region down to the underlying base and placing a suitable premix patch, filling the depression with premix materials.

*7) Pot Holesandpatching*

*a) General Description*

These are holes in the surface layer or extending into the base course that have a bowl form and come in different sizes. These often arise in wet areas or following rain and are brought on by localized material breakdown.

*b) Unit of Measurement*

Depth in cm. and area of pothole in cm.sq.

*c) Causes*

*d) Treatment*

Treatment is done by patch work or patch repairs. To fill potholes (after cleaning) with the premix open/dense graded patching or even penetration patching and followed by compaction.

*8) Patch Deterioration and Repairs*

*a) General Description*

This is the portion of the pavement surface that has been removed and replaced/repaired. The damage to the surface could be because of cracking, potholes, etc. These are shown in photographs 29 to 30.

*b) Unit of Measurement*

Square meter of surface area and number of patches at each severity level.

*c) Classification or Severity Level*

*Low*– Patch is in good condition or has low severity distress of any kind.
*Moderate*— Patch has moderate severity distress of any type and patch repairs are carried out as per type of distress.
*High*– Patch has high severity distress of any type.

*d) Causes*

Main causes of patch deterioration are as follows

- Poor mix design and obsolete (out of date) maintenance technique.
- When repairing small defects are not done in time.

*e) Treatment*

To have proper mix-design and choose aggregates and binders as per prevailing climatic conditions and specifications.

Their paired patch should merge with the type of original surface and eradicate the cause of failure.

*9) Bleeding, Raveling and Weathering: Bleeding*

*a) General Description*

A film of bituminous material on pavement surface which creates a glossy and reflective surface. Surface becomes soft in hot weather and slippery and hard in cold weather or wet climatic conditions. Bleeding can be seen in figure 3 Bleeding occurs when the bituminous binder moves upwards and collects as a film on the surface.

*b) Unit of Measurement*

It really cannot be measured. However, % of road length showing bleeding can be measured.

*c) Classification or Severity Level*

*Low*– Black colorings of pavement surface visible.

*Moderate*– Distinctive appearance with excess asphalt.
*High*– wet and glossy look and tyre marks a very evident and easily seen.

*d) Causes*

- Excessive use of binder in pre-mix design or in semi-dense carpet (SD).
- Heavy prime/tack coat.
- Poor quality of aggregates leads to their fracture and eventual loss.
- Non-uniform spread of cover aggregates in semi-dense carpet.

*e) Treatment*

- If bleeding is uniform apply cover aggregates or sand.
- If bleeding irregularly, then the affected area is removed and rectified by replacing it with a properly designed mix.

*10) Ravelling and Weathering*

*a) General Description*

It is wearing away of the pavement surface due to dislodging of aggregate particles (raveling) and loss of asphalt binder (weathering). Raveling is more common in premix bituminous constructions. Raveling starts from surface downwards or from edge inwards.

*b) Unit of Measurement*

Sq.mts of surface area at each severity level or % of road length affected by this defect.

*c) Classification or Severity Levels*

*Low* – Wearing away of the aggregate and or binder has started but has not progressed significantly. Fine aggregate is blown off, leaving behind pock marks on the surface.
*Moderate* – Aggregate and or binder has worn away and the surface texture is becoming rough and pitted, loose particles generally exist.
*High* – Aggregate and binder has worn away and the surface texture is very rough and pitted.

*d) Causes*

- Use of inferior quality and poor compatibility aggregates and binder and possibility of overheating.
- Construction during wet and cold weather.
- Inadequate compaction during construction.

*e) Treatment*

- Repair is done by adding a larger quantity of binder, the rate of application depending on degree of raveling and weathering.
- Application of binder and covering with coarse sand.

If severely raveled, then a renewal coat with premix material would be necessary.

## V. SYSTEM IMPLEMENTATION

### *A. Maintenance of Roads in Different Terrain and Climatic Conditions*

In challenging terrain and climatic circumstances, upkeep of roads and transportation networks requires specific consideration. The current essay emphasizes the issues with and approach to road maintenance in hilly locations, deserts, high elevations, and snow-covered places. The following are the primary reasons for road failures in the aforementioned locations. [8]

### *B. Drainage*

The most crucial element for a road's stability and performance is proper drainage. Water flow or stagnation can undermine the pavement, harm the shoulders and slopes, and wash out culverts in addition to causing soil erosion. Therefore, it is important to make sure that culverts and causeways are in good working order so that water may flow freely and rapidly away from the road surface [5]. While inspecting various drainage work types, the following things need to be looked through.

- Side Drains: Drain blockage.
- The drain's cross section has been harmed.
- Silting and ponding in the drain.
- The bed is being eroded.
- Silting blocking of the waterway in culverts as a result of debris buildup.
- Bed erosion at inlet and outflow.
- Cracks appearing in the abutments as a result of settlement.
- The deck slab's reinforcement being seen.

The table below lists the drainage work's faults, their causes, and the necessary corrective actions

Table 2: Defects and Remedial Measures In Drainage Works

| Type of Defects | Main Causes | Remedial Measures |
|---|---|---|
| Side Drains | | |
| Ponding | Inadequate cross section | Deepen/widen the drain |
| Silting | Too Flat slope Causing low velocity | Deepen drains or provide lateral Drains if feasible |
| Blockage of Drain | Accumulation of debris, growth of vegetation | Cleaning, Clearing of vegetation |
| Erosion of bed/sides | Too steep slopes | Provision of drain checks: Regarding/Re-aligning drains. |
| Culverts | | |
| Silting and blockage of debris | Invert slope too flat culverts constructed at too low level. Vegetation and Debris carried by Floor get lodged in the culverts | Cleaning and clearing of debris |
| Erosion of bed at Culvert outlet | Too steep grade of Culvert | Repair erosion and flatter grade if feasible |
| Settlement cracks | Settlement of soil below the culvert | Repair of cracks in case of minor settlement. In case of major settlement, culvert to bere-constructed. |
| Exposure of Reinforcement in deck Slab | Due to in adequate cover, displacement of form works while concreting | Remove rusting if any and do grouting with concrete mix. |
| Causeways | | |

| | | |
|---|---|---|
| Cracks in paved surface | Settlement of slab,Shrinkage etc. | Repair (sealing of cracks). |
| Damages/ loss of Guideposts and flood gauges | Due to accident, floods, etc. | Replacement |

### *C. Identification of Deficiencies in Existing Road Pavements*

The following categories should be used to classify the flaws in the current road pavements
Road segments with structural flaws should be found where pavement deterioration and failures occur often. Rapid rate of failure would continue to occur in these areas unless the structural defect is corrected by suitable strengthening measures or overlay building. [10].

- Inadequate cross slope of pavement surface resulting in poor surface drainage.
- Inadequate capacity of road-side drains.
- Leakage water from the water supply pipelines and sewerage pipelines which are located under the pavement on several urban road stretches.

### *D. Development of Methodology for Maintenance*

*1. Quality Assurance*

All facets of a road project, including design, supply, and maintenance, as well as the lengthy process of construction and maintenance, should be covered by the quality assurance system. The following guidelines should be followed [12]:

- Bitumen and aggregates need to be examined to determine their characteristics and behavior.
- The right grade of bitumen should be applied according on the amount of traffic and the weather.
- Aggregates ought to be dry and spotless.
- Bitumen and aggregates should be heated under regulated circumstances to the required temperature.
- The area that has to be paved should be carefully cleaned after any required corrections.
- The mechanical system should be chosen over the manual approach to building and maintaining a structure.
- The temperatures for rolling and laying should be managed.

*E. Inspection of Roads and Assessment of Maintenance*

It is crucial to regularly evaluate the road in order to spot flaws and their causes, set priorities, and implement the proper corrective actions. All road maintenance facilities should keep a Road Inspection Register for this purpose..:

The numerous operations include: - Inspections are conducted by a junior engineer once every week.

- By the assistant engineer once every month.
- By the Executive Engineer every three months.
- In crucial areas, different Engineers' inspections could occur more often. It must be more than those mentioned above. Before and after rain is the optimum time to evaluate a road.

*1. Check list for inspection*

A list of important points to be seen during inspection is given in Table 3.3.

Table 3: Check List of Points to Be Examined During Inspection for Maintenance

| S. No | Item | Points to be examined |
|---|---|---|
| 1 | Pavement | Magnitude and location of cracks, potholes, undulations and other pavement failures etc. |
| 2 | Shoulders | Width and cross-fall, side slopes, erosion, need for embankment turning or other protective measures |
| 3 | Drainage | Adequacy of cross section, blockage, damage or siltation, bed slopes, need for lining and increase in section etc. |
| 4 | Safety | Safety at slides/blockage/breaches/deep cuts damages to culvert or bridge; horizontal and vertical clearance in respect of power lines, roadside trees etc. |
| 5 | Roadside Clearance | Whether aggregates and bitumen are stacked properly for safe traffic operation and safe material against washing away during the rain. |
| 6 | Protection Works | The condition of Retaining/Breast walls, parapet walls, drains, chutes, pitching on slopes etc. |
| 7 | Road Furniture | Whether these are correctly located, need cleaning/re-painting etc. |
| 8 | Roadside Trees | Numbering of trees, disposal of dead trees etc. |
| 9 | Landslides | Behavior, effectiveness of control measures already taken, likely problem areas including sub-surface drainage. |
| 10 | Snowfall/ Damages | Advance action required for snow clearances, repair of snow structures, additional requirements. |
| 11 | Toe erosion | Where the road alignment follows the course of river, especially in hilly terrain, erosion of the hill slope below the road formation will affect the stability of the road. Control measures required |
| 12 | Encroachment | Encroachments; fancy, and action taken for their removal |

- An annual calendar of road maintenance activities must be made and implemented.
- The cause of the distress must be investigated and the defect on the pavement surface should be repaired at the earliest..
- If an existing pavement fails based on the criteria of maximum acceptable limits for deflection, then maintenance decisions have to be taken by providing adequate overlay thickness. The overlay thickness can be determined as follows:
- For a shorter length of existing pavement section say less than 5 km, the overlay thickness can be determined using the procedure laid down in IRC: 81-1981.

- For a length of existing pavement section say more than 5 km, the overlay thickness can be determined using the analytical design procedure developed at University of Roorkee and published by IRC. The analytical approach gives the various alternative pavement design sections. Depending upon the availability of funds, the optimal design section can be selected for overlay [7]

If an existing pavement fails based on the criteria of reaching all the parameters to the maximum acceptable limits, then the maintenance and rehabilitation decisions are taken as follows

- The cracked area is sealed through the filling by stone chips and the spray of bitumen. This portion is properly compacted by rollers to ensure uniformity in the surface.

After making necessary corrections to the existing surface in accordance with the previously mentioned two criteria, overlays of various sorts and thicknesses are built in accordance with MOST standards.
With careful quality control and material selection throughout construction, overlays will last longer, be more comfortable, require less time to travel, and cost less to operate.[6]

## VI. SIMULATION AND RESULTS

### *A. General*

Through the research, an attempt has been made to bring the maintenance component of the highway system to the attention of all parties involved, particularly the field engineers and decision-makers. Our road system's flaws and poor maintenance procedures have been exposed. Simple and affordable maintenance techniques have been proposed. Field engineers might use this information to provide efficient maintenance to protect the initial investment they made while building the highway system.

### *B. Applications 0f the Study*

This study has identified certain pressing problems with the highway system and economic loss associated to highways. Roads that are in bad condition cause more VOC, discomfort, accidents, etc. This research will aid engineers in maintaining the highway system in all types of terrain and climatic situations, including plain regions, hilly regions, deserts, locations with excessive rainfall, high altitudes, and snow-covered areas.
It will assist the field engineers in determining the severity of various inflexible pavement distresses/defects.
Overlays will last longer if repairs are made to existing pavements by sealing and fixing cracks. This will raise comfort levels, enhance ride quality, and lower running expenses for vehicles.
We may expect to ride on better roads in the future if these flaws in the highway system's inflexible pavements and the construction of a technique for maintaining it are fully implemented.Figure 4 shows the Rock Loss
Checking can be seen in figure 5 Segregation can be seen in figure 6 Pumping can be seen in figure 7.

Figure 1: crack sealing

Figure 2: Maintenance

Figure 3: Bleeding

Figure 4: Rock loss

Figure 5: Checking

Figure 6: Segregation

Figure 7: Pumping

## VII. CONCLUSION

According on the findings of the study, the following conclusions have been made:

The preservation of the investment made in the highway system as well as the comfort and safety of the road user depend greatly on the proper design, routine inspection, and maintenance of the drainage system.

All different kinds of distresses have been categorized. For varying degrees of each suffering, there are several causes and treatments.

It is crucial to recognize and fix the flaws in the current highway maintenance procedures and system.

In this study, impacting factors such as cracks and cracking patterns, roughness, rut depth, potholes, and deflections were taken into account. The severity levels of the aforementioned factors have been used to categorize them..

Any one or all of the influencing parameters can be brought to their absolute maximums before a maintenance decision is made.

Before doing any substantial maintenance (overlay, renewal coat), the minor distress (cracking, potholes, pushing, rutting, etc.) must be fixed. If small flaws are fixed before overlaying, even a thinner overlay will produce superior results.

## CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

## REFERENCES


[1] Jain S. S. "Analysis, Design and Evaluation of Flexible pavements for Indian Environment", Ph. D., Thesis, University of Roorkee, Roorkee, 1987. H Q. Director General Border Roads, "Historical Cell", New Delhi.

[2] Gobinder Singh – Seminar "Towards better roads in hills", BRO, HQ., DGBR, New Delhi, Oct.1990.

[3] Jain S. S., Gupta A. K., Khanna S. K., and Safa Ebrahim, "Performance Analysis of Overlays for Maintenance Management of Flexible Pavements", International Road Federation (IRF) Conference, Calgary Canada, July 3–7, 1994.

[4] IRC:81–1981, Indian Road Congress, "Tentative Guidelines for Strengthening of Flexible Pavements using Benkelman Beam Deflection Technique", 1981.

[5] Technical Instruction No.2, "Maintenance of Roads", HQ. DGBR, New Delhi, 1992. IRC: 82–1992, "Maintenance of Bituminous Surface of Highway", 1992.

[6] "Asphalt Overlays for Highway and Street Rehabilitation", The Asphalt Institute, Manual Series No.17(MS-17) June,1983.

[7] Gupta A.K., Jain S.S., and Bhatia S.K., "A Study of Relationship between Rut Depth, Deflection and other distress modes of Flexible Pavements", IRC Journal Vol. 55 – 1, July1994.

[8] Gupta A.K. and Jain S.S., "Deflection Studies Continuation on Overlays of Selected Test Sections", Research Scheme R – 6, Sponsored by Ministry of Surface Transport, Govt. of India.

[9] ASTM, "Bituminous Materials for Highway Construction, Water Proofing and Roofing Soils", ASTM Standard Part XI, American Society for Testing and Materials.

[10] DSIR, "Soil Mechanics for Road Engineers", HMSO, London, 1964.

[11] Jain S. S., Gupta A. K., Khanna S. K., "Characterization of Sub-Grade Soils for Design of Flexible Pavement", Journal of Institution of Engineers, India, Vol. Jan.1987.

[12] Yoder E. J., "Principles of Pavement Design", John Wiley & Sons, Inc., NewYork, 1967.

[13] "National Report on Road Maintenance in India", Regional Road Maintenance Seminar, Manila, Philippines, 16–21, Oct.1980.