Asset Management of Roads, Evolution and Techniques

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Abstract- *The road network is one of the largest assets of the country and is mostly government owned. The agencies employed for the transport infrastructure must maintain, operate, improve, replace and preserve this asset. At the same time, the financial and human resources needed to achieve the performance goals of the road network must be managed carefully. All of this is accomplished under the public, who pay for this part of the transport system, are regular users of the asset. There is an increasingly demand for improved levels of quality, in terms of safety, reliability and comfort, from the road network. For this, governments are placing greater pressures on road administrations to improve the efficiency, accountability and the management of the community's asset. Asset management basically means a systematic process of maintaining, upgrading and operating assets, combining engineering principles and theories, and providing tools to facilitate a more organized and flexible approach for making the decisions necessary to achieve the public's expectations.*

I have taken a portion of Rourkela road for my project work. I have analyzed it using QGIS. I have taken 33 points under observation. According I got the coordinate data's and from there I found curve data's and found out super elevation, coefficient of friction, traffic flow value , ESWL value. Accordingly I got the values of each of these components and analyzed it. I found the basic reason behind the failure of roads which is mainly due to repeated application of heavy loads and we can find the alternate routes for movement of heavy vehicles to eradicate these problems.

I. INTRODUCTION

Management of the road asset involves the application of engineering and management practices to optimize the type of service outcome for the most cost-effective financial input. The function of the asset manager is to optimize investment and outcomes within the constraints of finance, service type and resources. Taking only the pavement and surfacing assets into consideration, the optimization is applied using life-cycle management approach. An experienced practitioner is needed to carry out some form of needs-assessment or review against expected pre-treatment service level, and make adjustments based on real performance. The objective is to minimize the extent of unplanned maintenance resulting from haphazard performance. Risk assessment and its management are essential road asset management considerations. The outcomes of the Forward Works Program need to be reviewed in terms of future possible risk, and equally, risk should be considered at the individual treatment level. It is entirely appropriate to review individual treatments based on risk disclosed at the design or construction stage that is not appreciated at the planning stage. Therefore maintenance is essential between design, construction and asset management teams if unforeseen or underestimated risk potential becomes apparent. For example, unexpected soft pavements or other factors may be detected that may affect long-term pavement and surfacing performance in future.

Project Objectives:

- Development of single road database for NHs supported by analytical tools to be used by NHAI and MORTH
- Institutionalize RAMS in NHAI and MORTH to assist in planning, programming and budgeting for road maintenance and upgrading works
- Integrate GIS within RAMS to form publicly accessible Traveler/Tourist Information System.

Asset Management – Background

An efficient rural road infrastructure is very important for economic and social development of any country. The benefits from the investment in road sector are indirect, long term and, not immediately visible. Roads are important assets for any nation. However, merely creating these assets is not enough.Rural Roads Development under PradhanMantri Gram SadakYojana

Road Connectivity is not only a key component of rural development by promoting access to economic and social services and thereby generating increased agricultural incomes and productive employment opportunities, it is also as a result, a key ingredient in ensuring any sustainable poverty reduction program. Notwithstanding the efforts made over the years at the State and Central levels through different

programs, about 40 per cent of the habitations in the country are still not connected by All-weather roads.

Importance of Pavement Asset Management

Low-volume roads, which are said to make up more than 80 per cent of India's road network, are a critical component of a country's infrastructure system. Farmers, families, and businesses rely on the low-volume road network to provide access to market centers, educational institutions, health centers, recreational sites and other facilities. However, traffic volumes are not proportional to the number of kilometer of roads that must be maintained, so funding for maintenance and rehabilitation on these roads is frequently inadequate to address the growing backlog of needs.

Preventive Maintenance Techniques

Liquid Seal: Liquid seal consists of an application of liquid bitumen (penetration grade, cut-back or an emulsion) and covering the same with aggregate. This is applicable for the rectification of fatty surfaces, stripping, loss of aggregates and raveling.

Slurry Seal: Slurry seal is a mixture of fine aggregates, mineral filler and emulsified bitumen with water added to achieve slurry consistency. The ingredients are mixed and spread evenly on to bituminous surfaces to fill cracks, repair raveled pavements, smooth or hungry surfaces, rectify loss of aggregates, rejuvenate oxidized and open-textured old bituminous surfaces, and to provide a skid resistance surface.

Fog Seal: Fog seal is a light application of emulsified bitumen, usually without a cover aggregate. It is used to increase the binder content of bituminous surfaces, rejuvenate oxidized and old surfaces, fill in crack sand preventraveling. It can also be used as an emergency treatment measure for hungry surfaces.

Pavement Preservation

As a component of system preservation, pavement preservation is aimed at preserving the investment in our highway system, extending pavement life, and meeting our customers' needs. It is the timely application of carefully selected surface treatments to maintain or extend a pavement's effective service life. Pavement preservation does not include new or reconstructed pavements or any activity that significantly increases the structural capacity of the existing pavement

Timely Maintenance

More recently, pavement preservation has been integrated into an agency's planning and design activities. Further, efforts to improve the cost-effectiveness of maintenance and rehabilitation programs have led to the development and implementation of pavement preventive maintenance programs that emphasize keeping good roads in good condition through planned, early applications of maintenance treatments.

Implementing the Pavement Preservation Philosophy

The delay in rehabilitation needs is more than offset by the fairly low cost of preventive maintenance treatments, resulting in dramatic cost savings for preserving the road network. The deferred need for rehabilitation is reflected in the modified performance curve due to the application of a preventive maintenance treatment. Other benefits can be realized through the use of a pavement preventive maintenance program. Some of the benefits documented in the literature are:

- Higher customer satisfaction with the condition of road network;
- The ability to make better, more informed decisions on an objective basis;
- More appropriate use of maintenance techniques;
- Improved pavement conditions over time;
- Reduced road user costs

The Road Ahead

An issue that is of emergence is the performance related specifications (PRS) and associated performance level warrantees in the implementation of maintenance programs.

Data Collection Objective

The data items are collected over the road network of 3,000 km. The objective of this data collection is to demonstrate:

- That adequate data items were identified for the development RAMS;
- That procedures adopted are appropriate for network level RAMS.

Data Collection Equipment

Road Measurement Data Acquisition System (ROMDAS) from New Zealand is deployed to collect the data. ROMDAS has successfully been used for collecting inventory, condition and pavement related information by various agencies.

Rut Depth

Multi point laser ROMDAS Transverse profile Logger (TPL) Lasers are is fitted for measuring the Rut depth.

Secondary Data

Following data is collected from Secondary sources:

- Pavement Composition
- Pavement History
- Median Details
- FRL
- HFL
- Way side amenities
- Traffic Data
- Road Side existing Utilities
- Accident Data
- ROW
- Bridge GAD (General Arrangement Drawings)
- Bridge and Culvert Inventory List

Pavement Width

Width of the carriage way or the width of the pavement depends on the width of the traffic lane and number of lanes. Width of a traffic lane depends on the width of the vehicle and the clearance.

1. <3.75 m;
2. 3.75 m - 5.50 m;
3. 5.50 m - 7.0 m;
4. 7.0 m - 9.0 m;
5. 9.0 m - 14.0 m;
6. >14.0 m

Side Drain Type

A drain is a small to moderate depression created to channel water. It can be used for drainage, to drain water from low-lying areas, alongside roadways or fields, or to channel water from a more distant source for plant irrigation. It is categorized as follows:

1. Open unlined;
2. Open lined;
3. Covered lined;
4. No drain;
5. Drain not needed.

Cross Section

A cross section is a vertical plane (slice) taken at right angles to the road control line showing the various elements that make up the roads structure. It is normally viewed in the direction of increasing chain age. The cross-section of the roadway should indicate

1. Cut
2. Fill
3. Level

II. PERFORMANCE BASED ROAD MAINTENANCE CONTRACTS

Insight and Advantages

The traditional way of contracting road maintenance is based on a schedule of unit prices and estimates of quantities. The works to be performed are specified in the contract and payments are based on measured executed works. By contrast, a Performance Specified Road Maintenance Contract defines the minimum conditions of road, bridge, and traffic assets that have to be met by the contractor with certain serviceability. Payments are based on how well the contractor manages to comply with the performance standards defined in the contract, and not on the amount of works executed. The nature of the contract allocates responsibility for work selection, design and delivery solely to the contractor. Hence, the choice and application of technology and the pursuit of innovation in materials, processes and management is all up to the contractor.

III. LITERATURE REVIEW

In most countries, the road network constitutes one of the largest assets and is most government owned. The employees responsible for the transport infrastructure must maintain, operate, improve, replace and preserve this asset. Asset management basically means “A systematic process of maintaining, upgrading and operating assets, combining engineering principles with theories, and providing tools to facilitate a more organized and flexible approach for making the decisions necessary to achieve the public’s expectations”.

Study Area

Procedures that I will do for asset management system will consist of the of many components. My study areas will include following things:

- Asset characteristics – including data on asset condition, asset use and asset features.
- Methods of maintenance.
- Prediction of models – It includes future conditions including forecasts and growth rates.
- Life-cycle cost analysis procedure.

- Decision-aided tools –It includes risk analysis procedures for ranking projects, etc.
- Asset management strategies for future.

Treatment Lengths for Safety

In many cases treatment lengths are similar with the lengths that will be scheduled for resealing.

The exceptions are:

- When a treatment has to be applied in a reactive manner to deal with a specific kind of failure, such treatments may well be applied only to specific part of a treatment length.

Life Cycle Cost Analysis Procedures

One idea is that indefinite extension of life can be achieved through the application of maintenance treatments.

For this discussion the key issues predicted are:

- A resealing treatment never starts a new life cycle.
- Typically the treatment that initiates a new life cycle will be the one that normally renews the

Structural capacity of the asset present.

Inputs Given

Service levels are considered as the outcomes that the asset provides for the end users (e.g. the assets of the pavement and the service level of its desired roughness). Service levels can be applied as fixed standards or the desirable targets. If established as desirable targets.

Asset Present Condition

Then we will consider the current condition of the assets. It is obvious that not all assets (e.g. roads) in a road network will have the same capacity to meet the required level of service. The current status of some of them will be close to the ‘as-built ‘condition, meeting or exceeding the required level of service provided.

Literature Survey:

Public and private agencies have always tried to maintain their infrastructure assets in healthy and serviceable condition at a minimum cost. Therefore, they practiced infrastructure management. However, as most of the country’s infrastructure systems reached maturity and the demands placed on them started to increase rapidly in the mid- 1960s, infrastructure agencies started to focus on a systems approach for infrastructure management.

Gap Acceptance Theory

In traditional gap acceptance models, it has been assumed that the vehicles in the major stream have absolute priority over the vehicles in the minor stream. It means that the major stream is unaffected by the minor stream vehicles. Within unsignalized intersection theory, it is also assumed that drivers are both consistent and homogenous.

Queuing Theory

Starting from the capacity at unsignalized intersections, further traffic parameters, which represent the quality of traffic operations, can be evaluated. Queuing theory is generally used to evaluate situations which involve average delays, average queue lengths, distribution of delays and distribution of queue lengths. In 1962, Tanner established the equations for the average delays for minor stream vehicles at unsignalized intersections with only one major stream and one minor stream. This kind of intersection belongs to the M/G2/1 queuing system, M represents the traffic flow arrival pattern of the minor stream, i.e. exponentially distributed headway; G is service time, i.e. the time spent in the first position of the queue.

Traffic Rerouting Control Approaches

A number of techniques have been developed previously for routing control in transportation networks: so as to alleviate traffic congestion, which involve user equilibrium assignments and control strategies that are constructed by combining optimal control theory and macroscopic traffic flow models. Messmer and Papageorgiou applied a nonlinear optimization approach based on the METANET model to handle the route guidance problem in motorway networks, a parallel solution derived in terms of user equilibrium principles has been proposed by Wie et al. Another method to this problem of integrated control is the application of a linear programming approach as described in Papageorgiou where both motorways and signal-controlled urban roads are considered.

IV. STUDY AREA AND DATA COLLECTION PROCEDURE

Trans CAD is the first and only Geographic Information System (GIS) designed specifically for use by transportation professionals to store, display, manage, and analyze transportation data. Trans CAD combines GIS and

transportation modeling capabilities in a single integrated platform, providing capabilities that are unmatched by any other package. Trans CAD can be used for all modes of transportation, at any scale or level of detail.

Trans CAD provides:

- A powerful GIS engine with special extensions for transportation facility.
- Mapping, visualization, and analysis tools designed for transportation applications and uses.
- Application modules for routing, travel demand forecasting, public transit, logistics, site location, and territory management.

Methods Adopted –

- Networks adopted
- Matrices constructed
- Routes and Route systems taken
- Linear Referencing done

Matrices Constructed:-

Matrices hold data such as distance, travel times, and origin-destination flows that are essential for many transportation applications. Trans CAD provides functions for creating and manipulating matrices, and tools for spatial analysis and advanced visualization of matrix data. This combination lets you see and understand transportation flows and network characteristics in new and different ways.

Linear Referencing:-

Trans CAD allows you to identify the location of transportation features as a distance from a fixed point along the route. Trans CAD can display and analyze these data sets without conversion, and includes dynamic segmentation functions to merge and analyze linear-referenced data sets. This makes Trans CAD an obvious choice for:

- Facility infrastructure and operations data's
- Accident locations spotted.
- Pavement or rail condition ratings.
- Traffic flows and transit ridership data's.
- Facility alignments taken.
- Capital project data's.

Data collection

Serial no.	Roads	lanes	Speed limit
1	Road1(to NIT)	1	30k mph
2	Road2(to Ambagan)	2	40km ph
3	Road3(to station)	2	50k mph
4	Road3(to adhuban)	1	40k mph

About Trans CAD

Trans CAD extends the traditional GIS data model to include transportation data objects such as transportation networks, matrices, routes systems, and linear-referenced data. These extensions make Trans CAD the best data management and analysis tool for working with transportation data. You can use the GIS functions to prepare, visualize, analyze, and present your work, and use the application modules to solve routing, logistics, and other transportation problems with greater ease and efficiency than with any other product. Networks and matrices can be of virtually unlimited size.

About QGIS:

QGIS (Quantum GIS) is a cross-platform free and open source desktop geographic information system(GIS) application that provides data viewing, editing, and analysis capabilities.

V. RESULTS AND ANALYSIS

Super elevation:

Super elevation is the transverse slope to counteract the centrifugal force and to reduce the tendency of vehicle to overturn or skid.

Overturning:

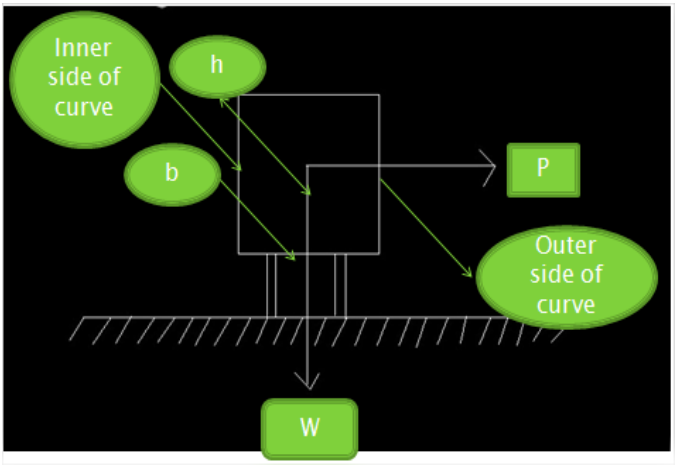
It basically means both the outer wheels from the road and the vehicle may touple.

For no overturning: **(p/w)=(v^2)/g.R< (b/2h)**

Skidding:

In case of skidding the wheels will be in contact but will go off track from the road i.e., toward outside.

For no skidding: **(p/w)= (v^2)/g.R< f**

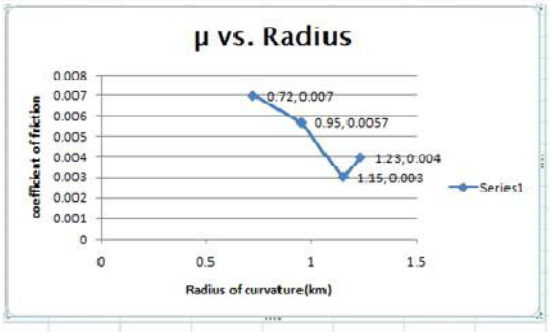


Input & Output Data's For Super Elevation & Friction:

Sl no.	curve	From & to	Curve length(km)	Angle(degree)
1	c1	Bhagbati mandir to space chowk	0.75	60
2	c2	Telephone to ambagan	0.60	30
3	c3	RSP residence to c. tower	0.86	40
4	c4	Municipal clg to h. vatika	0.91	55

Coefficient of friction:

Different friction for different curves values of coefficient of



Traffic flow value 'C'

It is the average of volume of vehicles carried by the road. It is very important to decide whether the road is good condition or critical condition. It is expressed in terms of number of vehicles/lane/ day.

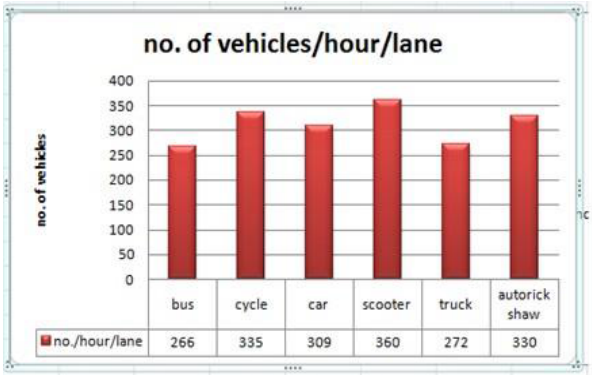
Input values for traffic flow of road 'c' of road

Sl no.	Type of vehicle	Length(m)	Speed(km/hr)
1	bus	11	55
2	cycle	1.85	25
3	car	4.2	36
4	scooter	1.9	48
5	truck	6.7	36
6	autorickshaw	2.1	25

Output 'c' values

Sl. No.	Type of vehicle	No. of vehicles/hour/lane calculating individually	Fraction–no. /net sum	No. of vehicles from each type
1	bus	1620	0.142	266
2	cycle	2036	0.179	335
3	car	1873	0.165	309
4	scooter	2190	0.192	360
5	truck	1658	0.145	272
6	autorickshaw	1996	0.176	330

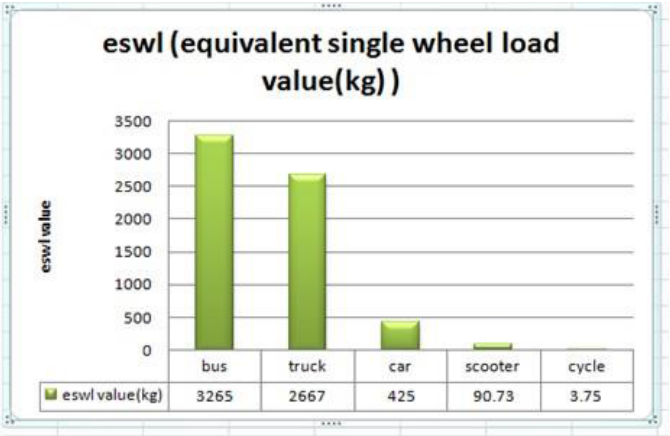
Comparison of traffic flow values of road



ESWL (Equivalent Single Wheel Load):

ESWL is the single wheel load which produces the same value of maximum stresses at the depth Z as the dual wheel assembly. ESWL can be determined graphically. It is also one of the important criteria in asset management of roads.

Comparison of ESWL (Equivalent Single Wheel Load) values:



Shear failure and cracking:

- Shear failures are associated with the inherent weakness of the pavement mixtures, the shearing resistance being low due to inadequate stability or excessively heavy loading.

Longitudinal Cracking:

- Due to frost action and differential volume changes in sub grade longitudinal cracking is caused in pavement, transversing through the full pavement thickness.
- Settlement of fill and sliding of side slopes also would cause this type of failure.

Reflection Cracking:

- This type of cracking is observed in bituminous overlays provided over existing cement concrete pavements.
- The crack patterns as existing in cement concrete pavements are mostly reflected on bituminous surfacing in the same pattern.

VI. CONCLUSION

- Friction, super elevation and traffic flow values are important factors to evaluate road assets.
- The main reason of failure of this road is repeated application of heavy loads.
- For future safety, we must go for an alternate route for heavy vehicles so as to prevent further degradation of roads.

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