ROAD ASSET MANAGEMENT: EVOLUTION AND TECHNIQUES

A THESIS SUBMITTED IN PARTIAL FULFILLMENT

OF THE REQUIREMENTS FOR THE DEGREE OF

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By

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National Institute of Technology

Rourkela

CERTIFICATE

This is to certify that the thesis entitled, "**ASSET MANAGEMENT OF ROADS; EVOLUTION & TECHNIQUES**" submitted by **RAJESWARI BHOLA** in partial fulfillments for the requirements for the degree of Bachelor of Technology 2013-14 in Civil Engineering at **National Institute of Technology**, **Rourkela** is an authentic work carried out by him under my supervision and guidance. To the best of my knowledge, the matter embodied in this report has not been submitted to any other University / Institute for the award of any Certificate.

Prof P.K. Bhuyan

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Last but not the least I would like to thank my parents, who taught me the value of hard work by their own example. I would like to share this bit of happiness with my mother and father. They rendered me enormous support during the whole tenure of my stay at NIT, Rourkela.

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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 basicallly means a systematic process of maintaining, upgrading and operating assets, combining engineering principles and theories, and providing tools to facilitate a more organised 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 hav analysed it using QGIS . I have taken 33 points under observation. According I got the coordinate datas and from there I found curve datas and found out super elevation, coefficient of friction, traffic flow value , ESWL value. Accordingly I got the values of each of these components and analysed it. I found the basic reason behind the failure of roads which is mainly due to repeated applicaton of heavy loads and we can find the alternate routes for movement of heavy vehicles to eradicate these problems.

CONTENTS

Chapter 1 : INTRODUCTION

Management of the road asset involves the application of engineering and management practices to optimise the type of service outcome for the most cost-effective financial input. The function of the asset manager is to optimise investment and outcomes within the constraints of finance, service type and resources. Taking only the pavement and surfacing assets into consideration, the optimisation 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-treatmentservice level, and make adjustments based on real performance. The objective is to minimise the extent of unplanned maintenance resulting from hapazard performance.Risk assessment and its management are essential road asset management considerations.The outcomes of the Forward Works Programme 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 maintainance is essential between design, construction and assetmanagement 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.

Chaper 2 : LITERATURE REVIEW

2.1 Objective- 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 organised and flexible approach for making the decisions necessary to achieve the public's expectations". Moreover, governments are placing greater pressures on road administrations to improve the efficiency and management of the road asset. It is for these reasons that that many governments are planning how they can implement the concept of asset management in the road sector.The main objective is to analyse the asset system management for urban road infrastructure using GIS. The objective is to simply apply the right treatment at the proper time to achieve the expected level of service.

2.2 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 characterstics – including data on asset condition, asset use and asset features.
- Methods of maintainance.
- 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.

The softwares that will be used for above works are GIS software. It has a wide range of application which involves the use of a combination of digital maps and georeferenced datas. With the help of this I will analyse my result. TransCAD software is the basic software by which I will approach.It will include:

2.2.1 Treatment Lengths for Safety:

In present best practice is for programmes to be developed is based on needs, assessed data and treatment length level. A treatment length is defined as a uniformly performing portion of pavement that performs differently to the portions on either side of it.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.

.The original treatment length may then be split into two separate treatment lengths.

2.2.2 Life Cycle Cost Analysis Procedures:

Life Cycle asset management is the concept of planning and analysing of all needs,requirements and activities that will be necessary to gain fullfill life of the asset,from the current status , and is commonly referred as 'cradle to grave' analysis. 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.

The selection of treatments is based on consideration of all treatment options and strategies that are possible over the full life of the asset used.

2.2.3 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, the term 'investigatory'is frequently used which means a level at which the justification for treatment or correction should be always considered. The construction standards establishan expected new type of service level. For example, one key service level expectation that is rated very highly by the public, and is implemented through construction standards, is related to the presence of loose sealing chip. This is a construction outcome, and the service level is achieved through the seal design.

2.3 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. The condition of other assets may be at various stages of deterioration and at or below the required level of service provided.

2.4 Prediction of Performance -

After the condition of each treatment length is known, this information can be transferred into models that are assigned to predict the performance and failure modes of the asset, under the influence of the demands of traffic and environment and in terms of the levels of service provided.

2.4.1 Optimisation of Treatment options and Strategies:

The next step is optimisation of options and strategies which includes the complicated decision of choosing a factor based the optimisation process. Common option includes optimisations based on:

•Asset conditions and performances .

•Total transportation costs

•Agency costs against fixed service level 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. This process lead to today's Asset Management concept. The process started with 3 things i.e, the development of pavement management systems (PMS), continued with bridge management systems (BMS) and infrastructure management systems (IMS), and has recently evolved into asset management (Ferreira and Flintsch, 2004). My literature reviews will include periodic

maintenance, planning, road investments, traffic information and services, land acquisition and administration.

I have read the papers of A GIS-Based Integrated Infrastructure Management System Adelino FERREIRA and Anabela DUARTE, Portugal,OECD papers, practical guidelines for cpr of urban roads . I have taken my referances from these papers and hence will continue my project. I have read about TransCAD software and its tutorials and its inputs, outputs and working and how a map is designed from it.

Chapter3 : STUDY AREA AND DATA COLLECTION PROCEDURE

I have analysed it using GIS(Geographical Information Survey) through TransCAD software.

TransCAD is a state-of-the-art GIS that you can use to create and customize maps, build and maintain geographic data sets, and perform many different types of spatial analysis. TransCAD includes sophisticated GIS features such as polygon overlay, buffering, and geocoding, and has an open system architecture that supports data sharing on local- and wide-area networks.

TransCAD is the first and only Geographic Information System (GIS) designed specifically for use by transportation professionals to store, display, manage, and analyze transportation data. TransCAD combines GIS and transportation modeling capabilities in a single integrated platform, providing capabilities that are unmatched by any other package. TransCAD can be used for all modes of transportation, at any scale or level of detail.

TransCAD 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 .

TransCAD has applications for all types of transportation data and for all modes of transportation, and is ideal for building transportation information and decision support systems. TransCAD runs

on readily-available hardware under Microsoft Windows and embraces virtually all desktop computing standards. This has two important benefits:

- You can acquire and install TransCAD at a much lower cost than any other integrated GIS and transportation modeling solution
- You don't have to build custom applications or complicated data interchange modules to perform transportation analysis with GIS data

3.1 Methods Adopted -

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

3.1.1 Networks adopted:-

Transportation networks are specialized data structures that govern flow over a network. Networks are stored in a highly-efficient way, enabling TransCAD to solve routing problems very quickly. Networks can include detailed charact

- Turn delays and restrictions
- Overpasses, underpasses, and one-way links
- Intersection and junction attributes taken.
- Intermodal or interline terminals, transfer points, and the delay functions
- Zonal centroid connectors.

- Link classifications and performance functions done.
- Transit access and walk transfer links eristics.

3.1.2 Matrices Constructed:-

Matrices hold data such as distance, travel times, and origin-destination flows that are essential for many transportation applications. TransCAD 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.

3.1.3 Routes and Route Systems adopted :-

Route indicates paths taken by trucks, autorickshaws , cars, buses, or individuals traveling from place to place. TransCAD includes tools which create, display, edit, and manipulate routes, and unique display technology for mapping routes in a clear and compelling fashion. You can construct a specific set of related routes into a single route system layer, and include route attributes, stop locations, and vehicle schedules.

3.1.4 Linear Referencing:-

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

- Facility infrastructure and operations datas

- Accident locations spotted
- Pavement or rail condition ratings
- Traffic flows and transit ridership datas
- Facility alignments taken
- Capital project datas

3.2 Approaches-

3.3 Analysis using TransCAD-

3.3.1 TransCAD details:

3.3.2 Area under observation:

3.3.3 Data collection :

Serial no.	Roads	lanes	Speed limit
1	Road1(to NIT)	1	30kmph
2	Road2(to Ambagan)	2	40kmph
3	Road3(to station)	2	50kmph
4	Road3(to Madhuban)	1	40kmph

3.3.4 Results obtained from TransCAD:

Serial no.	**Road**	**From node**	**To node**	**Transcad flow value(vehicles/hr/lane)**
1	**To NIT**	**1**	**5**	**355.91**
2	**To Ambagan**	**2**	**5**	**587**
3	**To Station**	**4**	**5**	**855**
4	**To Madhuban**	**3**	**5**	**435**

3.3.5 Problems associated:

3.3.6 About TransCAD:

TransCAD 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 TransCAD 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.

3.4 QGIS-

3.4.1 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.

QGIS allows users to create maps with many layers using different map . Maps can be assembled in different formats and for different uses. QGIS allows maps to be composed of raster or vector layers. The vector data is stored as either point, line, or polygon-feature. Different kinds of raster images are supported and the software can perform georeferencing of images.

Procedure followed:

*First the datas of the area under observation is collected.

*Their corresponding positions and elevations are noted down.

*The map is drawn in autoCAD and according to the given dimensions given.

*Then it is converted into shape file using CAD2shape software converter.

* Then by putting the shape file we will get 2 formats i.e, point format and line format.

*Then the datas collected are converted into csv file and are put in QGIS.

*These datas are used to add vector layer.

* Then we will obtain digitalized form of the map.

* Then we will get corresponding coordinates of the points taken.

*Using those coordinates we will calculate the radius of curvature of the turning points.

* Then using mathematical formulae we will calculate coefficient of friction, super elevation of the curves.

* Then we will note down the speed of the vehicles at different curvatures and average weight of the vehicles.

*Using these value we will find the traffic flow value of the road under observation.

* Then ESWL(equivalent single wheel load) of vehicles is calculated.

* Then graphs are drawn between radius of curvature and coefficient of riction, super elevation and their correspending characterstics are studied.

* Also bar chart for different vehicles are drawn and their ESWL and traffic flow values are compared.

* Then the reason for failures of road are studied.

*The prime reason for failure of road is repeated application of heavy loads over the same road continiously.

* Then alternative ways to prevent the failure of road are suggested.

*One of the way is to provide the alternate route along same line for heavy vehicles or to limit the movement of heavy vehicled along that path continiously.

3.4.2 Data Collection For QGIS:

- Over 33 points are taken for observation and it covers the whole ring road closed path.

- It has four curves and it forms a closed loop.
- And length between the consecutive points are calculated from the data.

(Length b/w points forming path)

Sl.No	From	To	Length(km)
1	B-4/1, CIVIL TOWN	HANUMAN STATUE	1.86
2	HANUMAN STATUE	HANUMAN VATIKA END	0.37
3	H. VATIKA END	UDIT NAGAR	0.6
4	UDIT NAGAR	RAIL LINE OVERBRIDGE	0.21
5	RAIL LINE OVERBRIDGE	CHEND CHAKKA	1.23
6	CHEND CHAKKA	MAA BHAGABATI MANDIR	0.94
7	MAA BHAGABATI MANDIR	FINISHING TOUCH	0.21
8	FINISHING TOUCH	SPACE CHOWK AIRSTRIP	0.54
9	SPACE CHOWK AIRSTRIP	DEER PARK	0.96
10	DEER PARK	JUBULI PARK	0.37
11	JUBULI PARK	HOME AND HOPE SEC-17	1.55
12	HOME AND HPE SEC-17	SEC-18, HIGH SCHOOL	0.23
13	SEC-18, HIGH SCHOOL	TELEPHONE BHABAN	0.43
14	TELEPHONE BHABAN	AMBAGAN CHOWK	0.6
15	AMBAGAN CHOWK	VIP ROAD	0.72
16	VIP ROAD	RING ROAD	0.57
17	RING ROAD	SEC2, A/85	0.7

18	SEC-2, A/85	SEC-3, JAGANATH TEMPLE	0.44
19	SEC-3, JAGANATH TEMPLE	GAYATRI MANDIR	1.1
20	GAYATRI MANDIR	I.G. PARK	0.32
21	I.G. PARK	RSP'S RESIDENTIAL QUARTER	0.68
22	RSP'S RESIDENTIAL QUARTER	RSP COOLING TOWER	0.49
23	RSP COOLING TOWER	I.G. PARK END	0.37
24	I.G. PARK END	HUGE STEEL BALL	0.23
25	HUGE STEEL BALL	RKL STEEL CITY	0.55
26	RKL STEEL CITY	ADMINISTRATIVE BUILDING	0.64
27	ADMINISTRATIVE BUILDING	PLANT SIDE CHOWK	0.24
28	PLANT SIDE CHOWK	SARNA CHOWK	0.69
29	SARNA CHOWK	MUNICIPAL COLLEGE	0.86
30	MUNICIPAL COLLEGE	H. VATIKA	0.51
31	HANUMAN VATIKA	H. VATIKA END	0.4

- Their rectangular coordinates and corresponding elevations are also noted.
- These coordinates are used to find consecutive lengths.

3.4.3 Coordinates and its corresponding elevation data:

Sl.No.	Place	x coordinate	y coordinate	Elevation(ft)
1	B-4/1, CIVIL TOWN	40.3	147.5	627
2	H.STATUE	65.6	146.5	641
3	H. VATIKA	77.8	147	634
4	UDITNAGAR	83	155	650
5	RAIL LINE CROSS	73.6	160.2	653
6	CHEND CHAKKA	68.4	194	711
7	MAA MANDIR	64.2	208.5	694
8	FINISHING TOUCH	63.3	211.8	682
9	SPACE CHOWK	65.1	225.9	669
10	DEER PARK	75	229.2	691
11	JUBULI PARK	87.2	228.2	705
12	HOME AND HOPE	136.5	229.7	688
13	HIGH SCHOOL SEC18	145.9	229.2	680
14	TELE. BHABAN	147.3	228.2	666
15	AMBAGAN CHOWK	157.2	228.7	668
16	VIP ROAD SQUARE	171.3	230.1	671
17	RING ROAD	181.1	230.2	698
18	SEC2, A/85	187.2	220.3	714
19	SEC3, JAGANATH TEMPLE	184.4	218.9	700
20	GAYATRI TEMPLE	178.3	192.6	707
21	I.G. PARK	173.1	189.3	720
22	RSP QUARTER	167	174.7	685
23	BADRINATH TEMPLE	163.7	166.7	652

24	RSP COOLING TOWER	165.2	161.6	651
25	I.G. PARK END	164.2	154.5	636
26	HUGE STEEL FOOTBALL	158.6	150.3	628
27	RKL STEEL CITY	149.7	149.4	629
28	ADMINI. BUILDING	137.9	148	634
29	PLANT SIDE CHOWK	121	146.1	643
30	SARNA CHOWK	113	144.2	646
31	MUNICIPAL COLLEGE	107.9	145.6	642
32	MUNICIPAL COLLEGE GARDEN	94.7	143.7	624
33	GOVT. H. SCHOOL. U. NAGAR	94.3	150.3	637

3.4.4 Input map:

- This closed loop area is the area of my study.

- The four corners are basically Hanuman vatika, Space chowk, Ring road and RSP residense area.

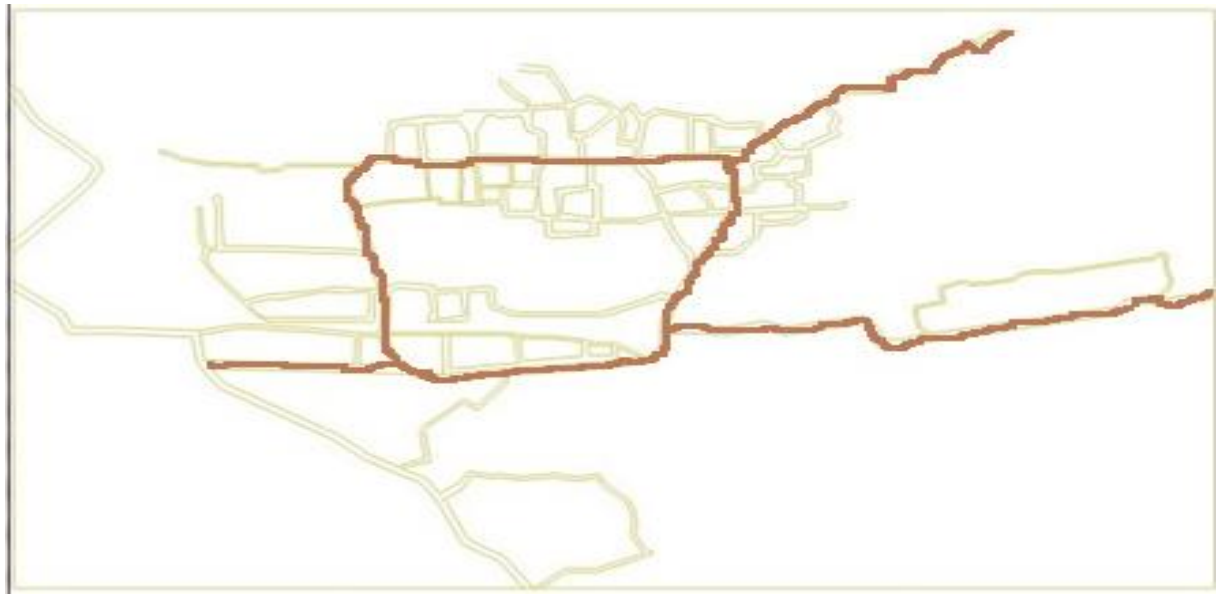
3.4.5 Map drawn on autoCAD:

- This map is drawn on autoCAD using respective dats and proper coordinates.
- This red closed loop path indicates the area of my project under observation.

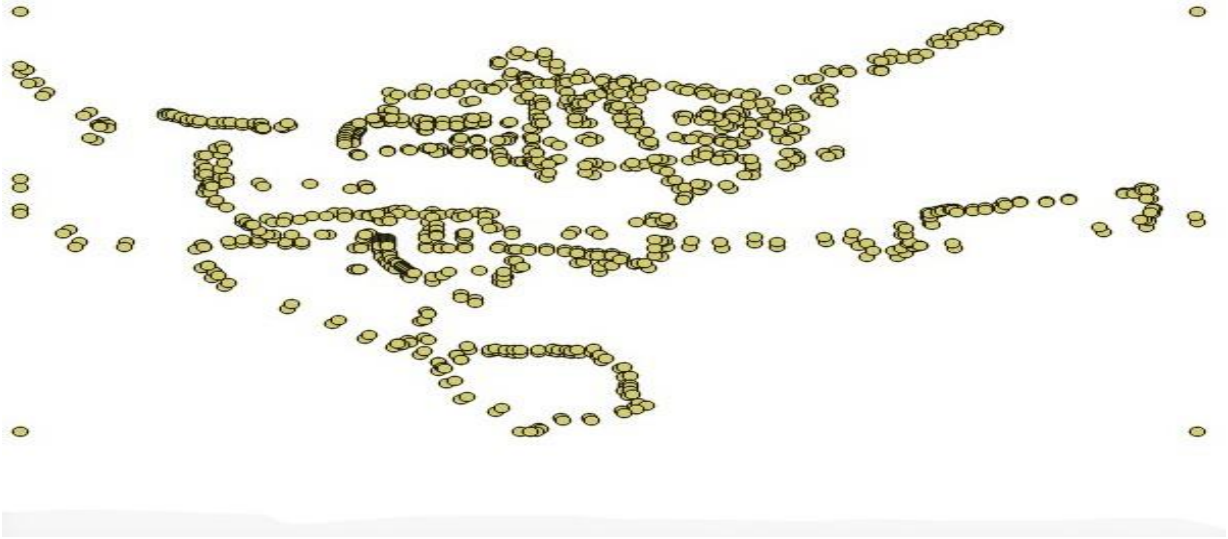
3.4.6 Conversion to shape file using software CAD2Shape7.0 :

- This software gives two formats of the autoCAD map.
- One is line format and the other one is point format.
- We will take line format for futher study because it gives a sharp path which clearly identifies the route.

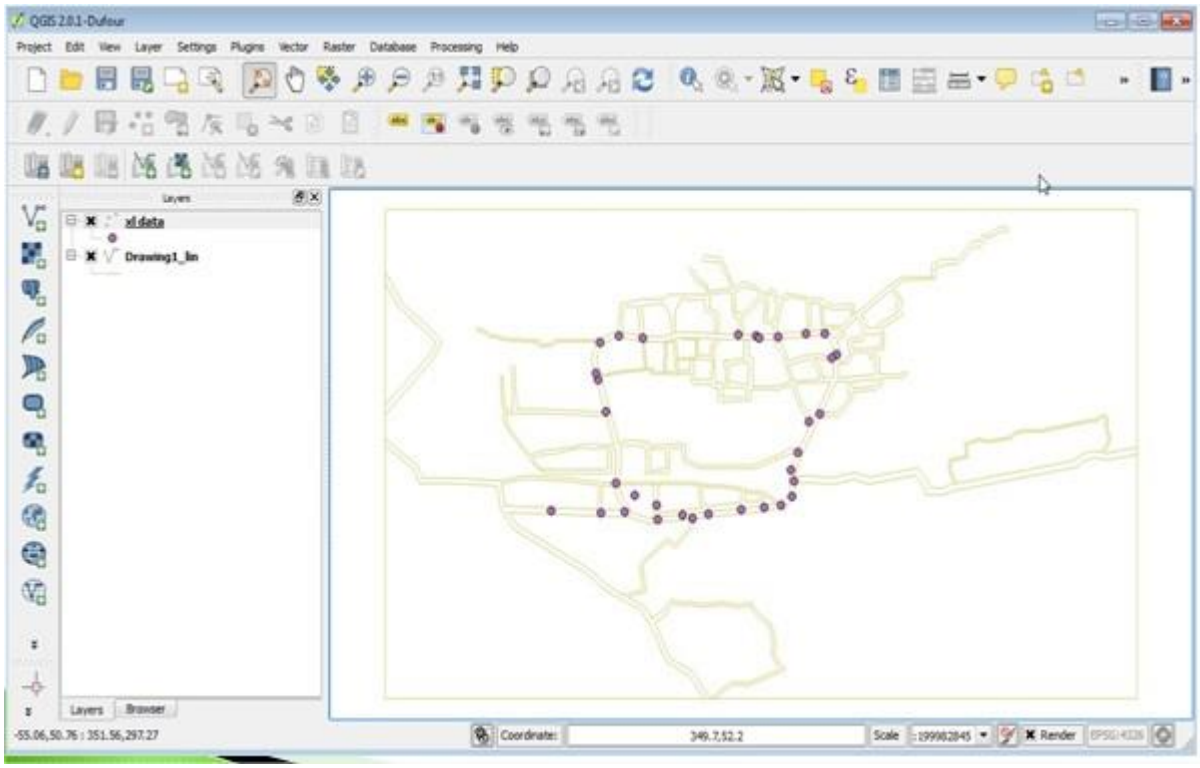
Line format:



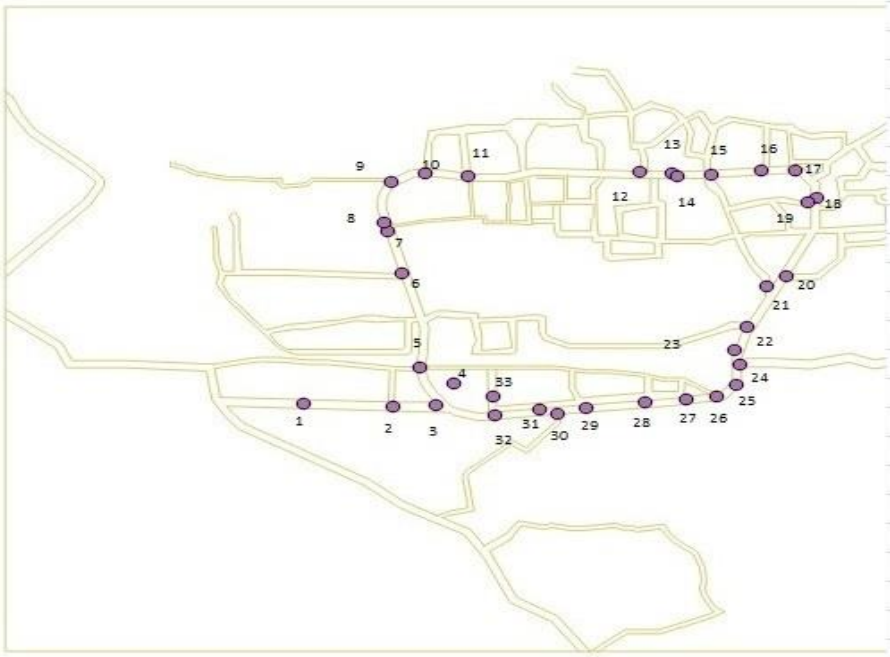
Point format:



3.4.7 Map output from QGIS:



3.4.8 Map with all 33 points indicated:



1	B-4/1, CIVIL TOWN
2	HANUMAN STATUE
3	H. VATIKA END
4	UDIT NAGAR
5	RAIL LINE OVERBRIDGE
6	CHEND CHAKKA
7	MAA BHAGABATI MANDIR
8	FINISHING TOUCH
9	SPACE CHOWK AIRSTRIP
10	DEER PARK
11	JUBULI PARK
12	HOME AND HPE SEC-17
13	SEC-18, HIGH SCHOOL
14	TELEPHONE BHABAN
15	AMBAGAN CHOWK
16	VIP ROAD
17	RING ROAD
18	SEC-2, A/85
19	SEC-3, JAGANATH TEMPLE
20	GAYATRI MANDIR
21	I.G. PARK
22	RSP'S RESIDENTIAL QUARTER
23	RSP COOLING TOWER
24	I.G. PARK END

Chapter 4: RESULTS AND ANALYSIS

4.1 Super elevation:

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

4.2 Overturning:

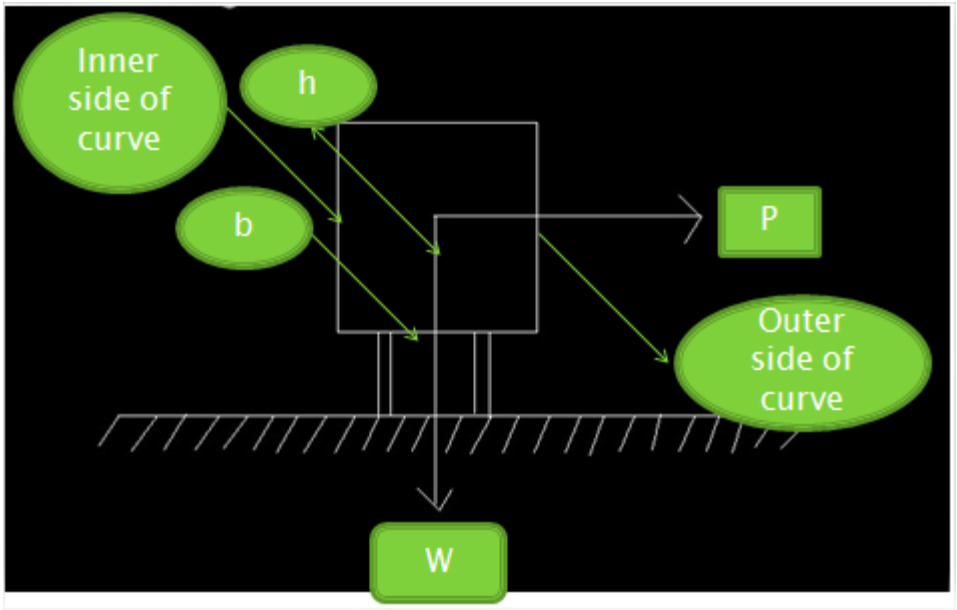
It basically means both the outer wheels from the road and the vehicle may touple.

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

4.3 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**

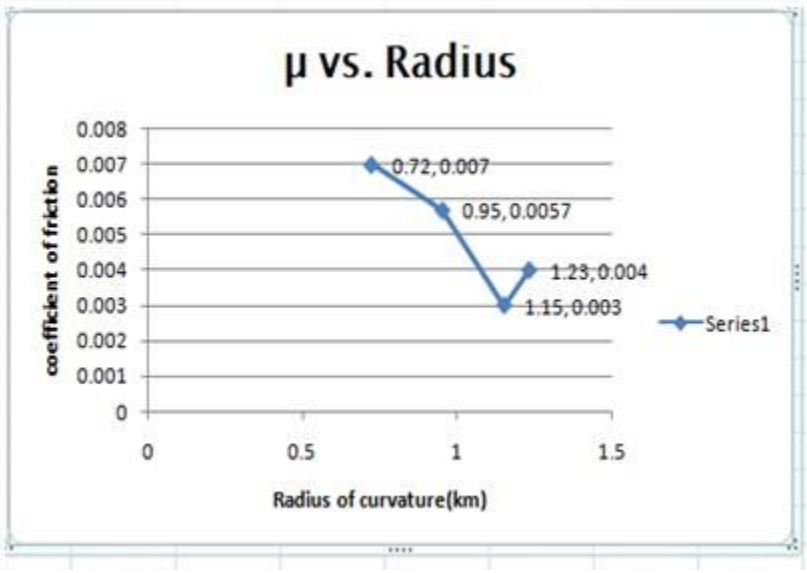


4.4 Input & output datas for superelevation & friction:

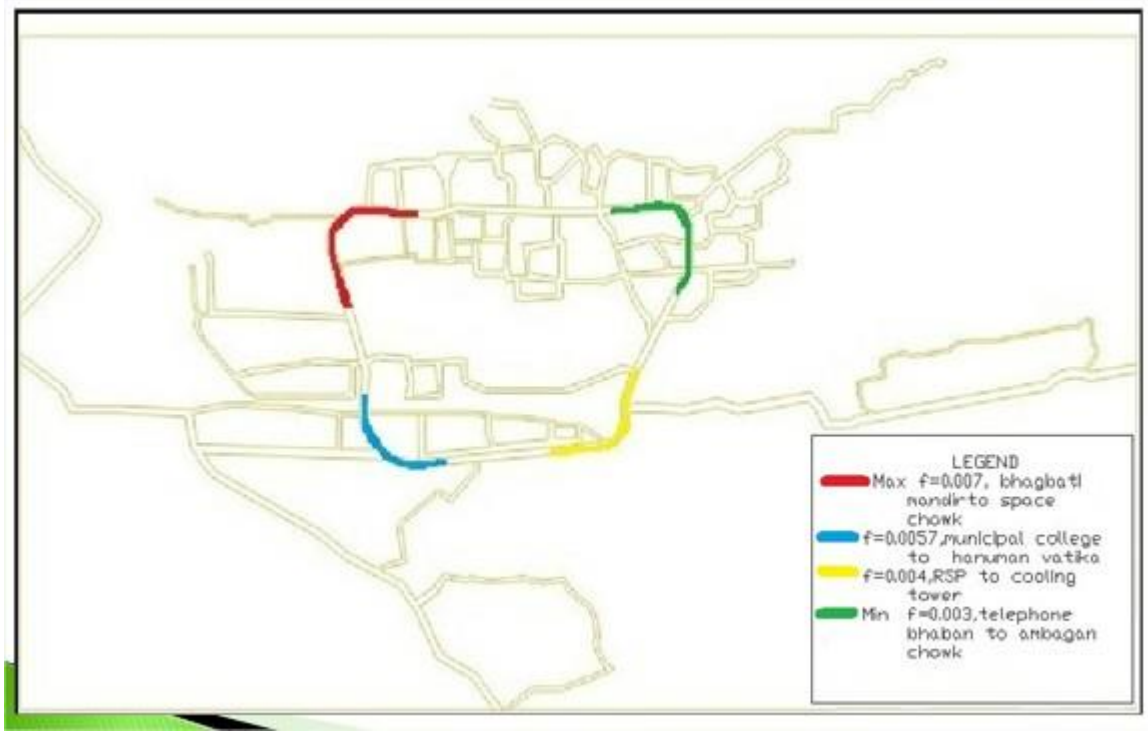
Sl no.	curve	From & to	Curve length(km)	Angle(degree)
1	c1	Bhagbati mandir to space chowk	0.75	60
2	c2	Telephone to ambagan	0.60	30
3	c3	RSP residence to c. tower	0.86	40
4	c4	Municipal clg to h. vatika	0.91	55

4.5 Coefficient of friction:

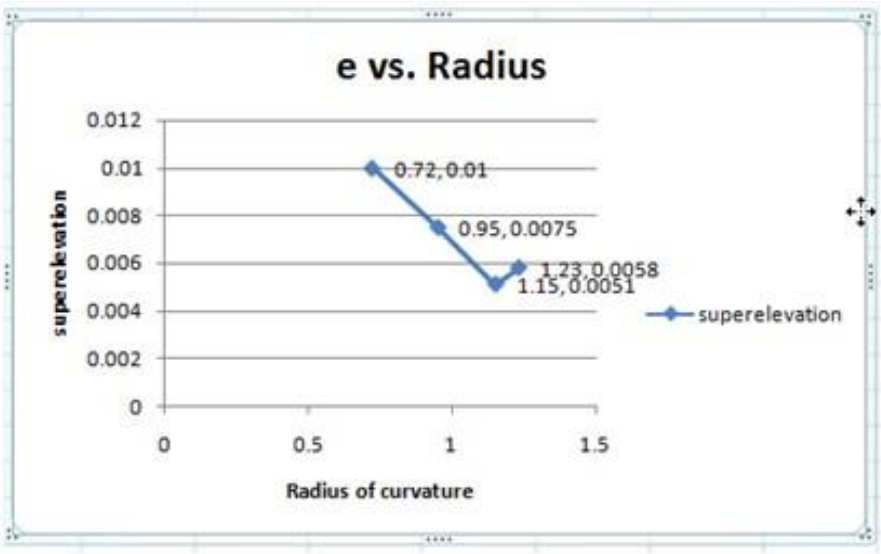
Different friction for different curves values of coefficient of



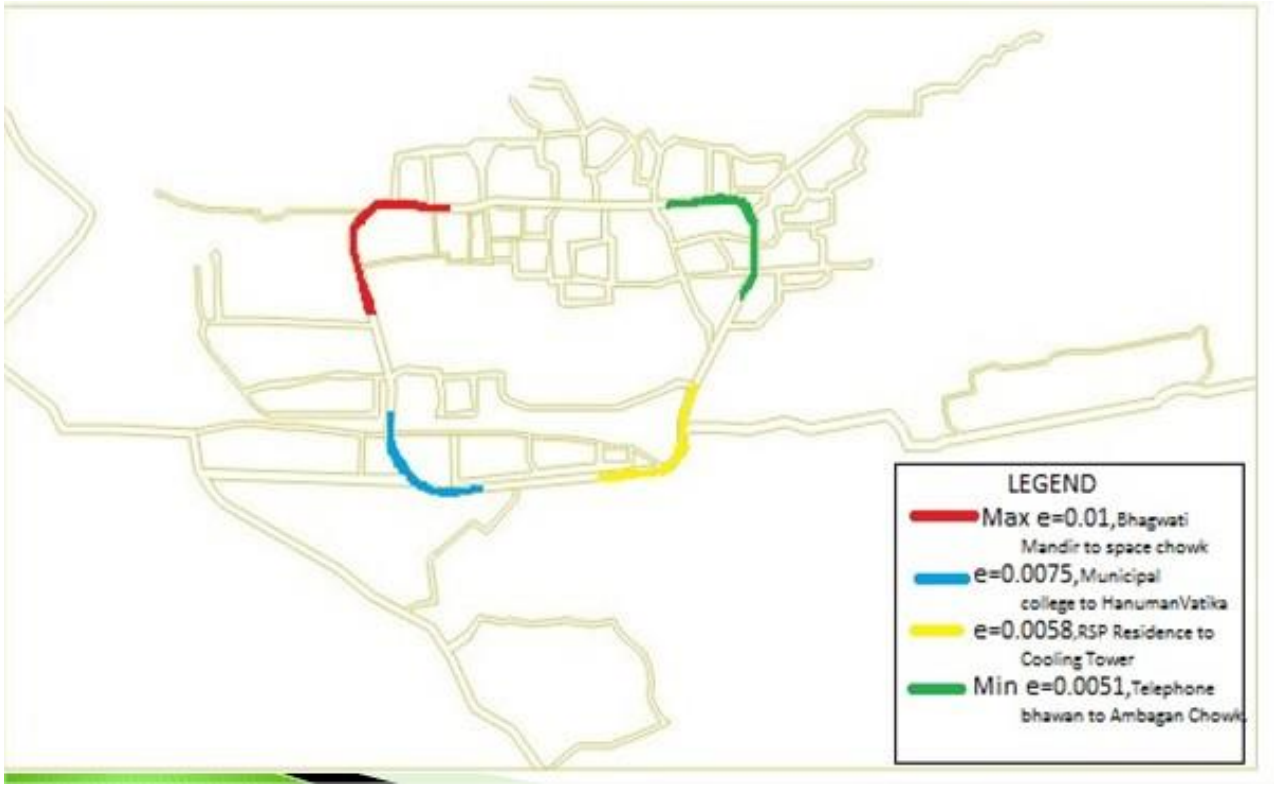
Max and min values of coefficient of fricton for different roads



Different ‘e’ values for different curves



Max and Min values of superelevation(e)



4.6 Traffic flow value ‘C’

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

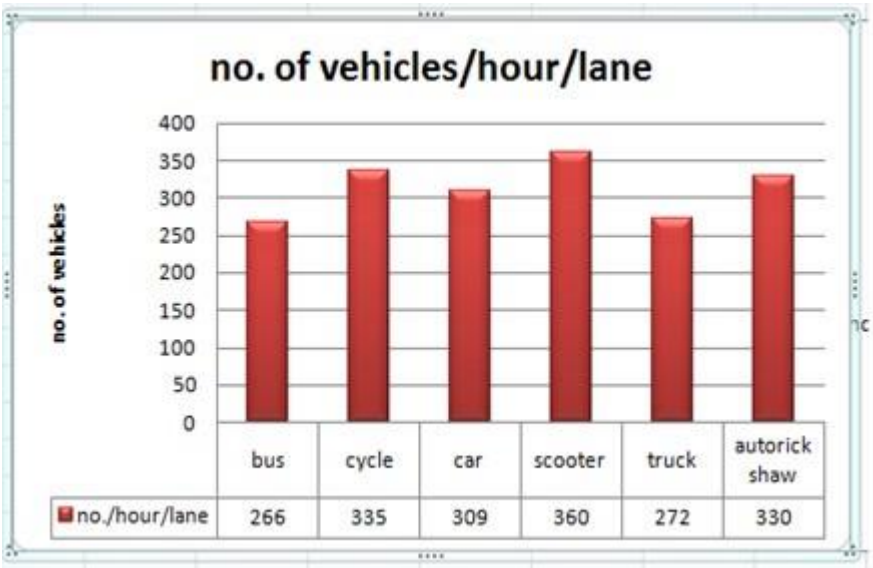
Input values for traffic flow of road ‘c’ of road

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

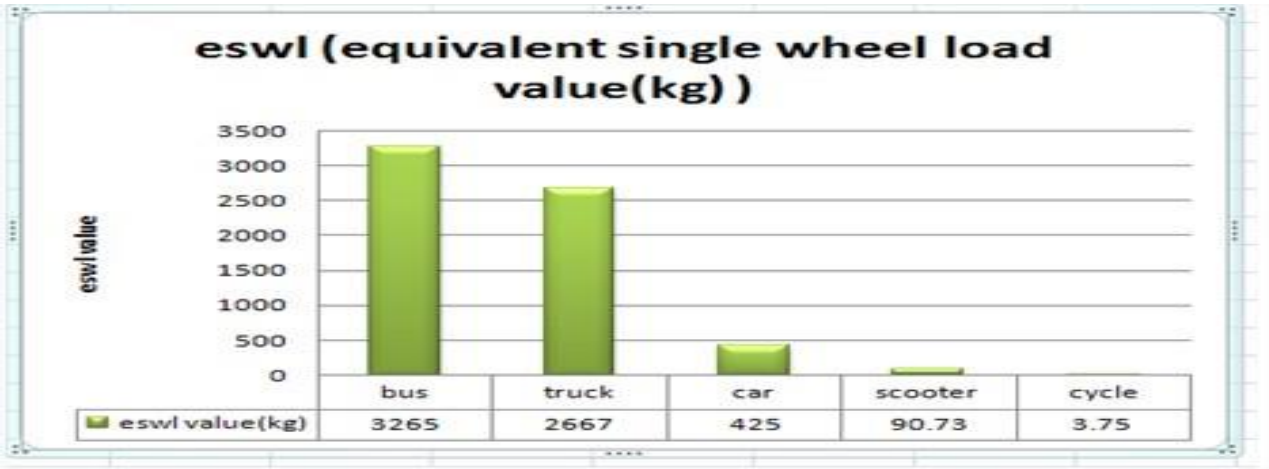
Comparison of traffic flow values of road



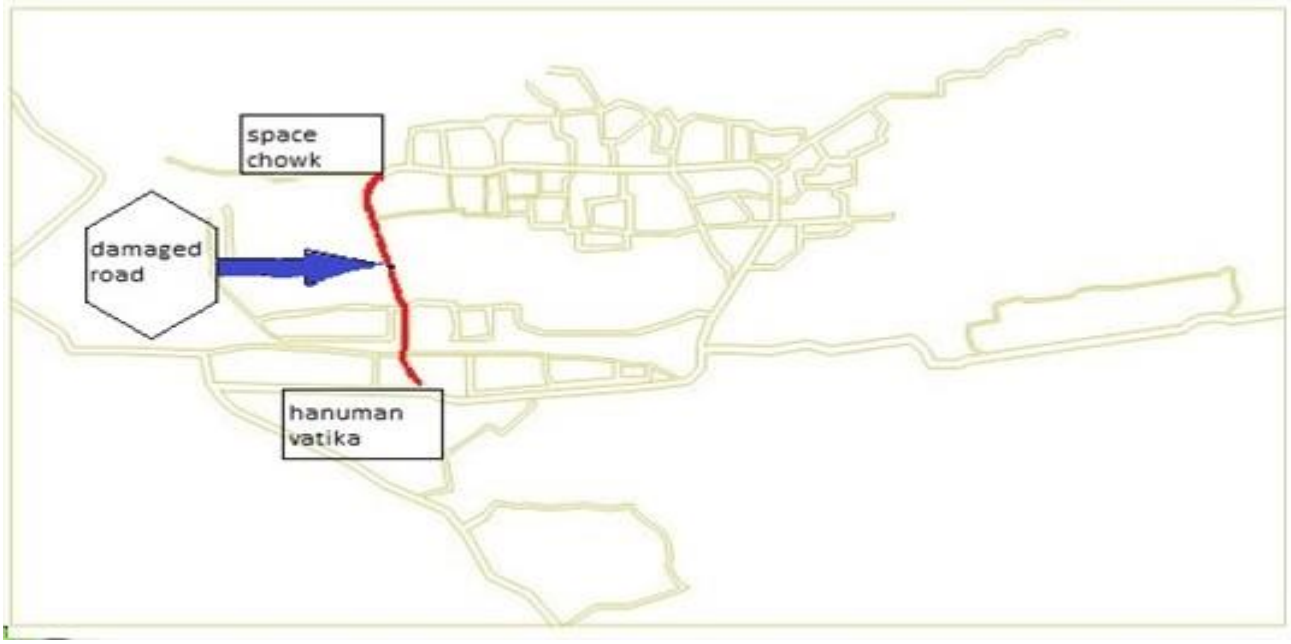
4.7 ESWL(Equivalent Single Wheel Load):

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



The damaged road due to repeated application of heavy loads



4.8 Failure reasons

4.8.1 Aligator(map) cracking:

*This is the most common type of failure and occurs due to relative movement of pavement layer materials.

*This may be caused by the repeated application of heavy wheel loads resulting in fatigue failure or due to moisture variations resulting in swelling and shrinkage of subgrade and other pavement materials.

*Localized weakness in the underlying base course would also cause cracking of the surface course in this pattern.

4.8.2 Consolidation of pavement layers:

*Formation of ruts are mainly attributed to the consolidation of one or more layers of pavement.

*The repeated application of loads along the same wheel path cause cumulative deformation resulting in consolidation deformation longitudinal ruts.

4.8.3 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.

4.8.4 Longitudinal Cracking:

*Due to frost action and differential volume changes in subgrade 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.

4.8.5 Frost Heaving:

*In shear failure , the upheavl of portion of pavement is followed with a depression.

*In case of frost heaving , there is mostly a localized heaving-up pavement portion depending upon the ground water and climatic conditions.

4.8.6 Reflection Cracking:

*This type of cracking is observed in bituminous overlays provided over existing cement concrete pavements.

*The crack pattern as existing in cement concrete pavements are mostly reflected on bituminous surfacing in the same pattern.

4.8.7 Lack of Binding with Lower Layer:

*Slipping occurs when the surface course is not keyed/ bound with the underlying base . This results in opening up and loss of pavement materials forming patches or pot holes.

*Such conditions are more freqent in case when the bituminous surfacing is provided over the existing cement concrete base course or soil cement base course.

Chapter 5 SUMMARY AND CONCLUSION:

5.1 Summary:

Asset management basically means systematic way of maintaining, upgrading and operating physical assets in order to meet public expectations. I have taken a portion of Rourkela road for my project area. Then I collected 33 points around the road and collected datas of the points. I collected their positions and corresponding elevations. Then I got the map of the road with all data. Using those datas I found out the superelevation, coefficient of friction, ESWL, flow capacity of the road. Then I analysed the results and predicted the reasons behind the failure of the road. The main reason for the failure of the road is due to heavy application of repeated loads . It can be prevented by creating alternate routes for heavy vehicles.

5.2 Conclusion:

*****Friction, superelevation 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 degardation of roads.

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