Pavement Maintenance and Management of Urban Roads Using HDM 4

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ABSTRACT: Sustainable development of any country depends upon the type and quantum of road transportation infrastructure provided. Day by day transportation planning in urban and rural is becoming more and more difficult due to the enormous increase in the traffic. In our present study, we have taken a stretch of 3.0 km highway road, mentioned as Belagavi - Khanapur road, 4th gate to BEMCO and Old Dharwad road. The following survey has been carried out: Traffic volume study, Income study and Geometrical study of the road for the purpose of collection of data and for the further proceedings the selected road length was subdivided in to 3 stretches of length 1.25km, 0.8km & 0.95km, respectively. The traffic volume study was carried out to know the number of vehicles plying on the road. Income study was carried out to know the amount of money that the passengers are spending while travelling on the road. The geometrical study of road was carried out to know the rise and fall, horizontal curvature & to study the l section of the road. The data collected is used to provide the maintenance required for the different road networks using HDM4 software. Different alternative strategies are evaluated, and the optimum maintenance strategy required for the design life is suggested for implementation.

KEYWORDS: Pavement, Low volume roads, Calibration

1. INTRODUCTION:
Transportation contributes to the economic, industrial, social and cultural development of any country. Transportation is vital for the economic development of any region since every commodity produced whether it is food, clothing, industrial products or medicine needs transportation at all stages from production to distribution. In the production stage, transportation is required for carrying raw materials like seeds, manure, coal, steel etc. In the distribution stage, transportation is required from the production centres namely farms and factories to the marketing centres and later to the retailers and the consumers for distribution. The inadequate transportation facilities retard the process of socio economic development of the country. The adequacy of transportation system of a country indicates its economic and social development.

2. LITERATURE SURVEY
To begin with the project it is more essential to have general and detailed information regarding the subject content, strategic approaches, available research in the subject area, interpreted results and drawn conclusions. Keeping the above in mind, a detail review was conducted to know the available information in the subject, need to research, development and improvement. It gives us an idea about the objective to be achieved for the present work from the works which are already carried out. The brief details of the case studies which have been referred for the present study are mentioned in the below paragraphs:
3. METHODOLOGY
Volume count was done, the collected data was converted in to passenger car unit (PCU). Terrain condition was obtained with the help of google earth. The data collected is further analysed with the help of the software. The result are obtained, various maintenance strategies are obtained. The various alternatives are compared.

3.1. STUDY AREA
The District Headquarters, Belagavi is a picture of contrasts. It is also known as Kunda Nagari. Belagavi is famous for its temples and the religious-minded traveler could find a number of temples here-the main ones being Kamal Basti (in Belagavi Fort) Kapileshwar temple, Shani temple and the Maruti Temple.
It has present population of about 632,453. The district comprises 1278 villages with an area of 13,415 km² with a population of around 11 lakh. The city is provided with necessary communication and infrastructure facilities like rail, road, telecommunication, radio and television stations, internet etc. The study area is as shown in Fig 3.1

![Fig. 3.1](image-url)
4.1.1. Periodic maintenance thresholds (for example, reseal pavement surface at 20% damage). Improvement thresholds (for example, widen roads with volume/capacity ratio greater than 0.8). Development standards (for example, upgrade gravel roads to sealed pavements when the annual average daily traffic exceeds 200 vehicles per day). The above examples do not imply firm recommendations to be used by road authorities.

4.1.2. Life cycle prediction of deterioration, maintenance effects & costs: For the particular traffic loading, HDM-4 is able to calculate the deterioration of the road structure and the surface for each year of the analysis period. If the user provides the maintenance option then HDM-4 can apply the maintenance, calculates the cost of maintenance and the effects thereof. For example, if the user gives the option that whenever the roughness will reach 6 IRI, an overlay has to be applied. In this case the HDM-4 will calculate the roughness increase every year due to traffic loading and whenever the roughness will reach 6 IRI, HDM-4 will apply an overlay. As an effect of this maintenance the roughness will be decreased to an extent as will be specified in the overlay option. HDM-4 will also calculate the cost of the overlay with the help of the rate supplied by the user.

4.1.3. Road user costs and benefits: The road user costs consists of the Vehicle Operating Costs (VOC), the Travel Time Cost (TTC) and the Accident Cost (AC). If no maintenance is done (do nothing option) the road user costs will be high but if any maintenance is applied such as overlay (do something option), the road user costs will be reduced to a great extent. If the Road user costs of the above two options are compared then it will be seen that a benefit will be obtained by doing the maintenance.

4.1.4. Economic comparison of project alternatives: For the maintenance of the road, the user might have various maintenance strategies. HDM can calculate the economic indicators like NPV, IRR etc for every option of the maintenance strategies for the projected analysis period. The most beneficial maintenance option will be one that gives the maximum economic return.

5. ANALYSIS OF PAVEMENT

5.1. Deterioration Condition
Highway Development and Management Tool (HDM-4) is designed to make comparative cost estimates and economic evaluations of different construction and maintenance options. HDM-4 includes relationships for modelling Road Deterioration (RD) and Road Works Effects (RWE). These are used for the purpose of predicting annual road condition and for evaluating road works strategies.

5.2. Procedure for Program Analysis
The procedure for project analysis is summarized below.
1. Creating new programme, defining various sections, normal traffic details, section attribute details are done.
2. The selected road stretch is included in the program analysis for the maintenance and management. The created road network and vehicle fleet is included in the program details. The out currency is chosen as dollar and the discount rate is assigned to be 10%.
3. Under program details AADT values are fed for the sections and the vehicles are selected and the initial composition of the total traffic volume is calculated and the annual increase of 7.5% is considered annually.
4. Under standard specification base alternatives and various other alternatives are assigned for the maintenance and improvements are suggested. In base alternatives maintenance measures such as 50 mm overlay, patching and cracking are selected. Improvement measure such as 1 m widening is provided for 1st alternative along with some maintenance. 2 m widening and addition of one more
lane is provided as improvement measure for 2nd and 3rd alternative respectively. Certain maintenance measures are also suggested.

5. Generate the reports and print the required outputs.

6. **CALIBRATION OF HDM-4 DETERIORATION MODELS**

The HDM-4 was run for the same loading, Distress and structural condition as that of initial pavement condition. The distress progressions are then plotted on a graph to find the variations in the predictions made. The calibration factors for Initiation and Progression are altered and the model is run to obtain the progression of distresses. The obtained values are given in Table 1.

The four overlay options considered as M&R alternatives for this study are defined in the Table 2. The first alternative, Base alternative represents minimum routine maintenance in terms of crack sealing and pothole patching only, till such time when the reconstruction of the pavement section becomes inevitable.

The deterioration of the pavement section under various Maintenance & Rehabilitation Alternatives is analysed. Roughness is the most useful indicator of the pavement deterioration or average condition of the pavement section. Progression of roughness is shown in figure 1. The progression of roughness can be tracked to check that the works are correctly triggered according to the specified intervention criteria. From the deterioration summary shown in Table 3, it is identified that even after 15 years, the riding quality of Ultra-Thin White topping is the excellent and the most desirable one without any intervention. So it eliminates the Routine maintenance cost.

7. **Result**

7.1. Program analysis is carried out to obtain the results as shown in fig. 7.1. A graph of average roughness vs time (in years) is obtained. Life cycle analysis is performed and various maintenance and improvements are evaluated and are assigned for the road during the design period of the road.
8. Conclusions

8.1. Based on the analysis conducted for various road improvements, 1m widening is found to be the most beneficial.

8.2. From the analysis, responsive maintenance is found to be more logical as we are considering the amount of damage that the pavement has undergone.

8.3. Some of the important factors that HDM 4 takes into account include the effect of road improvement or maintenance, the effect of deterioration of the pavement and the effect of change in vehicle dynamics on the vehicle operation cost.

8.4. Based on the various improvement and maintenance strategies suggested like rout+SD+50mm overlay, patching and crack sealing, rout+50mm overlay, the software gave result as alternative 3 is the best choice.

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