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pavement distress and condition models for the INDIA

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Abstract:- *Pavements represent an important infrastructure to all countries. In INDIA, huge investments have been made in constructing a large network. This network requires great care through conducting periodic evaluation and timely maintenance to keep the network operating under acceptable level of service. Pavement distress prediction and pavement condition prediction models can greatly enhance the capabilities of a pavement management system. These models allow pavement authorities to predict the deterioration of the pavements and consequently determine the maintenance needs and activities, predicting the timing of maintenance or rehabilitation, and estimating the long range funding requirements for preserving the performance of the network. In this study, historical data of pavement distress and pavement condition on the main and secondary road network of ROHTAK were collected. These data were categorized,*
processed, and analyzed. These data have been employed to generate prediction of pavement distress and condition models for the INDIA.
Throughout the study, the most common types of pavement distress on have been identified. The behavior of these distress types has been investigated. A sigmoid function was found to be an excellent representation of the data. Seven for urban main pavement distress models (UMPDM) have been developed. In addition, six urban secondary pavement distress models (USPDM) have been developed. Moreover, two pavement condition models have also been developed, one for urban main pavement condition (UMPCM), and the other for urban secondary pavement condition (USPCM). The developed models provide a reasonable prediction of pavement condition. The models were assessed by standard error and residual analysis. A suitable procedure for the implementation of the models has also been proposed.
Key words:-*pavement, sigmoid, UMPDM*

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I. INTRODUCTION

Transportation systems include highway, rail, air, marine and pipelines. Of these, only marine and pipelines do not make use of pavements. The major elements of the highway system are the pavements. For air travel, runways, taxiways, and parking aprons are pavements. The pavements represent one-half of total highway expenditure and moreover expenditure on pavements continues to grow as maintenance and rehabilitation are required (Haas et al. 1994). Transportation infrastructure plays a vital role in the economic, social, and state of all countries and this role cannot be neglected. The impact of growth and prosperity achieved in this sector extends to include other sectors, and therefore, there is a strong relation between growth in the transportation sector and the growth of a country's economy as a whole. All this is reflected in the significant contribution made by this sector to Gross Domestic Product (GDP) and increasing financial returns to the country directly or indirectly. Some studies indicate that costs attributable to transportation are on average almost 20% of the final cost of a product; thus, reducing transportation cost will reduce produc cost. For example, reduction of transport cost by 10% leads to lower cost of the final product by almost 2% (SAMA 2004). The contribution of the transportation sector to the GDP of the United States of America for example, represents almost 20% and in Germany, 4.17%, which means that the contribution of this sector in many industrialized countries has significant importance on estimated GDP of these countries. This means that it is necessary to allocate a significant proportion of the budget to the transportation sector, as the sector is considered an important source of government revenue and has a big role in the growth of the country's GDP (SAMA 2004). Some of the most productive projects are those of roads because of the potentialeconomic savings. Therefore, the amount spent on establishing and expanding the network of paved roads and bridges has a direct and speedy return in reducing transport costs and hence stimulating economic growth.

1.2 OBJECTIVE OF THE STUDY

Urban road management is the focus and novelty of this research. Urban roads have their own characteristics as discussed in the previous two sections. In addition to that, pavement distress information is used as quality measure of pavement for urban roads where roughness and deflection measurements are not performed because of a lack of equipment availability, high cost, or do not measure parameters relevant to deterioration on urban roads. It was noticed that road agencies consider PMS as a planning tool for maintaining the network. They used condition indicators in different ways and forms to report on pavement condition on the basis of distress data at network level. This study will focus only on ROHTAK. Therefore, this research will be directed to achieve the following main objectives:

 Reviewing the concept of pavement deterioration models and the factors
associated with their performance at network level for urban roads,

 Reviewing and identifying the main pavement condition indicators,

 Reviewing the currently used PMS in Saudi Arabia and some well known PMS around the world,

 Developing two groups of distress models for Urban Roads Network (URN); one group is called Urban Main Pavement Distress Models (UMPDM), and the other is called Urban Secondary Pavement Distress Models (USPDM).

Developing two pavement condition models for Urban Roads Network. One model is called Urban Main Pavement Condition Model (UMPCM) and the other is called Urban Secondary Pavement Condition Model (USPCM).

 The approach to model individual distress types for urban roads and setting up some applications especially maintenance program because pavement distress types models can be used in detailed manner for developing a demand-based localised maintenance program.

II. LITERATURE REVIEW

Owusu-Ababio (1998) applied ANN to model performance of thick asphalt pavement. It was concluded that the ANN model outperform the multiple linear regression model in terms of standard error and R square value. As result of a research used ANN to develop model to forecast pavement crack condition in university of South Florida, the research concluded that the ANN can be effective tool for pavement maintenance planning (Lou et al. 2001). An application of the Canadian Strategic Highway Research Program (C-SHRP) Bayesian statistical analysis methodology for pavement deterioration modeling by the Ministry of Transportation, Ontario, Canada is described by Hajek and Bradbury in reference (Hajek et al. 1996). In this application, several distress prediction models were constructed initially based on the data alone using linear regression technique as required for the C- SHRP Bayesian analysis. After evaluation, the best one was selected for further analysis. Subsequently, five experts with 10 to 30 years of relevant experience and knowledge of pastfailures of pavement surface containing steel slag aggregate were requested to rate the level of distress at different age with different traffic and asphalt binder content using a scale from 0 (no distress) to 10 (sufficient distress that unmistakably requires a rehabilitation treatment). Separate matrices for cracking and ravelling were used since the distress index

III. ProjectNeedandImportance

The proposed project is a part of the proposed 8-lane access-controlled Greenfield Delhi-Mumbai highwaycorridor (~1,335 km) interlinking different State & National highways while connecting Delhi to Mumbai. Theproject is planned as an ambitious high-speed corridor which provides high speed connectivity between statesof North India and states of West & South India, more importantly giving a reliable access to the country'sprominent economic and social hubslikeMumbai, Delhi, Vadodara, Jaipur etc.

The proposed highway will provide better connectivity to several towns and cities viz. Gurgaon, Alwar, Dausa,SawaiMadhopur, Tonk, Bundi, Kota, Jaora, Ratlam etc. and give an infrastructure fillip to the states of Delhi,Haryana, Rajasthan, Gujarat, Madhya Pradesh and Maharashtra. The highway will be access-controlled andensure high speed traffic movement from Delhi to Mumbai. The proposed alignment is selected so as to coverone of the most important North-South arterial connectivity in the country, further interspersed with feederhighwayson itseithersides.At present, the connectivity between Delhi and Mumbai is either via NH-48 or via NH-19 & NH-47, which are4/6lane.Thenewproposedhighwayshallbringdownthetraveldistancebyapproximately95Km(ascompared to alternate routes) and result in time savings of over 2-3 hours. Moreover, the new highway facilityisaccesscontrolledandhencewillprovidegoodridingquality,bettersafety,andareliableinfrastructure.Allofthese elementswill result in cost savingsandefficiency improvement.

Theprojectwillfurtherhavefollowingbenefitsatnational andregionallevel:

High-speed connectivity and access: The projected corridor is a proposed 8-lane, access-controlledhighway. This will avoid traffic congestion and speed-up the freight movement. It is expected thatoverall, the proposed Delhi-Mumbai corridor will reduce the travel time between the two economichubsby half.

Aiding economic growth: The seamless connectivity will provide better access to vehicles as a link tothe National Highways. The project will reduce travel time and provide boost to trade and commercelinkedto theregionsconnected through thishighway.

Growth of backward areas: The biggest strength of the alignment is that it plans to cover backwarddistricts of Rajasthan. As a result of connectivity and access to other parts of the country, thesebackward areas will be aided to integrate with other part of county. Further, freight and passengertrafficon thehighwaywillhelp promotingancillary economy oftheseregions.

Decongestion of existing National and State Highways: The proposed corridor will take away trafficpressuresfromexistingSHandNHpassingthroughvariouscities.Also,long-distancetrafficwillshifttotheproposedhighway, therebyleavingtheNHandSH forregionalandlocal usage.

Usageshift: Long-distancetrafficwillshiftfromexistingNationalHighwaystotheproposedhighway,resultingin lessercongestion on thesehighways

Improvedsafety:Duetoaccesscontrol,theRoadway&TravelSafetyofthetrafficconnectingthecities willbeenhancedastherewill beminimumdistractions& conflict zones

Supporttoindustry: DifferenttypesofindustrieslikeManufacturing,Tourismetc.alongtheproposed corridorwillbe facilitated in their businessoperationandreachability

Following majortypesoftrafficload isexpectedontheproject:

Commercial and Industrial: Traffic on the existing roads is driven by local, commercial and industrialtraffic. Industries such as cement, chemicals and minerals are present along and around the proposedcorridor as it traverses through Haryana, Rajasthan and Gujarat. These industries are expected tobenefitfromthehighway.

Tourist: Passenger traffic will be generated due to many places of tourist interest in the districtsconnected bytheprojectcorridor. Apart from placesofhistoricalimportancesuchas forts andpalaces, traffic would be augmented due to several famous religious places such as the MehandipurBalajiTemple(Dausa)andwildlifeparksandsafarilikeRanthamboreNationalParkandTigerReserve.

Health and Education: Faster connectivity and accessibility toDelhi NCR will help in higher flow oftraffic from Rajasthan, especially for higher education, tertiary healthcare and specialized treatments.Reduction in travel time will allow patients to avail OPD / other medical services from the capitalregion.

WaterandEnergy-SourceandAvailability

Rainfall is the major source of ground water recharge in the state. However, Rajasthan receives much lowerrainfall compared to the other parts of the country. Out of the total rainfall, a sizable portion in the beginningof the rainy season is used for building the soil moisture and is also lost to evaporation because of its aridconditions.

AspertheCentralGroundWaterBoard(CGWB),thenormalannualrainfallofRajasthanis549.1mm.However, during the period from 2005 -14, highest average annual rainfall of the State in the year 2011 andlowestintheyear2009.Therainfalloftheyear2014is20.8%lessascomparedto2013.Thestatereceives90

% rainfall from southwest monsoon from June to September. The amount infiltrating through the soil mass tocontributetogroundwaterstorageisoftheorderof5%to7%inareasunderlainbyhardrocksand10%to15%inalluvial areas. *(Source:Ground waterYearBook 2014-2015).*The proposed project is falling in the east of Aravalli ranges the main drainage istowards North–East. Therivers of the Rajasthan are mostly seasonal with only two river basins (Chambal and Mahi) being perennial. TheChambal catchment occupies 23% of the total geographical area of the state. The proposed alignment iscrossing the Canal coming from Galwania Dam, Laban distributary Canal, Chakan River, Mui River, Mej River,and Chambal River, which are the main sourcesofthesurfacewater in theproject area.

InadditiontotheSub-Clause111.8.3ofMoRTHSpecifications,TheContractorshallsourcetherequirementof water preferably from surface water bodies, rivers, canals and tanks in the project area. Only at locationswhere surface water sources are not available, the Contractor can contemplate extraction of ground water,afterintimation and consent from theCGWB.

To avoid disruption/disturbance to other water users, the Contractor shall extract water from fixed locations.and consult the local people before finalizing the locations. The Contractor shall comply with the requirementsofRajasthanGround WaterDepartment and seek their approval for extraction ofground water.

Bore wells installed and used for the project shall be left in good operating condition for the use of localcommunities.TheContractor shall prevent anyinterference withthesupply toorabstraction from, andprevent any pollution of, water resourcesasa result ofthe execution ofthe Works.

ItisestimatedthattheProjectwillneed~3,395MLwaterforconstructionphase.Thewaterfortheconstructionphasewillbe metbywatertankersfromapprovedvendors.Bore-well,ifrequired,willbeoperated after approval fromthe competent authority.

Power,duringconstruction,willbesourcedfromlocaldistributioncompany.DGsetsasalternativearrangementwillalso bearranged in construction camp.

IV. SITEANALYSIS

SiteConnectivity

The proposed route is well connected with the existing road infrastructure(including nearby National andStateHighways) and accessible throughSH-1, SH-33 and NH-116.

LandForm,Use&Ownership

Theproposed projectcovers ~65.0kmoflength. Landusesidentifiedalongtheproposed corridorare:

AgriculturalLand

Built-upLand

ForestLand

BarrenLand

The details of the land-use pattern will be given in the detailed EIA report. For the development of proposedhighway 650.0 ha of land will be acquired in SawaiMadhopur, Tonk, Bundi and Kota. Majority of the landownership is with farmersand other private entities.

Forest&WildlifeArea

According to the **Forest Survey of India**, the recorded for area of the state is 32,737 SQM, which is 9.57 % of itsgeographicalarea.TheReserved,ProtectedandUnclassifiedforestsare38.11%,55.64%and6.25%respectively of the recorded forest area. However, as the digitized boundary of recorded forest area from thestatecoversonly an area of23,105 SQM (State ofForest Report, 2017).

The proposed alignment passes through the buffer area of Ranthambore Tiger Reserve and National ChambalSanctuary, whereas, Ranthambore National Park and SawaiMadhopur Wildlife Sanctuary are located at anapproximatedistanceofabout12.9 kmand10.5kmrespectively.

Best effort has made to keep the proposed alignment outside from the buffer Area of the Ranthambore TigerReserve. Affected buffer area of Ranthambore Tiger Reserve will be estimated after joint inspection with forestdepartment. Project alignmentisalso passingthrough thePapdi protectedForest Block inBindi division.

Topography

SawaiMadhopur lies at an elevation of 257 metres above mean sea level while Tonk and Bundi lie at 289 and268 metres above sea level respectively. The proposed road alignment follows flat and undulating terrain.Detailed topographic mapwillbeprovided at EIA stage.

ExistingInfrastructure

A number of commercial and residential structures fall in the proposed stretch. The detail of the structuresshall provide in the EIA report.

SoilClassification

Black, alluvial and brown soils are commonly found in this area. The soil is clayey to sandy loam in texture.Black soil isthe major varietyfound in the area.

V. Conclusion

The main aim of this study was to assess the efficiency of Tehran–Karaj railway electrification system by considering RE concept. This study has used a new framework, the combination of four key variables, including health, safety, ergonomics, and RE. Then, a questionnaire was designed based on the mentioned concepts. Cronbach's alpha was calculated and its value was 81%. This value indicates the high reliability of the obtained data. In this study, DEA approach was used to solve the problem. First, performance of the railway system was evaluated while considering three variables (health, safety and ergonomics). The results showed that the number of efficient DMUs was equal to six and total average of efficiency scores of all DMUs was 0.857. Then, the efficiency of the system was calculated by considering RE concept (health, safety, ergonomics and RE). The results showed that ten DMUs were efficient and total average of efficiency scores was equal to 0.888. The number of efficient DMUs had a considerable growth about 67% and the mean of efficiency scores had a relative growth about 3.6% by considering RE concept. Hence, RE concept plays a very important role in performance enhancement of the railway transportation system. Another aim of this study was to determine the most effective factor of RE among teamwork, redundancy, and self-organization factors. The results indicated that the means of efficiency scores of teamwork, redundancy, and self-organization factors were 0.876, 0865, and 0.871, respectively. As a result, teamwork has the highest effect on the system performance and, hence, it is the most effective factor among RE factors. Finally, the Spearman test was used to validate the results of this study. The value of the test was 89% and showed that the results are valid.

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