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A COST OPTIMIZATION PROCESS OF MAINTENANCE AND CONSTRUCTION COST OF STRETCH 272KM ON NH44& NH67 ROADS

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ABSTRACT: The maintenance and rehabilitation of existing, develop road offices are ending up slowly progressively critical and significant parts of highway movement. Because of these qualities building up a maintenance and rehabilitation arrangement for roads is troublesome and new ideas and logical methodologies should be acquainted with location this issue. Enhancement models is one such systematic methodology which aides in making a cost- advantage analysis of maintenance and rehabilitation exercises of roads and in contrasting the different potential options with give out the best movement inside the budget dispensed, before being really completed in commonsense.In the present study it was planned to define a multi-target advancement model considering all essential just as adequate components dependable in 'maintenance and rehabilitation exercises' of highway offices to limit the all out cost and increment the complete return in wording profits by improved road condition subject to the pragmatic limitations looked by concerned organization and client because of deterioration in road condition. A non-ruled arranging hereditary calculation II (NSGA-II) based C writing computer programs was considered and used to approve the created model. Ultimately, the proposed advancement model is contrasted and ongoing field information gathered from National Highway Division, Andhra Pradesh in order to guarantee its usefulness and convenience.

Keywords: Analytical Models, Multi-Objective Optimization Model, Road Maintenance and Rehabilitation, Pavement Management Systems (PMS), Model Validation, Genetic Algorithm.

I INTRODUCTION

The maintenance and rehabilitation of existing, develop road offices are winding up progressively significant parts of highway action. A proficient maintenance the board approach is basic for a safe and cost-viable transportation framework.Choices to keep up existing road offices includes various potential alternatives in exercises extending from routine maintenance to rehabilitation or reproduction, in the spatial and transient assignment and conveyance of assets all through a highway organize, and in decisions between speculations versus non-interests in a specific road arrange. In addition the planning of maintenance projects suggests the capacity to assess life-cycle execution and costs, with tradeoffs estimated in financial just as specialized terms. Delaying road maintenance results in high immediate and roundabout costs. In the event that road imperfections are fixed quickly, the cost is typically humble. On the off chance that deformities are disregarded, a whole road segment may flop totally, requiring full recreation at multiple times or more the cost, by and large, of maintenance costs. Still then numerous nations will in general support new development, rehabilitation, or recreation of roads over maintenance. Because of these attributes, the advancement of fix and rehabilitation strategy is confounded, and new ideas and expository methodologies should be acquainted with location this issue.In any case, nearly little work has been given to the advancement of expository models as enhancement models planned explicitly for maintenance programs. These models venture the future conditions and execution of roads by distinguishing insufficiencies and utilize a cost-advantage analysis to choose monetarily legitimized enhancements for roads from among different options accessible.Any monetary analysis should consider the most extreme inclusion of advantages like changes in road maintenance costs, changes in mishap rates, expanded travel and reduction in vehicle working cost and travel time; and social advantages as ecological impacts, change in value of merchandise moved, increment in horticultural and modern yield, changes in administrations, changes in land values and so on. Assessing the advantage part of a transportation framework is troublesome, and now and again is absurd to expect to evaluate benefits for certain segments like social advantages, future traffic circumstance and so forth.Transport request in India has been developing quickly. Subsequently, traveler and cargo development in India throughout the years have progressively moved towards roads than different methods for vehicle. In 2009-10, the road arrange in the nation conveyed 85.2 percent of the absolute traveler development by roads and railroads set up together. Likewise, the relating figure for cargo development by roads was 62.9 percent. The yearly development of road traffic is required to be 10 to 11%.The absolute road length in India expanded in excess of multiple times during the 60 years somewhere in the range of 1951 and 2011. From 3.99 lakh kilometer as on 31st March 1951, the road length expanded to 46.90 lakh kilometers as on 31st March 2011. The biggest steady increment of 3.56 lakh kilometers was in the length of provincial roads. The second most astounding expansion in road length during to 2011 was by Other PWD roads (1.70 lakh kilometers). Urban roads included a critical length of 1.11 lakh kilometers of roads during a similar period. The steady increment in National Highways, State Highways and Project roads were 4,344 kilometers, 11,663 kilometers and 20,034 kilometers, separately. All the above realities are as indicated by the Basic Road Statistics of India, 2008-09, 2009-10 and 2010-2011 distribution by Ministry of Road Transport and Highways (MORTH) Transport Research Wing distributed in August 2012.

While the engine vehicle populace has developed from 0.3 million out of 1951 to 59 million out of 2004, denoting a 180

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overlap increment, the road system has extended from 0.4 million km to 3.5 million km, a 9 crease increment as far as length during a similar period. New development just as updating of roads by method for extending of carriage-ways, improving surface quality, fortifying/reproduction of old/powerless scaffolds, courses and shoulders, and so on has been done to get together the expanding traffic request. Thus the present blast in the vehicle part and road area may even build the future development rate of road traffic.While the traffic has been developing at a quick pace, it has not been conceivable to give coordinating interest in the road segment, because of the contending requests from different divisions, particularly the social areas.Numerous areas of the highways are needing limit extension, asphalt reinforcing, rehabilitation of scaffolds, improvement of riding quality, arrangement of traffic wellbeing measures, and so forth. The tremendous system of roads worked throughout the years with gigantic speculations needs legitimate maintenance. Be that as it may, the lacking progression of assets has not allowed legitimate maintenance of the current road organize, as likewise the feeble planning, booking and checking of maintenance operations.

II LITERATURE REVIEW

Markow et al. (1987) demonstrated that the improvement of asphalt maintenance and rehabilitation arrangement is convoluted by a few components the board options should along these lines be assessed based on life-cycle costs, with tradeoffs estimated in monetary just as specialized terms. They talked about an explanatory methodology, dynamic control hypothesis, which demonstrated to be an appealing improvement strategy for overseeing highway foundation including all the key factors of enthusiasm with actually right designing also, monetary connections communicated inside the issue detailing (e.g., conditions portraying changes in asphalt condition because of deterioration or fix, or varieties in rush hour gridlock levels because of development or redistribution) having certain components of the issue in their fundamental structure to maintain a strategic distance from numerical inconveniences (e.g., traffic is thought to be consistent), and drives straightforwardly and productively to the arrangement of ideal maintenance and rehabilitation strategy. It was expected to be connected in monetary investigations of asphalt the executives options, to survey tradeoffs among asphalt design, maintenance and rehabilitation, and to measure the ideal planning of maintenance and rehabilitation activities.

Ouyang and Madanat (2004) exhibited a scientific programming model dependent on discrete control hypothesis for deciding the ideal rehabilitation recurrence and force on an arrangement of asphalts which limits the life-cycle cost for a limited skyline by consolidating both nonlinear asphalt execution model and number choice factors into a mixed-whole number nonlinear programming (MINLP) to plan different rehabilitation activities in an arrangement of asphalt offices under budget requirements. Two distinct arrangements, a branch-and-bound calculation and a covetous heuristic, are drawn nearer and numerical analysis demonstrated that the heuristic methodology gave a decent estimate to the accurate optima with much lower computational costs which is valuable for enormous scale useful issues.

Yin et al. (2008) exhibited an incorporated and powerful methodology for assessing the venture important to keep up or improve the future degrees of administration and asphalt states of offices in a highway organize at an altogether lower cost when contrasted and preservationist speculation plans. They expected future travel requests and office conditions as dubious and the scientific program is fathomed by means of a cutting plane calculation. Numerical outcomes from the Sioux Falls system recommend that the methodology can possibly address practical systems.

Lamptey et al. (2008) exhibited a contextual investigation for streamlining choices on the best blend of preventive maintenance (PM) medications dependent on Decision Support System and timings to be connected in the reemerging life-cycle (interim between reemerging occasions) utilizing affectability analysis, for a given highway asphalt area fusing key framework the board ideas of treatment-explicit triggers, execution bounce models, and execution pattern models. The study results demonstrated that contrasted with organization costs, client costs are increasingly delicate to changes in the markdown rate which can impact the decision of ideal PM plan.

III MODEL FORMULATON

A scientific improvement model comprises of a target work and a lot of limitations communicated as an arrangement of conditions or disparities speaking to genuine issues in practically all just as tremendous zones of basic leadership procedures, for example, building design, monetary portfolio determination, the board science and operations look into divisions. The fundamental objective of the enhancement procedure is to discover values of the factors that limit or augment the target work while fulfilling the limitations. This outcome is called an ideal arrangement.

Streamlining issues are comprised of four essential fixings:

1. The scientific (i.e., diagnostic) model that portrays the conduct of the proportion of viability is known as the goal work. That is, the amount or objective to beamplified or limited is known as the goal work. Most streamlining issues have a solitary target capacity or more than one goal called multi-target work.
2. A choice variable is a variable that can be straightforwardly constrained by the leader and which influences the value of the goal work. On the off chance that there are no factors, we can't characterize the target work and the issue requirements.
3. The wild information sources are called parameters of the model. The info values might be fixed numbers related with the specific issue.
4. Constraints are relations between choice factors and the parameters. A lot of limitations enables a portion of the choice factors to take on specific values, and reject others.

Numerous streamlining issues include number and discrete factors and some consistent factors too with nonlinearities in the target capacity and imperatives and can be displayed as Mixed Integer Nonlinear Programming issues (MINLPs). The utilization of MINLP is a characteristic methodology of planning issues where it is important to at the same time upgrade the framework structure (discrete) and parameters (ceaseless). The capacity to be upgraded in this setting typically includes costs and benefits from the design. MINLP issues are decisively so hard to understand, in light of the fact that they consolidate every one of the challenges of both of their subclasses: the combinatorial idea of mixed number projects (MIP) and the trouble in settling non- arched (and even curved) nonlinear projects (NLP).The general form of a MINLP is Minimize f (x, y) Subject to g (x, y) ≤ 0 x ∈ X y ∈ Y integer The function f (x, y) is a nonlinear objective function and g (x, y) a nonlinear constraint function. The variables x, y are the decision variables, where y is required to be integer valued. X and Y are bounding-box-type restrictions on the variables.

Cracks/potholes and patches parameter:-

Cracking begins at the bottom of the asphalt surface (or stabilized base) where tensile stress and strains are highest under wheel loads. The cracks propagate to the surface initially as a series of parallel longitudinal cracks. Sometimes hardening of asphalt on the surface can lead to block cracking. Patching is done to repair existing pavement and it adversely affects riding quality. Rutting, corrugations, potholes etc. are also considered as surface distresses. Maintenance is applied according to the severity of cracks (low, medium, high) and the area affected. However longitudinal and transverse cracks are linearly measured. Moreover transverse cracks are given more weightage than longitudinal cracks as a driver can avoid longitudinal cracks by shifting to other lanes but cannot avoid transverse cracks. Mathematically,

$$SC = R1lL + R2lT + R3.A$$

Where

SC= Surface Cracks/Potholes/Patches Parameter

R1, R2, R3=Weights of different types of cracks which is user defined depending upon the severity of cracks

lL= Length of longitudinal cracks

lT= Length of transverse cracks

A= Area of alligator or block cracks, potholes, patches etc.

$$PSR = 5*e^{-0.0041(IRI)} \quad \text{...equation (2)}$$

Table Respective PSR values of IRI values

IRI (inches/mile)	PSR=5e^(-0.0041*IRI)
80	3.601
85	3.529
90	3.457
95	3.387
100	3.318
105	3.251
110	3.185
115	3.120
120	3.057
125	2.994
130	2.934
135	2.875
140	2.816
145	2.759

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150	2.703
155	2.648
160	2.595
165	2.542
170	2.490

IV MODEL VALIDATION

The presence of multiple objectives in a problem gives rise to a set of optimal solutions known as Pareto-optimal solutions, instead of a single optimum solution which are not dominated by rest of the solutions in the search space. In the absence of any further information, one of these Pareto-optimal solutions cannot be said to be better than the other which demands to find as many Pareto-optimal solutions as possible.

Classical optimization methods for solving multiple objectives have limitation of converting the multi-objective optimization problem to a single-objective optimization problem by emphasizing one particular Pareto-optimal solution at a time. Hence, to generate multiple optimal solutions, the classical optimization model has to be used for several times increasing the complexity of the problem and is also time consuming.

Over the past decade, a number of multi-objective evolutionary algorithms (MOEAs) have been suggested which are non-classical, unorthodox and stochastic search and optimization algorithms. Evolutionary algorithm (EA) mimics nature's evolutionary principles to drive its search towards an optimal solution, i.e. the true Pareto-optimal region. They have the ability to find multiple Pareto-optimal solutions in one single simulation run saving time and decreasing complexity. Since evolutionary algorithms (EAs) use a population of solutions in each iteration, instead of a single solution, a simple EA can be extended to maintain a diverse set of solutions. There exists four different evolutionary algorithms (EAs) such as genetic algorithms (GAs), evolution strategy (ES), evolutionary programming (EP) and genetic programming (GP). The Population Size is given 64 as 64 data points were obtained from data collection. Number of objective functions is given 2 and number of constraints is 7as per the model. Number of binary-coded decision variables is given 2 and number of real-coded variables is given 2 as per the model. Number of generations selected was 100 and selection strategy is Tournament Selection with chromosome length of 20. For the first binary-coded variable for rehabilitation, number of bits assigned is 10 with lower limits and upper limits given as 0.0 and 1.0 respectively. For the second binary-coded variable for repair, number of bits assigned is 10 with lower limits and upper limits given as 0.0 and 1.0 respectively same as first binary-coded variable.For the first real-coded variable representing repair interval of the formulated model, lower limit and upper limit is given as 2.0 and 5.0 respectively and for the second real-coded variable representing rehabilitation interval of the formulated model, lower limit and upper limit is given as 8.0 and 10.0 as per the field data collected. Variable bounds for both the real- coded variable are not rigid.Crossover selected on binary strings is uniform X-Over. Crossover parameter in the SBX (simulated binary) operator is given as 50.0 and Crossover probability is given as 0.60. Mutation Probability for binary strings is

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given as 1.0 and mutation probability for real-coded vectors is given as 0.10. Random Seed is given as 0.10.

V CONCLUSION

The above computer program is executed giving the necessary GA parameters as described above. The result from the program is as follows:

- For the first real-coded decision variable representing repair interval, the result recommended using 4. 1 –˜ 4 as the optimum repair interval.
- For the second real-coded decision variable representing rehabilitation interval, the result recommended using 8. 3 –˜ 8 as the optimum rehabilitation interval.
- The above optimum repair and rehabilitation interval obtained from the computer program is matched with the collected field data and it was observed that the optimum repair interval of 4 years from the program matched with the field data by 32.81 % and the optimum rehabilitation interval of 8 years from the program matched with the field data by 54.35 %.

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