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Application of Green Highways Credit System on Highway Project

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Abstract: **-- Road Transport is a critical infrastructure for economic development of a country. It influences the pace, structure and pattern of development. The capacity of National Highways in term of handling traffic (passenger and goods) needs to be in keeping pace with the industrial growth. India is having one of the largest road networks of over 46.99 lakh km. It comprises National Highways, Expressways, State Highways, Major District Roads, Other District Roads and Village Roads. A growing demand of passenger and public transport has led to a significant increase in air pollution and greenhouse gas (GHG) emissions. A study conducted by the Central Pollution Control Board (New Delhi, India) in six cities – Delhi, Kanpur, Bangalore, Pune, Chennai, and Mumbai, concluded that the transportaion sector contributes to more than 30 percent of the ambient air quality in these cities – either directly from the vehicle exhaust or indirectly via the re-suspension of dust on roads due to vehicular movement. The health impacts of air pollution from the transport sector are significant – and the nature of the issue is that those areas with the most population density are most affected. The government has taken many initiatives for green highways. By using a live case study project we have implemented a credit system for Green Highway system.**

Keywords **- Highway, Sustainability, Green Road Rating System and Environment.**

I. INTRODUCTION

India has a second largest road network in the world and India has a road network of 5,472,144 kilometres (3,400,233 mi) as on 31st March, 2015. At 1.66 km of roads per square kilometre of land, the quantitative density of India's road network is higher than that of Japan (0.91) and the United States (0.67), and far higher than that of China (0.46), Brazil (0.18) or Russia (0.08). Road transportation is very important to India's economy. It enables country's transportation system to contribute 4.7 percent towards India's Gross Domestic Product (GDP), as compared to railways that contributed 1 percent in 2009-2011 FY. India has National Highways of 97,991 Km of National Highways, 167,109 Kms of State Highways and 1,101,178 Kms of other PWD roads. Now a day's India is contributing towards Expressways too, as India has 1208 Kms of expressways as of 2013. The Ministry of Road Transport and Highways (MoRTH), Government of India has promoted Green Highways (Plantations, Transplantations, Beautification and Maintenance) Policy - 2015, aim of which is to help the environment, help local communities, and generate employment by planting trees along all the highways in the country. The target for the first year is to plant trees along 6,000 km of highways. Under the aegis of the Policy, development of green corridors is proposed along developed and upcoming National Highways in the width available in existing Right of Way (ROW) in the form of median and avenue plantations.

Background of the study:

A green highway is a road transportation system constructed per a relatively new concept for roadway design that integrates transportation functionality and ecological sustainability. An ecofriendly approach is used throughout the planning, design, and the construction phases. The result is a highway that will benefit transportation, the ecosystem, urban growth, public health and surrounding communities.

Green highway construction can incorporate several technical elements including, but not limited to the followings, but if the following is implemented in a project, the project may be titled as a green construction project:

Bio retention Swales, Porous Pavements, Environmentally Friendly concrete, Forest Buffer, Restored and Storm water Wetlands, Stream Restoration, Wildlife crossing, Soil amendments, Storm water Management with Pervious Concrete Pavement etc.

Need of the Study:

The aim is to create a fossil-fuel-free corridor, as well as to demonstrate that investments in green technology boost the economy and contribute to sustainable growth and reduced environmental impact. In extension, this may mean emission-free destinations that are attractive to both residents and

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tourists. The region produces a significant proportion of renewable energy through wind power and hydropower; there is also production of biogas which means there is great potential for a sustainable transport system. One more important aspect we have to keep in mind is that the green highway initiative is the voluntary social movement comprising Govt. authorities of highway Dept. Environmental and Ecological department, other concerned Govt. Dept. Social institutions, private contractors, labour unions and parties helpful in implementing the social goals of green highway.

II. LITERATURE REVIEW

Transportation infrastructure constitutes a considerable portion of the built environment. Each and every infrastructure investment in the transportation sector can have long lasting implications not only for the transportation system itself, but also upon its interaction with larger environmental, economic, and social systems. According to American Association of State Highway and Transportation Officials(AASHTO), the transportation sector worldwide is responsible for 22% of global energy consumption, 25% of fossil fuel use, and 30% of global air pollution along with greenhouse gases. It also accounts for 10% of the world's gross domestic product (GDP). With such significant shares in energy use, and both natural and economic resources, small adjustments to reduce each of these impacts from the transportation sector could lead to important benefits (FHWA, 2011).

Transportation sustainability should at the very least consider environmental integrity, impacts on economic development, and the social quality of life. System effectiveness can be considered as a fourth attribute necessary for transportation system sustainability, since a less effective system would not be an acceptable alternative.

Sustainability-related improvements can be made during all stages of a project. It is possible and desirable to consider social, economic, and environmental mitigation strategies during the planning and design phases. Construction methods are continually evolving to use renewable or less fuel, as well as to reduce impacts on the environment.

Necessary Considerations for the Core Elements of Sustainability (Jeon, 2007) is as follows:

Environmental aspects are Resource preservation (such as fossil fuels, land, etc.), air and noise pollution prevention, greenhouse effect prevention. Economic aspects are Economic efficiency, financial affordability, Regional economic development through improved accessibility, Social aspects are social equity related to income and minority groups, public health, safety and security, Accessibility to various services. System Effectiveness aspects are like System performance for Multimodal transportation System (Regional Highway, transit etc.)

The University of Saskatchewan, alternatively, studied the re-use of concrete and asphalt rubble materials; this research found that utilizing recycled materials in road construction provided superior structural performance while waste rubble was diverted from landfills, and leading to a cost saving of approximately 55% over using virgin sourced aggregates.

A recent master's thesis from the University of Waterloo by Peter Cheuk Pan Chan is a preliminary investigation that demonstrates Ontario's initiative to provide a green performance rating system for roads. Pan Chan focuses strongly on pavement materials, management, and design, but also considers land use planning, public transit, walkways and bikeways, and alignment. The report additionally utilizes cost as a strong metric with scaling factors (Pan Chan, 2010). Pan Chan focused much of his literature review on pavement materials, maintenance, and rehabilitation. He additionally reviewed design and construction practices, as well as several green initiatives such as LEED, Greenroads, and GreenLITES. GreenPave was a separate project carried out by the Ministry of Transportation (MTO, Canada) in the Material Engineering Research office. This rating system "is exclusively used by the MTO to environmental sustainability at the project level" (Pan Chan, 2010) While Pan Chan's report contains much useful analysis of sustainable roadway design and planning, its purpose was to propose a framework for creating an analysis tool, not to actually produce its own rating system, which was the purpose of this thesis.

III. METHODOLOGY

This task, through the literature review presented, established the context for this thesis by considering emerging rating systems for Green Highways transportation sustainability which can be applied in Indian National Highway projects and we will apply this on Construction of Canacona National Highway Bypass from km. 68/00 (CH 00/00) to km. 85/740m, (CH 7/740) on NH-17 (New NH-66) on P.M. Section in the State of Goa. The literature review provided a summary of current applications of green roads rating systems. From the information gathered in the literature review, the project assessed the application contexts, advantages, and disadvantages of the various rating systems considered. Of the programs considered in the literature review, the project we chose one existing framework to act as a template and starting point for the development of a grading system that might be used in Indian National Highway projects. Consideration among the diverse set of programs identified was widely based

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on our experience with road design, as well as information obtained from some transportation expert engineers, planners, and environmental specialists, who are associated in National Highway projects for several years. By reviewing projects with the initial system, the project team was able to obtain a sense of what the Project engineers considered critical to road design aimed at minimizing environmental impacts. After that we implemented the changes on the existing template and prepare final Grading system formats.

Finally we obtain main categories of Sustainable Designs (SD), Materials & Resources (MR), Storm Water(SM), Construction Activities (CA) and Energy & Environmental Control (ECC). The main categories are then further classified into sub-categories and each sub-category is awarded with some credit as per weightage. The credit system table will be mentioned later on.

CASE STUDY

GREEN ROAD CREDIT RATING SYSTEM

It is a rating system that awards credits for approved sustainable choices/practices which can be used to certify roadway projects based on the totalcredits earned. Such a standard can:

- Allow informed sustainability decisions.
- Provide a quantitative means of sustainability assessment.
- Stimulate improvement and innovation in roadway sustainability.
- Provide baseline sustainability standards.

ITEM	CREDIT	INDENT	Remark
Category: Sustainable Design(SD)			
SD-1:Alignment Selection	1/1	Avoid historical and ecologically sensitive areas.	Religion based Sensitive areas has been avoided by changing scope. Which is done by elevating the road alignment
SD-2: Context Sensitive Design	1/1	Roadway design appropriate for surrounding	Service Road has been provided and VUP is provided where needed
SD-3: Traffic Flow Improvement	1/1	Improved traffic flow	existing NH 66 travels for about 17 Kms to reach from the Chaudi to Mashem. Whereas the new alignment decreases the length to almost 7 Kms (reducing it by almost 10 Kms)
SD-4: Roadway Safety	2/2	Evaluate and improve roadway safety	Some part of the existing road was under Accident Prone Zone, that problem has been solved by Six laning of New NH66.
SD-5: Long-Life Pavement Design	0/3	Design pavement for long-life and lowest lifecycle cost	N/A
SD-6: Public Input	2/2	Obtain and incorporate community input meaningfully	Public Demands and services has been considered and solved as much as possible,

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			like Temporary drainage system for rain water sewar and Temporary Bridge for crossing Galgibaga River
Total SD credits available	**7/10**		
Category: Materials &Resources			
MR-2: Reuse of Pavement	0/ 2	Reuse the existing pavement structure	Not Done
MR-3: Recycled Content	2/ 4	Use recycled material	Recycling of materials has been done up to a certain extend, like Supporting PCC bed is been used cover of Temporary drainage.
MR-4: Life Cycle Analysis	0/ 3	Perform a life cycle analysis	N/A
MR-5: Regionally Provided Material	1/ 1	Minimize transportation impacts	Most of the materials used are locally available and local suppliers has been involved.
Total MR credits available	**3/10**		
Category: Storm water			
SM-2: Runoff Treatment	1/ 1	Meet enhanced runoff treatment criteria	Pipe Culvert has been provided to pass rain water during rainy season as mentioned in drawings.
SM-3:Permeable Area	0/ 3	Reduce impervious surface	Not Done
SM-4:Innovative Storm water Technology	0/ 2	Encourage innovation in storm water treatment	Not Done
Total SM credits available	**1/ 6**		
Category: Construction Activities			
CA-2: Reduce Fossil Fuel Dependency	0 / 1	Encourage alternate forms of fuel	Not Done
CA-3: Temporary Storm water Control	1 / 1	Encourage use of a temporary storm water control plan	Temporary Drainage system employed through temporary drain during project execution phase
CA-4: Noise Mitigation Planning	0 / 1	Reduce construction noise	No steps adopted.
CA-5: Paving Emissions	1 / 1	Reduce emissions from construction	No considerable emission was there.
CA-6: Paving	2	Encourage	Quality

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Construction Quality	/ 3	high-quality construction	was maintained properly.
CA-7: Quality Process	0 / 2	Encourage ISO 9000certification for the contractor	They are already ISO 9000 certified.
Total CA credits available	**4 / 9**		
Category: Energy & Environmental Control (EEC)			
EEC-1: Cool Pavement	**1/ 1**	Reduce the urban heat island effect	Reducing vegetation for structure is less as most structures located in non forest area.
EEC-2:QuietPavements	2 / 3	Reduce tire-pavement noise	Some better practices are adopted to reduce tire-pavement noise, like aggregate gradation, selection, equipment maintenance and heavy duty curing are adopted.
EEC-3:Light Pollution	1 / 1	Reduce light pollution	As per contract paper
		from roadway lighting	Clauses 16.1 contractor are responsible for lighting and adequate and efficient lighting are designed for the road.
EEC-4:Lighting Efficiency	1 / 1	Use energy efficient lighting	Energy efficient lights like Compact Fluorescent Light (CFL) are designed to implement.
EEC-5:Eco-Viaducts	1 / 1	Allow animal passage across roadways	Three number of box culverts are provided in the entire length of the project for villagers and animals passage.
EEC-6:VisualQuality	1 / 1	Encourage aesthetically pleasing roadways	The view is aesthetically pleasing like flower

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			plantation has been planned and Galgibaga and Talpona Bridge is located in such a location that sea-front view is visible.
EEC-7:PedestrianAccess	1/1	Provide for pedestrian access	Actually the road has been designed in a such way that no Pedestrian is required.
EEC-8: Bicycle Access	1/1	Provide for bicycle access	Service road is been provided, which has been connected with feeder road and passes has been provided to access, where bicycle can be accessed.
EEC-9:Environmental Mgmt. System	1/2	Encourage ISO 14000 certification for the contractor	Yet not certified but they are encouraging works which may be lead them to certify the same.
Total EEC credits available	**10/12**		
Grand Total Green Road credits	25/46		

IV. CONCLUSION

Green constructions are sustainable structures that are environment friendly, resource-efficient throughout its life-cycle: from planning to design, construction, operation, maintenance, renovation, and demolition. Green roads has various environmental benefits such as it reduces wastage of water, conserve natural resources, improve air and water quality, protects biodiversity and ecosystem. Along with that its social benefits are improving quality of life, improves occupant health and comfort. Though it will cost more,but that can be managed on a long term process, ie. as we are spending a huge money to overcome pollution, greenhouse effects. And these green roads can give us a life long sustainability.

The current Green Road system contains 46 possible points. Certification is based on achieving a minimum number of credits. The minimum level of certification is based on achieving roughly 40% of the credits. The following certification levels are proposed:

1.Certified:16-21 credits
2.Silver:22-26 credits
3.Gold:27-32 credits
4.Evergreen:33 credits or above

This is basically as assessment from an live project. According to our survey and analysis we give our project 25 out of 46, which is an approximate value. Hence the project we followed is come under Silver Credit Category.

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