Research Paper Engineering

Green Highways: A Future Need

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ABSTRACT

In a Green Highway Revolution, save energy, material and increase the productivity of the people working in the building the highway/highway designer who trying their best to protect the green environment by designing and constructing green highway.

The natural environment is the most precious resource we have as it sustains all forms of life on the earth. Due to the mismanagement of the environment many socio-economic problems have cropped up. To overcome these problems the World Green Highway Council, a top global not-for-profit organization is working to transform the property industry towards sustainability.

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General:

Green highway technology was initiated in USA since the year 2002 and then after it is being persuaded in that country though public private participation, a social group, known as Green Highway Partnership (GHP). The nationwide group of GHP in USA has also identified the characteristics of Green Highway and rating system of Green Roads. The Authority intends to start the systematic educative social movement including applications of Green Highway technology wherever possible in India on the similar pattern of GHP in USA.

In pursuance of the above technology, the Authority has undertaken the studies of Green Highway so as to formulate its general characteristics suitable to Indian environment and promote the use of Green aspects of the highway wherever possible. To work out more details on the subject and to formulate the action plan, it is proposed to constitute a Public Private Association in India viz. Green Highway Association India (GHAI). Such association and its branches at project level, Taluka level, District level, State level and National level shall work to promote the concept of Green Highway after formulating the characteristics and rating methodology for Green Highways.

Green Highway concept may go on developing in days to come depending upon Socio-economic priorities and research data that may come forth for adding or deleting in the present concept. Highway Research Center has undertaken the above work of implementing the concept of Green Highway in India and making available information on the subject to the concerned peoples & institutes including training to highway engineers.

Brief consideration for Green Highway:

Green Highways constitute transportation functionally and ecological sustainability so that transportation requirements and environmental functions are better than before. The expected contribution of Green Highways include reduced use of virgin materials, reduced energy use, mitigation of environmental burden, promotion of human health and safety, optimization of habitat and land use, improve business and communication and most important is reaffirm our commitment to future generation also. The traditional highway can be converted into green highway right from design process and shall undergo desired changes during construction and maintenance phases. Before the formulation of common characteristics of green highway it is always advantageous to understand the green practices to be followed during process of designs, construction and maintenance of highway. The below discussed green practices are not final and may change during days to come depending upon the research data that may come forth in this respect. Some of the practices may have to be replaced or some of the new practices shall have to be newly added depending upon social priorities and invented alternative practices in that time.

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. The green highway is not any Govt. stipulation of laws but the results of composite efforts rendered by public private associations. There are various Govt. stipulations and laws on minimum environmental requirements but we have to go much beyond these requirements and compliances so as to protect, as far as possible, the environmental and ecological process to its natural form without much impact of highway construction.

The brief description of each of the above area, to be developed to produce green highway, are given below.

1) Watershed driven storm water management:

Watershed driven storm water management is significant in reducing the storm water runoff from a highway as well as treating the runoff by natural ways. Storm water management is the techniques for holding and treating the runoff produced by a highway and diverting the storm water runoff to areas where it can infiltrate to the ground water table. The green infrastructure practices protect runoff water quantity and qual-

ity in two ways. First they reduce the amount of pollutants at site and ultimately are discharged into adjacent water bodies. Secondly they reduce the water that runs off the site. Infiltration & evapotranspirations of storm water are two natural methods of storm water treatment. The suitable methodologies for storm water management within ROW shall have to be evolved considering the present practices. In USA, technologies like bio-retention (Landscape designed to remove silt and pollution from surface water runoff), pervious pavement shoulders, environ friendly concrete, forest buffers, restored and storm water wetlands, stream restoration, soil amendments, wild life crossings etc. are being used. The field of watershed driven storm water management is constantly evolving and need attention of researchers.

It is challenging job to researchers to develop suitable and economical tools which will aid in design & analysis of storm water management and treatment alongside of highways.

The following few research opportunities in storm water management are listed below which are also hinted for development

i) Cost-benefit analysis of maintenance practices of storm water management (SM)
ii) Commonly applicable O & M practices for SM.
iii) Minimizing maintenance requirements of SM.
iv) Methodology of SM performance & designs.
v) Identification of critical needs within watershed for SM.
vi) Analysis of pollution reduction in water in SM.
vii) Cost-benefit demo for SM mitigation.
viii) Viable approaches to highway runoff management.

2) Recycle, Reuse and Renewable materials:
Recycling and reusing materials are both aimed at conservation of natural materials and reduction of waste during construction & maintenance of highways. But recycling and reusing are not the one and same activities. Recycling is process while reusing is practice. Making utilization of old railing, old kerb stone, reusing centering and scaffolding materials etc. are the examples of reuse. The old bituminous pavement material can be recycled in the form of new pavement through specially designed plant. The industrial byproduct/ wastes can also be recycled in various items of highway construction viz. fly ash, blast furnace slag, foundry sand, waste rubber tyres & rubber pieces etc. Recycling involve comparatively more energy, because we have to reprocess an item into a new product. Renewable materials can also be used in place of some non-renewable highway materials.

3) Conservation and Ecosystem management:
Conservation and ecosystem management has vital role in minimizing effect that highway system on its surrounding ecology. Many aspects of the ecosystem are affected by the highway construction. The most obvious effect highway have on the natural eco system is the displacement and division of natural habitat. Maintaining natural flows of rivers, streams etc. without changing the gorge of flow at highway site contribute to conservation of ecosystem. Similarly ecosystem management shall also include the use of wildlife crossings at the highway site and wildlife buffer zones.

4) Life cycle energy of Highway:
Energy is an important economic concern and construction and maintenance of highway requires large amount of energy. The energy is also consumed by vehicles travelling on highways. The reduction in life cycle energy consumption of highway is one of the objects of green highway. To implement the objective, it is obvious to innovate the practices that will reduce lifecycle energy consumption of a highway. These practices shall work to reduce emissions also so as to minimize the air pollution. The use of Warm Mix Asphalt (WMA) in lieu of Hot Mix Asphalt (HMA) is one of the practices to reduce the lifecycle energy in highway construction. The WMA consume considerably less energy than HMA due to lower production temperature in WMA. Cement is also very energy intensive material which is being used extensively in highway projects. To minimize the cement use, research has been made to replace a large portion of cement by pozzolona, fly ash and byproducts from steel plants. It is interesting to note that use of one ton of fly ash as a substitute for one ton of cement in concrete can have a total primary energy reduction of 4695 mega joules or equivalent of energy used in burning 147 liters of gasoline.

The highway shall be designed in such a way that energy consumption can be reduced during construction of highways.

Designs consideration for green highway in highway projects:

The above discussions lead to formulate the designs considerations of green highway in practical form as under:

i) Primary action plan shall have to be prepared while designing the green highway project so as to preserve and safeguard natural size, shape, flow of rivers, lakes and streams. Similarly natural beauty of environment i.e. forest, wildlife etc. shall have to be maintained without much disturbances.
ii) The proposal of minimum utilization of natural resources, materials and products shall have to be framed at designs stage only.
iii) The proposal of using Warm Mix Asphalt (WMA) in lieu of Hot Mix Asphalt (HMA) is to be considered at designs stage after considering quality of road, economical considerations and life of designed highway.
iv) The survey and provision of using fly ash &/ or other industrial waste products locally available for use in concrete/ asphalt roads shall have to be estimated at design stage of Highway.
v) The estimate of generation of useful milling materials while executing the project and proposal for utilization of the same for different areas viz. internal roads, service roads, on sides of road shoulders etc. shall have to be framed at design stage of the green highway.

Green Highway considerations at construction stage:
The designs considerations of green highway shall have to be well studied before the project put to execution and following aspects shall have to be strictly adhering to during execution so as to convert the highway project into green highway.

1) Reduce vehicle/ machinery fuel consumption & lower down fuel demand than estimated in actual construction.
2) Utilization of natural resources & virgin materials to bare minimum extent than estimated.
3) Recycling of byproducts and industrial waste viz.: waste rubber, fly ash, plastic, glass etc. in the locality shall be given priority.
4) Utilization of low electrical equipments viz. CFL, LED, LCD etc. on project site shall have to be ensured.
5) Selection and use of efficient construction equipments and plants which will help to reduce the pollution during construction. Monitor the performance of such plants periodically.
6) Utilization of natural and renewable energy source far camps, offices and execution site areas i.e. solar panels etc.
7) Minimize the waste of every kind. Disposal of hazardous and non-hazardous waste from construction site and reporting its environmental compliances to concerned authorities.
8) Utilization of spill control techniques and recycling techniques wherever possible.
9) Measuring & keeping record of environmental damages during construction phases in terms of air, water, land, flora, fauna & its special impact with sophisticated testing equipments.
10) It is most important to plant large canopy trees along both sides of highway. One should remember that one sqm. of green canopy absorb 0.2 kg of CO2 and other waste gases. Tree plantation interact the storm water, mitigate

the temperature, improve air quality and prohibit soil erosions. Median portions between lanes of highway shall also be used for plantation of herbs & shrubs so as to reduce CO2 and help to generate oxygen. Use more local species during the plantation which deliver more severity rate & reduce the rework of plantation.

11) It should be ensured that the compliances of environmental rules & regulations shall be much beyond the stipulated limitations.

Green Highway consideration during maintenance of highway:

1) Monitoring of plantation growth & implement techniques to increase the severity of plantations and survival ratio.
2) Monitoring ambient air quality & noise quality after construction.
3) The typical vehicles plying on the highway viz. S.T. buses, trucks, multi-axle vehicles etc. can be assessed for their life maintenance, fuel consumptions, travel life (in kms.) etc. so as to estimate the carbon emission by transportation system as a whole & methodology to reduce down the same and shrinking the related carbon footprints. The goal of sustainable transportation is to protect the environment & conserve natural resources while taking into consideration social need and cost- benefit ratio. The efforts shall have to make in association with transportation sector to reduce the emission of carbon and other detrimental foul gases that affect the environment.

Benefits of Green Highways:

Green highway is associated with a variety of social environmental, economic & human health benefits. The benefits of green infrastructure are particularly accentuated in urban & suburban areas where green space is limited & environmental damages are more extensive. Green infrastructure benefits include.

i) Social benefits: Highway has an important impact on local economies. Highway can draw a business into local society & provide local jobs & tax income. Due to decrease of materials in land fill, the land fill space will be decreased ultimately reducing user costs for communities around the land fill. Reduction in noise and reduced pollution from highways can increase the quality of life in the area. Similarly other benefits viz. decreased water use, use of recycled materials, protection to wildlife, decreased amount of pollutants Contained in surface runoff & increase in stream & recreational water quality etc. benefits can also be availed by the society.

ii) Reduced & delayed storm water runoff volumes: Green infrastructure techniques increase storm water infiltration rates, thereby reducing the volume of runoff entering into sewer systems & ultimately at lake, rivers & streams.

iii) Enhanced groundwater recharge: The natural infiltration capabilities of green infrastructure technologies can improve the rate at which ground water tables are 'recharged' or replenished. Enhanced ground water recharge can also boost the supply of drinking water for private & public uses.

iv) Storm water pollutant reductions: Green highway techniques infiltrate runoff close to its source & help to prevent pollutants from being transported to nearby surface waters. Once runoff is infiltrated into soils, plants & microbes can naturally filter & break down many common pollutant found in storm water.

v) Reduced sewer overflow events: Utilizing the natural retention & infiltration capabilities of plants & soils, green infrastructure limits the frequency of sewer overflow events by reducing runoff volumes & by delaying storm water discharges.

vi) Increased carbon sequestration: The plantation & soils which are the part of green highway approach serve as sources of carbon sequestration. In this process CO2 is captured & removed from the atmosphere via photosynthesis & other natural process.