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Feasibility Study of Green Road over Conventional Road

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Abstract–*The research work entitled with "Feasibility Study of Green Road over Conventional Road", deals with the comparative analysis by considering, different factors like Cost, Environmental Impact, Sustainability. Among all technologies research focuses on Plastic Waste technology and reuse of waste aggregate. In this research Cost is considered as very important factor.The aim of this paper is to explain the Actual Cost Requirement for the construction of green road and how the green road is more sustainable.Two studies have been performed between conventional bitumen road and green road to diagnose the cost required to complete 1 km of road. The data of cost is taken from the respective organisations and concerned persons involved in road construction project. In this research it is observed that green road is economically feasible if we consider overall cost till its end-of-life span.*

Key Words**:** *Green highways, green methods, watershed-driven, strong water management, Life cycle cost, carbon emission*

1. INTRODUCTION

India has the second largest road network across the planet at 4.7 million km. Road transportation has gradually increased over the years with the development in connectivity between cities, towns and villages within the country. India is that the developing country and within the economy of country, construction industries play an important role. Time and price are two main concerns during a construction and that they are used for planning a special project like infrastructure, roads etc. Construction management is defined because the applicationof management techniques and systems in construction to finish projects on budget, on schedule, safely and consistent with plans and specifications. Today, within the developing nations, roads play important a part of infrastructure of country. Any damage may cause many inconveniences to the transportation which ultimately will affect the longer-term growth of nations. On the opposite side with increased heating and global climate change, go green movement is gaining awareness overall. The combined solution for above problems is often green road. Using environmentally friendly material in transportation projects implies eco-friendly construction of roads with alternative materials over the traditional materials.

1.1 Conventional Road Construction: -

It is a really common construction process. this sort of construction method is usually adopted. There are various sorts of conventional road are as follows: -

Concrete*:*
It is a standard option for construction purposes as they're a solid material and may be used for building walls and native roads. This method is considerably less susceptible to wear and tear defects like rutting, cracking, stripping loss of texture, and potholes. this is often the most reason for its wide usage.

Asphalt*:*
This method of construction replacing concrete method in lately. They are very durable, water-resistant and may go more longer than the concrete. the main advantage of asphalt over concrete is its price. Moreover, asphalt includes low noise during pavement and it's easy to handle it for repairing and maintenance. that's why it's widely accepted and employed by the people for the aim of pavement surfacing.

Composite:
This method is widely used for the upkeep, recycling, and rehabilitation of the roads. The material is that the combination of both asphalt and concrete material.

Bituminous:
The solvent from the bituminous material will evaporate and therefore the bitumen will bind the mixture. it's utilized in construction because it's easy to supply, reusable, non-toxic, and a robust binder.

1.2 Green Road: -

Green highway is often defined by five broad topics like conservation and ecosystem management; watershed-driven strong water management; life cycle energy and emissions reduction; recycle, reuse, and renewable; and overall societal benefits. it's one

among the new technologies which are implemented recently in India for infrastructure development. Concept Green Road is to develop roads by recycling, reusing of waste materials without polluting the environment. one among method of developing Green Road is by using Cold Mix Technology. Green Highways constitute transportation functionally and ecological sustainability in order that transportation requirements and environmental functions are better than before. The expected contribution of Green Highways includes 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 vital is reaffirm our commitment to future generation also. the normal highway is often 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's always advantageous to know the green practices to be followed during process of styles, construction and maintenance of highway.

1.3 Road Construction Process

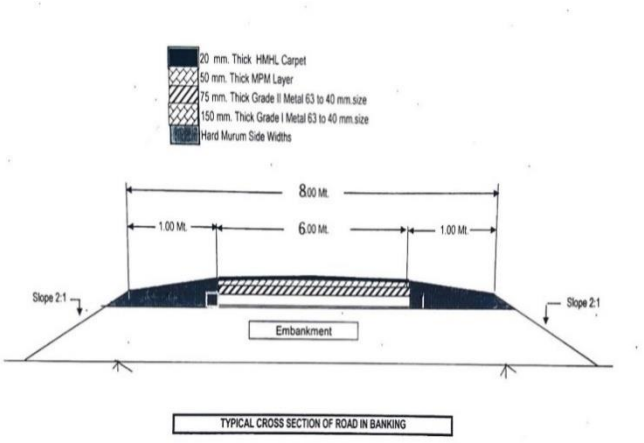

Figure – 1: ConstructionProcess

Stage 1: Preparation of Sub Grade: Excavation for roadway in earth, soil of all sorts, sand, gravel or soft murum including and spreading for embankment or stacking as directed. The formation or construction of the sub grade begins after the clearing and grubbing phase providing earth work in embankment.

Stage2: Preparation of GSB: Providing, laying, spreading and compacting stone aggregates of specific sizes to water bound macadam Grading l Aggregate.

Stage3: Construction of (MPM) surface: Providing and constructing 50 mm. thick Modified Penetration Macadam (MPM) road surface.

Stage4: Construction of OGP Surface and providing tack coat: Providing and Laying OGC 20 mm thickness Composed of 13.2 mm to 5.6 mm aggregates premixed with bituminous binder.

Stage 5: Sealcoat and Finishing: Providing bituminous Type A liquid seal coat on bituminous surface.

2. RESEARCHMETHODOLOGY

The principal aim of this study is to investigate the Initial and overall Cost requirement of green road construction and recycling of construction wastes for thane district (Rural). Promotion of recycling and reusing of waste materials in Road Construction will not only reduce the burden on the consumption of natural resources, but it will also reduce the embodied energy, which may become significant.

2.1 Objectives of the Project:

1. To specify the methods for green highway construction.
2. To Perform Comparative Analysis of green road construction over conventional road considering Various factors (i.e. Cost, sustainability, carbon emission etc.)
3. To provide sustainable environment to the encompassing by utilizing waste plastic material.
4. To investigate the most effective green construction cost optimizing strategies.
5. To increase the life span of road by improving quality.

2.2 Scope of the Study

1. To eradicate potholes.
2. To minimize global warming, greenhouse gases, and pollution.
3. The lifespan of the roads can be increased.
4. Eco-friendly in nature.
5. Reduced & delayed storm water runoff.
6. Enhanced groundwater recharge.
7. Reduced sewer overflow events.

2.3 Methodology of the Study

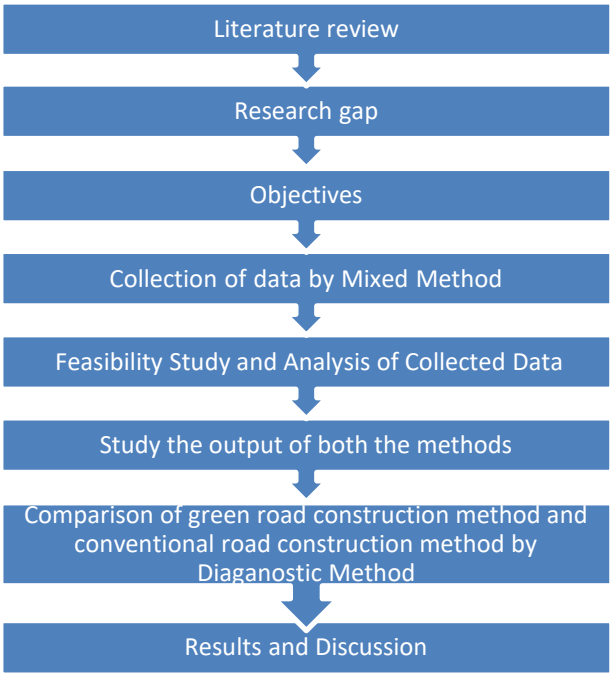

Chart – 1: Methodology

3. STUDY AREA PROFILE (THANE RURAL)

Thane is one among the 36 districts within the Maharashtra state of India. The district is on the western coast and falls under the Konkan division of the state. Until 1 August 2014 the district was dividedinto15 talukas,viz. Thane, Kalyan, Murbad, Bhiwandi, Shahpur, Vasai, Ulhasnagar, Ambarnath, Dahanu, Palghar, Talasari, Jawhar, Mokhada, Vada,Boisar and Vikramgad. However, thereon date the district was split in two with the creation of a replacement Palghar district, which took 8 of those talukas, leaving the reduced Thane district comprising Thane, Kalyan, Murbad, Bhiwandi, Shahpur, Ulhasnagar and Ambarnath talukas. The total numbers of villages are 1748. The Thane head quarter well connected to all parts by metal roads and highways. The towns are mainly covered by small and medium scale industries and factories.

3.1 Material Availability in Thane District:

(A) Stone Crushers:
1. Mahesh Stone Crusher, AnjurPhata, Bhiwandi.
2. Mhatre Stone Crusher, Koshimbe, Bhiwandi.
3. Jai Bharat Stone Crusher, Vahuli, Kalyan.
4. Shree Ganesh Stone Crusher, ChaveBhiwandi
5. Jijau Building Materials Suppliers,Wada

(B) Recycled Aggregate Supplier
1. Rajashree Stone Crusher, KalyanKarjat Highway.
2. Gajanan Stone Crusher, Bhiwandi Wada Road.
3. Chakuli Stone Crusher, Bhiwandi.

(C) Asphalt Plants
1. Nidhi Enterprises, Kharivali, Bhiwandi Wada Road
2. Daksh Enterprises, Wada Palghar Road
3. Kaypee Enterprises, Thane
4. Jai Bharat, Vahuli, Kalyan
5. Gajanan Enterprises, Bhiwandi Wada Road

(D) Plastic Waste
1. Rk Plastic Scrap, Thane Bhiwandi Road,
2. Sai Shraddha Plastics, Bhiwandi,
3. Rebot Plastic, Bhiwandi Vasai Highway,
4. Ekatvam Plastic RecyclingNavi Mumbai,
5. Recycle Karo, Mahape, Navi Mumbai,
6. Gayatritex Engineers Plastic Shredding, Bhiwandi,
7. GMS Plastic Machinery, Bhiwandi,

4. DATA COLLECTION ANDANALYSIS

4.1 For Conventional Road

Rate of Materials
Aggregate 80mm= ₹2550 per brass.
Aggregate 40mm = ₹3200 per brass.
Bitumen VG 10 = Rs 48000 per M.T.
Bituminous Macadam = Rs 3850 per Ton
Wash Sand = Rs3800 per brass

4.2 For Green Road

Rate of Materials:

Recycle Aggregate 80mm = ₹1900 per brass.
Recycle Aggregate 40mm = ₹2150 per brass.

4.3 Waste Plastic:

Rate of Waste Plastic = Rs 15 per Kg.

Construction Process Using Plastic Waste:

a) Dry process - within the dry process, the processed waste plastic is shredded and added to the recent aggregate. Shredded waste plastic size should rather be 2-3 mm for better spread and coating on the mixture. The shredded waste plastic is then added to the aggregates that are heated to 170ºC. The shredded waste plastic softens and melts to make a coating round the aggregates. The bitumen is also heated to 160ºC, then the plastic-coated aggregates are mixed with bitumen and used for road construction.

b) Wet process - within the wet process, the processed waste plastic in powder form is added to the recent bitumen. The powdered waste plastic is directly mixed with bitumen before adding them to the aggregates. It has to be ensured that there's a good mixture of plastic and bitumen, and therefore the temperature range for this method is 155ºC to 165ºC. Sahu and Singh (2016) suggest a 6-8% of

waste plastic powder within the bitumen mix.

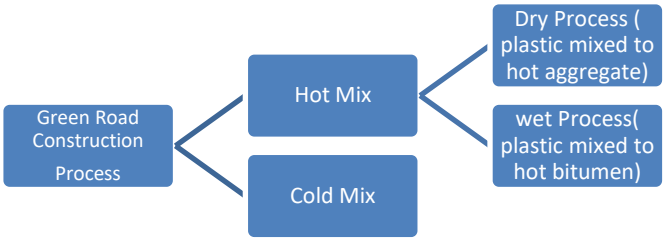

Figure -2: A Flow Chart Illustrating the Construction Process Using Plastic Waste

Alternate Technology & Equipment's
Warm mix asphalt
Half warm mix applications
Storm Water Management
Conservation and Ecosystem Management

4.4 Case Study:

(A) Bitumen Road Construction (Conventional)

Figure -3: Bitumen Road

General Description:
1. Total length of road = 1 km length
2. Width of road = 6 m
3. Life span of road = 15 years
4. Sit location = Bhiwandi (Rural)
   Rate = As per provided S.S.R. of PWD Government of Maharashtra for 2019-2020

Measurement Sheet

Sr	Description	No	L (m)	W m	H (m)	Q (m)	Remark (LxWxH)
1	Excavation	1	1000	6	0.4	24000 m3	=1000x6x0.4 =2400
2	Sub Grade Preparation	1	1000	6	0.3	1800 m3	=1000x6x0.3 = 1800
3	GSB (Grade I)	1	1000	6	0.15	900 m3	= 1000x6x0.15 =900
4	GSB (gradeII)	1	1000	6	0.075	450 m3	=1000x6x0.075 =450
5	Spreading murum	2	1000	1	0.275	550 m3	=2x1000x1x0.275 =550
6	Compacting murum	2	1000	1	----	2000 m 2	=2x1000x1 =2000
7	Construction Of MPM	1	1000	6	----	6000 m 2	=1000x6 =6000
8	Providing Tack coat	1	1000	6	----	6000 m 2	=1000x6 =6000
9	(OGC) surfacing		1000	6	----	6000 m 2	=1000x6 =6000
10	Seal Coat	1	1000	6	----	6000 m 2	=1000x6 =6000
11	Royalty Charges Materials	1	1000	6	----	3150 m3	=1800 +900+ 450=3150

Table -1: Measurement Sheet for Conventional Road

Rate Analysis

Stages	Rate	Conventional Road (Rs) (Rate x Quantity)
Excavation	73.00	1,75,200
Sub Grade Preparation and Soling	356.85	6,41,844
GSB construction (Grade I aggregate)	2075.1	18,67,590
GSB construction (grade II aggregate)	2259.2	10,16,662
Spreading and Compacting hard murum for side width	80.02	69,658
MPM Layer	173.90	10,43,400
Providing Tack coat	11.10	66,600
Open graded premix surfacing	133	7,98,000
Seal Coat	47.50	2,85,000
Information Board	8765	8,765

Royalty Charges	141.34	4,45,221
Quality Control Charges		14,000
Total cost of construction	**64,31,967 /-**	
Total Maintenance and Repair Cost	31,25,195	
Overall Cost	**95,57,162 /-**	

Table -2:Rate Analysis of Convention Road

(B) Rate Analysis for Green Road Construction Considering Same Dimensions:

General Description

1. Total length of road = 1 km length
2. Width of road = 6 m
3. Life Span = 20 years
4. Maintenance = Nil up to 10 years
5. Rate = As per provided S.S.R. of PWD Government of Maharashtra for 2019-2020

Market Rate of Green Materials Used:

Waste Plastic for BT Road=₹12/kg
Cost of Bitumen = ₹50/kg
Plastic Percentage Used in Bitumen = 8%
Recycled aggregate (I) =₹1900 per brass
Recycled aggregate (II) =₹2150 per brass

Calculation for plastic and bitumen quantity for (MPM Layer):

As per GVT. Of Maharashtra PWD S.S.R. guidelines
The rate of spraying of bitumen is 1.75kg per m2
Therefore, for 1 m2 = 1.75 kg of bitumen.

For 6000 m2 area,
Quantity of Bitumen = 1.75 x 6000
= 10500 kg of bitumen.

Plastic Waste Substitution for bitumen is 8%
Quantity of plastic waste in bitumen = 10500 x 8%
= 840 kg.

Quantity of Bitumen after Substituting 8% of plastic = 10500-840= 9660 kg.

(Rate of plastic waste is 15 per kg and rate of bitumen is 50 per kg)

Therefore, Cost of Plastic= 840 x15 = ₹12,600 for 6000 m2.
Cost of Bitumen = 9660 x 50 =₹ 4, 83, 00 for 6000 m2.

Rate Analysis

Stages	Rate (₹)	Green Road (₹)
Excavation	73.00	1,75,200
Sub Grade Preparation and Soling	356.85	6,41,844
GSB (grade I agg)60% new material and40%Recycled Aggregate	2075.10 689.38	11,81,614
GSB (grade II agg)60% new material and40%Recycled Aggregate	2259.22	6,54,520
Spreading and Compacting for both side	80.02	69,658
MPM Layer (92%bitumen & 8%plasic)	173.90 41.70	9,79,944
Providing Tack coat	11.10	66,600
Open graded premix surfacing	133	7,98,000
Seal Coat	47.50	2,85,000
Information Board	8756	8,765
Royalty Charges	141.34	3,68,897
Quality Control Charges		14,000
Total cost of construction	**52,44,069**	
Total Maintenance and Repair Cost	18,33,188	
Overall Cost	**70,77,257**	

Table -3: Rate Analysis of Green Road

5. RESULTS AND DISCUSSION

A. Cost Result at different stages of construction

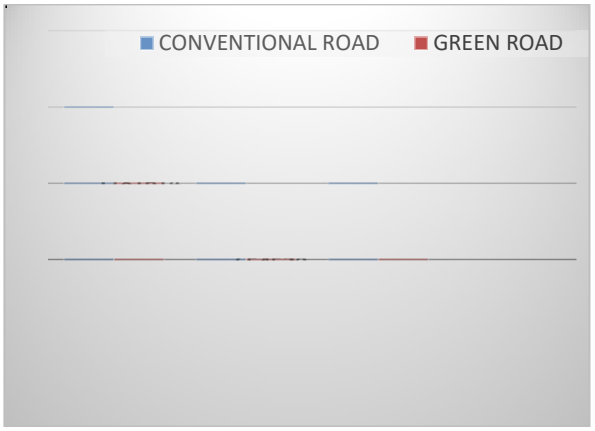

Chart -2: Cost Result at different stages of construction

Above table shows the cost results at different stages of construction in conventional road construction method and green road construction method. In Conventional Road construction granular sub base construction stage costs around ₹.18,67,590 While in green road construction it costs ₹13,49,529 because of using recycled material. In green road Construction **5**,18,061 will save. Likewise, in upper layer of grade II aggregate it costs ₹1016662 in conventional while it costs ₹7,48,368in green road construction. This huge difference is because of use of 40% recycled material. Only crushing charges of aggregate are added in that 40%. In green road Construction **₹2**,68,294 for granular Sub base will save. After that in MPM layer which consist of bitumen it costs ₹1043400 in conventional while 979944 in green road. In this we look small difference in both the costs. This is because only 8 % substitute material is used in the bitumen. Green road we use 40% recycled aggregate because of that 40 % royalty charges are also reduced.

B. Total Cost of Construction

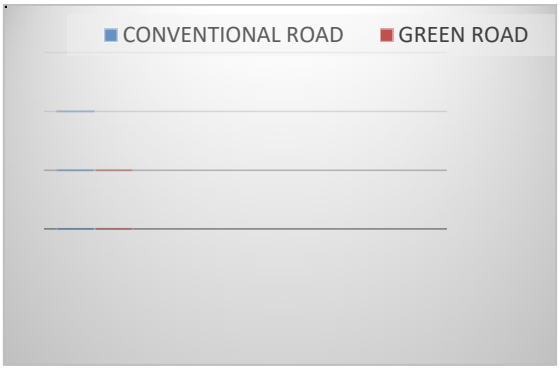

Chart -3: Total cost of construction at different method.

Above bar chart shows the total cost of construction at different methods of construction of road. In Conventional Road construction it costs ₹64,31,967 while the total cost of construction of green road is ₹55,12,673. The green road construction cost is slightly cheaper than conventional road. The cost of construction of green road is 14.29 % lesser than conventional road.

C. Maintenance cost result from both the methods

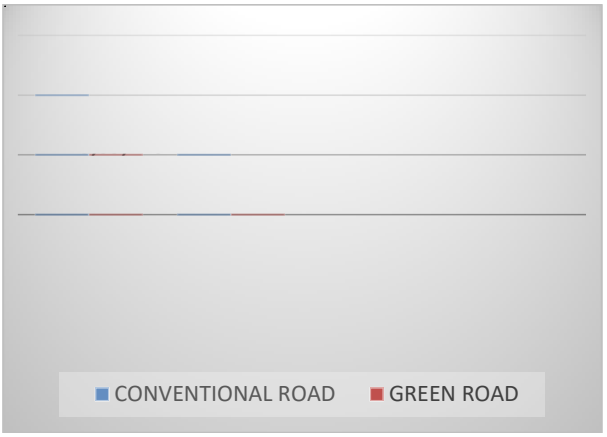

Chart No.4 Maintenance cost from both the methods

Above chart shows the maintenance cost of road till the end of its life span for both the methods.The routine maintenance cost of conventional road is ₹1875117 while in green road it goes to Rs13,78,170. Routine Maintenance cost of green road is 26.50% lesser than conventional road. Likewise, the major repair cost for conventional road is ₹1250078 whereas for green road it costs ₹11,02,534. Major Repair Maintenance cost of green road is 11.80 % lesser than conventional road The total maintenance cost for throughout its life span for conventional road is ₹31,25,195 whereas for green road it costs, ₹80,704. The difference of total maintenance cost between conventional road and green road is ₹644491 which is considerable because life span of green road is 5 years more than conventional road

D. Overall cost results for both the methods

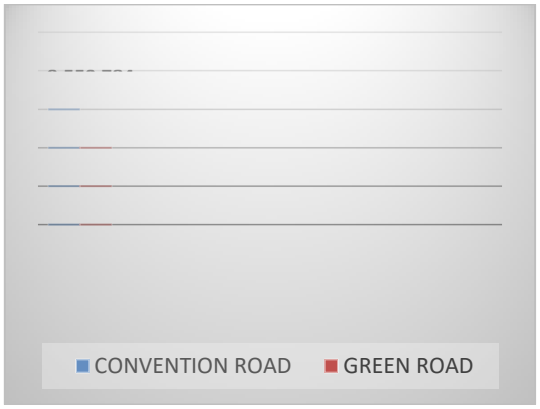

Chart No-5: Overall cost for both the methods

The above bar chart shows the overall cost of conventional road and green road. The overall cost for the conventional road method is ₹95,57,162 whereas the overall cost for green road method is ₹79,93,377. The difference between both the method is ₹15,63,785. This cost will save for every km in green road construction. The green road is 16.36 % cheaper than conventional road.

4. CONCLUSION

From the above project we can conclude that there is a considerable difference between the cost of construction and overall maintenance in green road and conventional road. From the data collected and analyzed we got ₹15,63,785 difference in cost of construction. So, we can say that the cost of construction done with green construction will help in lowering the budget by 16.36 %. The maintenance in green road is nil for initial 10 years as shown by previous researchers. As well as there is a 26.50**%** saving in regular maintenance over conventional road. There is up to 11.80**%** difference in major repairs for green road. Also, from the collection of data of Green Road and with conversations with experts involved in road projects there is lack of knowledge about green road concept, its total costs and maintenance. The planning and Costing of the green road is done for the selected area. It also improves the reduction in usage of energy, economical construction along with the sustainability. Hence it is a most recommended method of future construction roads.By Studying output data of both the methods it can be concluded that green road is better in all aspects such as cost, sustainability, environmental affect etc.

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