

# *Application of Green Highway Concept in Expressway Design*

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**Abstract:** The concept of green highway is a new concept conforming to the development of urban transportation in China. It aims to combine highway construction with ecological and environmental protection, so as to achieve the objectives of ecology, environmental protection, landscape, energy conservation and emission reduction, and promote the sustainable development of highway construction. This paper will focus on the application of green highway concept in expressway design, so as to provide reference for green highway construction in the future.

## **1. Introduction**

With the rapid development of the times, with the rapid development of urban construction technology and the increasing improvement of clothing, food, housing, and transportation, people begin to pursue higher quality of life and deeper spiritual pursuits, including the longing for a good ecological environment. In the process of highway construction, the completion of high-quality transportation facilities is accompanied by the negative impact on the environment. How to deal with the relationship between the two has aroused extensive discussion, and then came the concept of green highways, that is, adhere to sustainable development in planning, design, construction, and maintenance, to minimize and reduce the impact of engineering construction on the environment.

## **2. Overview of Green Highway Concept**

### **2.1. Concept of Green Highway**

Green highway refers to the highway with a harmonious relationship between traffic and external factors. The external factors are not only ecology, but also energy, society, economy, and other aspects. The concept of green highway has a new conceptual and regional nature and is a highway concept that can get along well with the environment in theory [1].

### **2.2. Significance of Green Highway**

The application of the concept of green highways in real life is reflected in the construction of highway network drawings, design, discussion, construction, and even later maintenance and

operation. It is a new agent concept that makes rational use of resources, energy conservation, and emission reduction, takes care of the environment, and pays attention to efficiency and quality in the complete highway life cycle. Its purpose is also to enable people to obtain a more comfortable and healthy living environment, achieve the ultimate effect of harmonious coexistence between man and nature.

### **3. Basic Principles of Green Highway**

#### **3.1. Reduce Damage and Respect the Original Appearance**

In the process of expressway construction, the earth block must be excavated, filled, molded, and piled first, and these processes will inevitably cause irreversible damage to the environment, especially the surrounding soil, soil layer, soil structure and even the restoration of vegetation may take longer than ever before. What is more, it will also have a destructive impact on the surrounding scenic spots and historic sites and residential houses, resulting in the damage of the local ecosystems, animals are difficult to inhabit and even no longer exist. Therefore, in the construction process, we should try to bypass the key protection areas and residents' houses, maintain the original appearance as much as possible, and reduce damage and loss [2].

#### **3.2. Life Cycle Principle**

To improve the quality and durability of the project, we should select the most appropriate materials in the early construction period and the later maintenance period, to improve the quality and durability of the project [3].

In the selection of construction materials, steel can be given priority, which not only has strong durability, but also has low cost. When the highway section encounters complex mountainous areas, the steel structure should be considered, which is of high quality and not easy to be damaged, and is the primary choice for highway construction; when enough space is set at the bottom of the bridge, the bearings can be replaced regularly to increase the service life of the bridge. At the same time, special attention should be paid to the maintenance place. The setting should be scientific and reasonable to facilitate rapid arrival, rapid maintenance, rapid cleaning, and rapid replacement after completion [4].

#### **3.3. Resource Saving Principle**

Making overall planning is of great significance to the later layout and energy conservation and emission reduction. The resources of the project should be used efficiently, strengthen the utilization proportion of local resources and local resources, reduce transportation losses, increase the utilization rate of recycled waste copper and iron, realize the green concept in the process of recycling, and actively recover residues and debris, waste roads and construction waste after the completion of the project, Realize re recycling and comprehensive utilization [5].

#### **3.4. Adhere to the Principle of Sustainable Development**

To adhere to sustainable development and overall regulation is to coordinate the relationship between the environment, roads, society, and other aspects, improve the utilization rate of goods on the basis of harmonious relationships, realize efficient and green construction, protect and make progress in construction. Overall planning refers to the implementation of the concept of overall planning and coordination in the whole process of road drawing design, construction planning,

building materials, and later maintenance, to ensure the completion of the project and harvest a good ecological environment [1].

### **3.5. Adhere to the Principle of Innovation Driven and Adjusting Measures to Local Conditions**

During construction, it should be emphasized to design the most appropriate project on a certain plot according to local conditions, clarify the positioning, grasp the direction, and design the project with characteristics, bright places and high grade, to reflect the importance of innovation, inject fresh blood and add new vitality to the cause of Expressway.

## **4. Application of Green Highway Concept in Expressway Design**

### **4.1. Rational Utilization of Resources to Achieve Intensive Economy**

When selecting the expressway route, pay attention to the terrain, try to avoid damaging farmland, avoid residential houses, cash crops, and forest areas with good ecological environment, and set the route in wasteland as much as possible [6]. The principle of "overall layout and intensive design" shall be implemented in the channel design, and the highway construction shall be completed as far as possible on the premise of ensuring resource conservation, to solve the travel difficulties of residents and other problems.

In terms of land resource protection, we should not occupy farmland plots as much as possible and avoid them as intensively as possible, to reduce the division of land by expressway, reduce farmers' labor cost and work difficulty, and reduce the probability of danger caused by farmers Crossing Expressway, which is essential and important. However, when it is difficult to avoid a large area of cultivated land, a high-speed viaduct should be established for crossing. The construction of the viaduct should be stable and safe to ensure the safety of farmers' personal and property.

At the same time, the cultivated land area can be avoided by reducing the width of the berm, to achieve the purpose of implementing the concept of green highway. In terms of energy selection, we can try to use rich solar energy resources, which can not only save resources, but also ensure sufficient energy. Although the solar energy situation in different regions is different, on the whole, we can save a lot of financial, material, and human resources and complete the project construction under the concept of energy conservation and emission reduction [7].

### **4.2. Pay more Attention to Ecology and Strengthen Protection**

#### **4.2.1. Rationalize Subgrade Design**

When drawing the first draft, professional designers should pay attention to the road radians, slope, top angle, and other aspects to ensure the natural connection between the road and the surrounding drainage ditch and the surrounding environment, and the smooth curve radians. When necessary, vegetation can be planted to cover the drainage ditch, which not only increases the greening area and forms a good ecological atmosphere, but also helps beautify and improve the overall visual feeling of the highway [8].

#### **4.2.2. Ecological Drainage Design**

Buried side ditches should be adopted, which are located on both sides of the road, which can not only reduce the flow rate of sewage on both sides, but also reduce the degree of vehicle loss during

later operation, but also reduce the human, material and financial resources invested in cleaning up highway garbage. It is not only more beautiful, but also safe, feasible, durable, and practical. The diversion is connected to the designed sedimentation tank, which evaporates the wastewater, to achieve the ultimate goal of cleaning the water flow on the road.

In view of the fact that the residual waste water during the transportation of dangerous goods often remains in the tunnel, a diversion ditch can be set to drain the polluted water and flow it into the sedimentation tank to avoid the polluted water flowing into the tributaries of nearby villages and causing harm to farmland, crops and even residential water [9].

### 4.3. Hidden Protection Design

The edge protection design is inevitable for the expressway. It is suggested to use anchor bolts and anchor cables and other facilities that can disperse the pressure. One of the reasons is that they are safe and reliable. The other reason is that they are beautiful and elegant. At the same time, they can make more use of the surrounding plants, plant plants of different colors, types, and levels, and block the protective fences on both sides of the road, which can reduce the visual fatigue caused by the simplification of road style.

The slope protection on both sides of the road mainly considers three-dimensional network grass planting to avoid being washed away by rain after the slope is built. At the same time, the design of high slope is also essential. Concrete can be used to calibrate the frame and anchor bolts to strengthen the frame. At the same time, it can be combined with greening. Planting bags can be planted on the upper part. After the plants grow luxuriantly, the protective hidden design can be achieved and traceless treatment can be achieved [10].

In addition to paying attention to greening on both sides of the fence, there are also open spaces on both sides of the road. It is suggested to adopt more local tree species. On the one hand, it has fast growth speed and is convenient for maintenance; on the other hand, it can better cultivate soil and facilitate the later planting of foreign tree species. When planting, pay attention to the stripping and storage of topsoil, which cannot be discarded at will. It should be placed near the spoil ditch to facilitate collective handling at the end. At the same time, a central green belt should be set in the center of the road, which plays a role of division on the one hand and drainage on the other hand to reduce road congestion. Flowers, shrubs, and small trees are usually selected for the central green belt of the road. The planting of tall trees will be avoided as far as possible, which will block the driver's line of sight and easily leave potential safety hazards. Small trees shall be set on the berm and grass and local vegetation shall be planted on the slope. Try to maximize the greening effect [11].

### 4.4. Selection and Planting of Surrounding Plants

The vegetation on both sides of the expressway is generally poor. For the selection of vegetation, it is a big problem. It is recommended to use more local plants, mainly small trees. On the one hand, it will not block the line of sight, on the other hand, it is more beautiful to plant in pieces, which will not affect the driver's driving line of sight, which is in line with the green concept of safety and ecology.

Pay equal attention to cost savings, construction and maintenance

The project should be comprehensively optimized, the concept of green economy should be systematically and comprehensively implemented, and the design of route of line should be taken into account, to achieve the purpose of harmonious coexistence and common development between the highway and the surrounding ecology, society and human settlements. For the three in one life cycle of construction, management and maintenance in the design, attention should be paid to the

initial cost and later maintenance investment, and the quality of the project and the durability of the road should be improved after calculating the expenditure, to achieve the optimal benefit [12].

I. implement the "five special actions"

#### **4.4.1. Maintain Balance between Filling and Excavation**

During the excavation and filling work, the earth-rock balance should be achieved as much as possible, the expenditure should be reduced to the greatest extent, the vertical transfer should be made as much as possible, and the excavated soil should be transported to backfill the vacancy in another place, to reduce the situation of debit and spoil, not only save the cost, but also reduce the damage to the natural environment and soil level, to achieve the effect of ecological and environmental protection [13].

When setting up spoil stacking sites, consideration should be given to the conditions of nearby rivers, especially those far away from the main river and areas with large water flows. They should be placed in remote soil ditches. Waste soil and stones should be placed in layers, with stones under and on the soil layer. In this way, it is also convenient for backfilling and can be used for rehabilitation and greening. At the same time, the corresponding drainage and protection design shall also be set for the spoil area. Because the soil layer is not firm, how to avoid water and soil loss shall be taken into account to ensure the maximum protection of the ecological environment.

#### **4.4.2. Adopt new Technology**

For example, new technologies such as BIM are not only conducive to the development of field work, but also beneficial to saving time, reducing cost, and improving quality. BIM Technology has the advantages of data visualization, accurate content, and small positioning error. It is widely used in the industry and is highly praised. During BIM work, calibrating the results can effectively avoid the time-consuming verification in the later stage. It is very beneficial to promote project progress, promote process supervision, and ensure quality safety, and remote control stability. Therefore, it is necessary to be good at using new technologies to improve the speed and quality of work, this also indirectly reflects the concept of green ecology [14].

#### **4.4.3. Pay Attention to Green Service Construction**

A service area or service center is set up at the stop point of the expressway. The domestic sewage used can continue to be used after being recycled and treated by the water purification system for flushing toilets and greening irrigation at the service point, to save water resources [15]. This technology is simple and easy to operate. It can not only reduce the loss of water resources, but also protect the surrounding environment and construct a green technology chain.

#### **4.4.4. New Tourism Projects**

The combination of transportation and tourism not only meets the current social needs, but also helps to tap the regional cultural characteristics, tap the diversified and complex history and culture, and generate various benefits. While meeting the needs of tourists, promote the local characteristics and drive the economic development of the small area. For the surrounding areas with good planting development, border sightseeing channels can be set up to drain the personnel, to facilitate people to pick rest camping, to a certain extent, also brings various benefits to highway setting [16].

## **5. Combination of Green Highway Concept and Drawing Scheme**

### **5.1. Overall Scheme Design**

The overall scheme design drawing is the optimization and improvement of the scheme after on-site investigation. It is the result of comprehensive consideration of early construction investment and later maintenance cost, safety, and durability. Its coordination with the surrounding terrain design, radians, corner setting, and other aspects are considered to form the final result - the overall scheme design drawing.

During topographic investigation, advanced technical means, such as aerial survey technology, shall be used to establish the digital topographic maps and digital models. These means shall be used for scientific and rigorous road route selection. At the same time, safety assessments, such as earthquake assessment and geological disaster risk assessment, shall also be considered. Scientific means such as geological remote sensing technology shall be used for detection, and a detailed topographic survey maps shall be drawn to indicate dangerous points and key concerns. At the same time, geological remote sensing, EH4, and other advanced technical means focus on the measurement of complex geology and tunnels, to provide a strong guarantee for the safe route selection of expressway [17].

### **5.2. Route Setting**

When determining the route, the bad road sections shall be bypassed to ensure safety and unnecessary loss. In the part of farmland shelterbelt, earthwork balance shall be considered to minimize the cutting of crop fields and minimize the consumption of waste earthwork and earth rock. Set the route scientifically, avoid the farmland forest network, set multiple route designs for comparison, and select the scheme with the least loss to the surrounding environment. If it is necessary to pass through, set the route along the slope too as far as possible to reduce the segmentation of farmland.

At the same time, the earthwork shall be balanced as much as possible. When there is more waste soil, it shall be temporarily stored in remote barren mountains and soil ditches. After the project is completed, the waste soil shall be recycled and transported to both sides of the road or the surrounding for greening transformation of the forest farm [18]. It can not only reduce waste soil, but also improve the greening rate.

### **5.3. In Terms of Subgrade Establishment**

To keep natural and beautiful, high slopes and large-area masonry slopes should be reduced, and unified prefabricated components should be used in energy conservation and emission reduction, to facilitate later maintenance and repair; when passing near the farmland, low fences shall be set to prevent sewage from entering the farmland and damaging the crops; Asphalt shall be used for highway pavement to reduce later consumption and reduce pollutant emission during construction [19].

### **5.4. Tunnel Design**

The selection of tunnel entrance is essential, which is not only related to the construction volume, but also affects the ecological situation of the surrounding plots. If it is not carefully considered, it will cause irreversible damage to the environment. First of all, we should pay attention to lighting and ventilation, select the East-West opening, reduce excavation works, make rational use of tunnel

waste slag after construction [20], and reuse resources to reduce expenditure and implement the green concept.

During the implementation of the tunnel lighting scheme, the materials should be changed, such as changing the LED lamp to high-pressure sodium lamp, or considering the tunnel LED color, changing lighting technology to reduce the visual discomfort of drivers when passing through the tunnel, while ensuring energy conservation and emission reduction and reducing power loss.

### **5.5. Fixed Point Setting of Service Station**

As mentioned above, the fixed-point setting of the service station should be considered in combination with the terrain to ensure that its location is reasonable and convenient for drainage, which is of great help to the traffic organization. At the same time, a parking lot equivalent to the passenger flow of the service station shall be set to ensure that people can have a full rest at the service station.

### **5.6. Power Setting**

When considering the setting of power supply, it can be considered to use new power generation equipment to replace the traditional generator for power generation, because in the past, the generator not only consumes large energy, but also the exhaust emission will have a great impact on the surrounding environment, which is very contrary to the global concept of green environmental protection. Therefore, it can be considered to erect temporary electrical equipment to ensure the construction power consumption without causing excessive pollution. It is also convenient to improve or dismantle in the later stage, which is very beneficial to the early completion of the project and cost saving.

### **5.7. Expressway Beautification**

Warning signs shall be set at tunnels, overpasses, and other places. If the road leads to the nearby scenic spot, scenic spot signs shall be added, and high-quality architectural sketches shall be set in the scenic spot. The level of plant configuration shall be analyzed, and evergreen tree species and flowers and shrubs shall be selected to ensure the appearance of pedestrians and beauty along the way. At the same time, evergreen trees and flowering shrubs shall be planted in rows on both sides of the road, and the tree species shall be replaced at a certain distance, which shall not be too long or too short, to avoid the driver's visual fatigue.

### **5.8. Set up Intelligent Monitoring Devices Such as Cameras**

Add road monitoring facilities, safety warning devices, distance warning, etc., and non-stop etc toll card points in the whole road section to improve driving efficiency, reduce the occurrence of safety accidents, and realize the intellectualization and rationalization of traffic [21].

## **6. Conclusions**

The rapid development of expressway brings about the increasingly tense environment, ecology and cultural landscape around. It is urgent to implement the concept of green highway and implement the measures of green highway. This paper explains in detail the concept and significance of green highway to its application on expressway, and makes suggestions from the perspectives of intensive saving, paying attention to ecological protection, innovation and more use

of new energy-saving technologies, using natural subgrade, energy-saving design, ecological drainage suggestions on traceless protection and various plant planting methods are made to achieve the purpose of ecological protection. At the same time, suggestions on energy protection are also made from multiple perspectives, such as land resources, earthwork balance, waste soil refilling, life cycle, solar power generation, and tunnel lighting, to improve the highway quality and the concept of biochemical green highway, so that the concept is no longer just suspended in the air and no longer on paper [22]. But to implement practical suggestions, to achieve sustainable development, achieve the harmonious coexistence of roads and nature, and minimize the loss of the environment. The concept of green highway plays an important role in the construction of expressway projects. Only by mastering the core technology and reducing losses in the design process can we promote the green development of highways [23]. I also hope this paper can make some contributions to the future development of green highways.

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