

2014

BioTechnology

An Indian Journal

FULL PAPER

BTAIJ, 10(8), 2014 [2875-2881]

The effect of mountainous area expressway on environment and security control based on biological and ecosystem model

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ABSTRACT

With the social development, change of highway construction concept and the requirement of sustainable development, people put more and more attention on the safety problem of highway driving, and generate more and more demand on visual enjoyment on driving environment. Therefore, the landscape construction of expressway is gradually known by people. However, one the one hand, the design of expressway landscape construction is still in starting stage and lack of systemic method guidance; one the other hand, the large-scale and dynamic expressway landscape construction is bound to affect the weak ecological system of mountainous area and how to take the safety of drive route is still in research. Based on the above background, this paper set up a set of expressway construction method for the mountainous area based on the biological and ecosystem model, including a relative complete environment evaluation, programming, design and theoretical guidance for landscape of expressway. That provides basis for the future relative research and also provides reference for the expressway construction of mountainous area. It is of great guidance meaning and practical significance.

KEYWORDS

Mountainous area expressway; Highway landscape; Safety planning; Color planning.



INTRODUCTION

With the constant development of living level, the basic transportation requirement has not satisfied people. The traffic transportation requirement turns from solving the basic traveling problem at the earliest into problem that whether can provide comfortable, safe, effective and rapid humanization traffic. Highway is required to meet itself traffic function, meanwhile, spirit level function such as comfort, beauty, etc should be paid more attention to. The connotation of expressway development evolves from the emphasis on “safety, pro-environment, lasting, economic ” into new quality view for human creating civilization wealth, emphasizing ecological environment, beautify visual space and inheriting humanistic spirit^[1]. Obviously, the above demands require higher and finer on expressway. Therefore, experts begin to devote to the construction of expressway. In recent years, scholars in our country have achieved more in this aspect. In *Research on the Planning and Design Technology of Expressway Landscape*^[2], Hu Sheng from Chang’an University proposed relative research theory and method on the planning of landscape of expressway and confirmed relative theoretical basis, which provides reference for the later research. In *Research on Route Selection and Evaluation of Mountainous Area Expressway on Pro-environment, Geology and Operation*^[3], Fu Wen from Chongqing Jiaotong University discussed the basic principle, procedure and solution for the environmental route selection and proposed the overall framework, which provides theoretical basis for exploration of harmonious development of environment and human activity and is of great significance.

This paper expanded research in order to make expressway, especially the construction and operation of mountainous area expressway obtain economical and social benefits, reduce the damage on natural environment to the lowest, and realize maximum ecological benefits and security assurance. It adopted system analysis method, defined the definition of expressway landscape, stated the composition and characteristics of expressway landscape, proposed landscape function and objects system, introduced the theoretical guidance of color science on the landscape construction of expressway, concluded the relative research method and put forward the overall frame of planning and design of landscape.

RELATIVE CONCEPT OF EXPRESSWAY LANDSCAPE

Academic world always tries to give the most accurate definition for landscape. However, the recognition on its connotation in different fields has great difference. Aesthetician define landscape as visual value which emphasizes on visual aesthetics, and understand it as scenery; geographers define it as the generic terms of all entity in geological space environment; ecologists think that landscape is the synthesis of ecological system in the perspective of vision; environmental appraisers regard it as landscape environment synoptically^[4]. Since landscape was introduced into highway field, the concept of highway landscape is always not unified. However, we can know that highway landscape is a kind of earthscape created by human, and it contains the physical attributes of landscape characteristics such as shape, size, color, etc as well as the spiritual attributes of humanistic characteristics such as history humanities, social economy, visual psychology, pictorial symbol by the induction of understanding of most people. Nowadays, the beauty of road has become one of the standards of contemporary fine life. It shows unique region characteristics and artistic style, embodies the material civilization and spiritual civilization of age progress and represents people’s desire and pursuit for beautiful thing^[5]. The purpose of highway landscape construction is to create a unique traveling experience and high-quality drive space for travelers and local public by maintaining, protecting, understanding and improving the inherent ecological environment along the highway, better represent the landscape characteristics of culture, history and region, and make highway into comprehensive environmental landscape integrated ecology, landscape, entertainment, aesthetics, culture, etc.. As the widest subsystem of the whole road system, the development of expressway is bond to evolve to the above aim direction. The definition of its connotation and characteristics can easier clear the development object, and thus lay foundation for the construction of expressway.

LAYOUT PLANNING OF EXPRESSWAY LANDSCAPE

Components of expressway landscape

Expressway landscape is mainly composed of natural landscape factor, human landscape and highway engineering itself.

(1) Natural landscape element

As the primordial landscape, natural environment is the texture and background of expressway landscape and performs decisive effect on highway linear layout and landscape effect^[6]. Natural landscape resource is the product that forms by synthesis of many geological environmental elements and factors. Among them, the most important factors are landform, water, astronomical phenomena, season, plants etc.

(1) Landform

As we all known, landform is the basic framework of natural landscape form. It is the basis of planning and design of expressway landscape. Other design elements rely on landform or related to it more or less. Landform determines the tendency and roadside environment of expressway and performs decisive effect on the design of highway landscape. In detail, the function of regional landform is as shown in TABLE 1:

TABLE 1 : The functions of landform

Functions	Concrete content
Function of landscape skeleton	Landform is the carrier basal plane of expressway design factor
Function of space composition	Landform is applied to control sight to compose different space types and spatial series.
Function of background	As the background of scenery, landform can set off main feature, increase depth of field and enrich landscape.
Function of landscaping	Landform has unique aesthetic characteristics and can use its form to realize landscaping.
Function of viewing	Landform can create good viewing condition and strengthen the focus function of landscape.
Function of engineering	Proper landform is good to linear geometric design, drainage and landscape engineering.

(2) Water

Water is the factors that contain vigor and change in highway landscape. It can form many wonderful beauties when blended with landform, organism, season, climate, humanity, etc. Highway landscape with water will become vivid and brings people eyeable beauty.

(3) Astronomical phenomena and season

Astronomical phenomena is the natural phenomenon that formed by astronomy and weather. The common astronomical phenomena are sunrise and sunset, rosy clouds, mist, seasonal aspect, etc.

An astronomical phenomenon has the most unreal aesthetic feeling in all landscape elements through visual experience. In design of highway design, people can use plant collocation to create pleasant expressway landscape according to different season, and thus brings comfortable drive environment^[7].

(4) Plant landscape

Plants with vitality are the most changeable factor in landscape, which can bring people nature consciousness and vitality. Besides traditional function, landscape performs very important role in construction of landscape. The function is as shown in TABLE 2:

TABLE 2 : The functions of plant in landscape design

Functions	Concrete content
Space construction function	Plant can shrink or widen space to form different spatial series by sight control.
Ornamental function	To create artistic conception and strengthen ornamental value of highway landscape by size, form, color, texture, etc of plant.
Ecological function	Maintain ecological balance, protect environment and beautify road environment.

(2) Human landscape element

Human is the crystal forms by accumulation, development and sublimation in long term historical development. It has obvious regional features. Although human landscape is the secondary landscape of expressway, it continues and adds the artistic conception and feature for region, reserves the memory of history, and represents the respect for history. In addition, human landscape preforms function of making the finishing point in the whole landscape of expressway.

(3) Highway engineering element

The elements of expressway engineering refers to the components of highway within land acquisition scope, including landscape system of expressway mainline, that is, highway mainline (route, road surface, medial strip, etc.), structures (overpass bridge, interchange, bridge, tunnel, etc.), green plant, side slope, etc; landscape system for expressway auxiliary facilities: information facilities (mark line, orientation guidance map, escutcheon, etc.), service facilities (toll station, service area, etc), safety facilities(anti chord board, guard bar, street lamp, etc.); last is the artistic landscape: sculpture, flower bed, art sketch, side slope mural, etc..

Safety planning of expressway

Safety planning of expressway can considered from the following two aspects: one is route selection: in the condition of meeting the demand of environment protection, route selection should consider the design of up and down wave road segment. TABLE 3 is the standard of Chinese highway engineering technology

TABLE 3 : Maximum longitudinal slope and minimum slope length

Design speed (km/h)	120	100	80	60	40	30	20
Longitudinal slope (%)	3	4	5	6	7	8	9
minimum slope length (m)	300	250	200	150	120	100	60

Second is the construction of landscape facilities: on the one hand, landscape design can make purposeful protection for the surrounding ecological environment; on the other hand, landscape environment design can avoid bringing damage for the surrounding environment in engineering project or can prevent the natural danger. The main means adopted is obstruction, semi-obstruction, dissuasion and warning. Obstruction is to positively control the behavior of people and passage of cars, to set obstruction facilities for ensuring the safety of human and car, such as setting green barriers, guard bar, etc. Semi-obstruction facilities is to create difficulty on behavior through the change of ground material or the change of height, and thus performs the function of advise on cars, such as colored pavement, vibration warning belt, etc.. Warning is to directly make use of the prompt function of words and sign to warn the activity boundary of people and cars and alert the danger.

PLANNING AND DESIGN OF EXPRESSWAY COLOR

Color is the important components of expressway landscape quality and the important carrier for the nature and humanity of road area. Good color design can make highway represent elegant, harmonious, comfortable, culture-filled road area environment. However, the bad color design can make highway lost beautiful visual effect, and sometimes can heavily affect the mentality of road user, which will lead to the safety problem of drive. Therefore, we should scientifically and strictly design the color component in expressway landscape.

Psychological effect of color

Color can affect the psychology and emotion of people. Russian scholar Kandinsky divided color phycology into direct psychological effect and indirect psychological effect. Direct psychological effect refers to the direct effect of color's physical stimulation on physiology of people, such as warm and cool feeling, weight sense, sense of dimensions and swell-shrink feeling. Indirect psychological effect is to take association of color as medium, then conduct to people's feeling, and thus induce the change of emotion. TABLE 4 is the indirect psychological feeling of color:

TABLE 4 : Indirect psychological feeling of color

Color	Warm color	Kindness, delight, activeness, enthusiasm
	Neutral color	Peace,common, harmony
	Cool color	Gloom, sadness, loneliness, deep think, tranquility
	Single color	Pure, seriousness
lightness	high lightness	Brightness and clearness, brisk, lightful
	medium lightness	steadiness
	Low lightness	Depression, heavy, deep
Saturation	High saturation	Gorgeousness, freshness, progressiveness
	Medium saturation	Steadiness, happiness
	Low saturation	Simplicity, elegance, conservation
Lightness and saturation	High lightness and low saturation	Tenderness
	Low lightness and high saturation	Strong

Planning method of expressway color

Planning of expressway color is based on the policy of totality to subsection, primary to secondary and combination of dot and line. First, the logo color of landscape unit is confirmed and then the color design of landscape element is conducted according to logo color and specific area.

(1) Selection method for logo color of landscape unit

Color of expressway can be regarded as a system. Therefore, the selection of logo color can follow the following procedures:

- 1) In the perspective of the whole road area environment, study the component factor of environment, architectural color, folk culture and national color as well as color aesthetic psychology and confirm the regional representative color system.
- 2) Compare the color selected in the beginning with the surrounding environment of highway. Use exclusive method to eliminate the color that is unharmonious with the natural environment or conflict with the traffic warning color.
- 3) Then use comparison and harmony rule of color, visual perception rule and the relationship of dimension and color landscape impression to confirm the logo color of road landscape according to the basic principle of color.

(2) Color design of landscape element

1) Color of tunnel and barricade

Color of tunnel and barricade is composed of abundant hue and belong to semi-natural color. For the color design of tunnel and barricade, we should select the material that is close to logo color as possible. Wall surface is transited by small area of medium gray material or plant, as shown in Figure 1 and 2:



Figure 1



Figure 2

2) Coating of bridge color

Coating color of bridge belongs to artificial color. Design principle should according to the surrounding environmental color and color of landscape unit. The main hue of bridge should be simple and quietly elegant. Meanwhile, small area of hue with high lightness is adopted for comparison to breakthrough the overall monotony.

3) Colored pavement

Colored pavement should be set on the special road segment such as tunnel portal, front and back of main line under Overpass Bridge, interchange, parking lot, toll station, etc for safety considerations. Its main function is to stimulate vision of drivers by color, and thus to improve the attention and vigilance and reduce accident.

4) Planting color

Color of plant landscape should pay attention to the coordination of plant color, the color coordination between plant and highway element and the color coordination of plant and logo color system. And too much different color system and chaotic arrangement should be avoided. In addition, selection of planted species should primary in local wildlife in order to make color more coordinating with the surrounding environment and logo color system^[8].

DISCUSSION

Design of expressway landscape is an important premise for constructing mountainous area expressway based on the model of biological ecosystems. This problem has gradually drawn people's attention. Research on planning, design and evaluation is still in the starting stage. This paper made a preliminary discussion on the planning and design as well as evaluation of expressway landscape in order to construct a set of mountainous area expressway model based on biological ecosystem, defined the connotation of expressway landscape, proposed the landscape function and target system, and make subject theory such as landscape ecology organically corresponding to the planning and design of expressway landscape. Based on that, it analyzed the component element in landscape, considered the safety planning problem of expressway while meeting environmental protection, analyzed from the aspects of route selection and landscape facilities, designed a set of expressway landscape design plan taking safety and beauty into account combined with color planning. That can have positive effect and help on design improvement and construction plan of road landscape.

ACKNOWLEDGEMENT

There is the National Natural Science Fund Project (51278514).

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