

Maintenance and Management of High Slope of the Mountain Expressway

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Abstract: In order to effectively reduce the incidence of expressway operation safety accidents, one should pay attention to expressway safety management, especially high slope maintenance and management. In conjunction, with the current situation of operation safety management of some expressways, many mountain expressways have high slope incidences from time to time, due to the extension of operating time, and inadequate maintenance management. Moreover, vehicle damage, and human death accidents caused by the high slope collapse, landslide, debris flow, and other disasters are often reported. Therefore, it is essential to strengthen the maintenance and management of high slope in the mountain expressways. This paper, will further elaborate the issues, which are related to the maintenance and management of high slopes in the in mountainous expressways.

Keywords: Expressway; High slope; Disease; Maintenance management

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1. Introduction

Expressway system, is one of the most important infrastructures in China's contemporary social system, which directly influence the country economic development, as well the life safety of the travelers. Therefore, it is important to give priority to the maintenance and management of high slope in the expressway in the mountainous areas, to reduce the disease risk of high slope, further to ensure the smooth the expressway operation. Thereby, the relevant maintenance units and managers should understand their responsibility, the possible types and causes of high slope diseases, and lastly try to eliminate all the possible safety risks in a short duration, by applying a series of safety and maintenance measures.

2. Connotation of high slope maintenance of expressway in mountainous area

The high slope maintenance of the mountainous expressway refers to the application and implementation of the relevant technologies, to ensure that the high slope remains stable. The high slope maintenance of mountainous expressway can be divided into daily and regular maintenance, further, can be divided into preventive, restorative, special, and emergency maintenance ^[1]. In order to improve the safety of the expressway operation, the maintenance unit, and the management staff should analyze the conditions of the high slope, which is under their jurisdiction by scientifically formulate the maintenance and management plan, and lastly, work with the attitude of being responsible for themselves and the society, to ensure the stable, and reliable operation of the expressway system in the mountain area.

3. Types of common diseases on high slope of expressway in mountainous area

In order to disturb the earth structure and destroy the ground balance during the expressway construction stage, the stability of the earth and rock is significantly reduced. Therefore, under the stimulation of external forces, natural disasters such as landslide, collapse and debris flow are easy to occur, which is also the main type of high slope diseases of expressway in mountainous areas.

3.1. Landslide

Landslide, refers to the phenomenon of high slope, slope, rock, and soil sliding along the weak surface under the action of gravity. The main reason for the landslide of the artificial slope, is the poor stability of the foundation at the foot of the slope. Further, due to the infiltration of a large amount of rain, the water in the earth rock layer on the slope become saturated, causing the pounding of the water resisting layer at the lower part of the slope, resulting an increase in the weight of the sliding body, and further, decrease its shear strength, thereby, causing the phenomenon of landslide (**Figure 1**). Additionally, under the long-term scouring action of rain, and increase in the degree of lameness, and weakness, causing the artificial slope to unable to bear its own weight, resulting in the overall sliding, which poses a serious threat to the safety operation of the expressway at the end stage. Therefore, engineers try to avoid the mountains geological sections, when designing the route for expressway, however, in certain situation, where this are cannot by eliminated, scientific reinforcement treatment should be planned, and carried out during the expressway designing and construction [2]. During the expressway construction, most of the construction enterprises do not strictly follow the reinforcement, or high design standards, to reduce or to minimize the construction cost, further, the construction enterprises unable to provide the maintenance help [3].



Figure 1. Photo of landslide during project construction

3.2. Collapse

The collapse disease often occurs in the road section, with steep slope greater than 30°. A large slope of the high slope, will cause the rocks and soil on the slope to be subject to instantaneous brittle failure, along with the cracks in the Eluvium, due to the underlying rock stratum with shallow weathering and the weak surface **Figure 2**. The collapse disease of expressway in mountainous areas is often happen suddenly, which may pose a threat to the safety of the mountain expressway operation. When the collapse occurs, it will lead to the interruption of expressway operation, and increase the vehicle load for other sections, resulting in serious traffic congestion, and adverse impact on the regional economic development, and logistics transportation. In the worst-case scenario, people, and cars can be smashed and buried under the collapse, leading to tragedy [4-5].

3.3. Debris flow

Debris flow refers, to a large amount of water and sediment discharged from the upper slope to the lower slope of the expressway in mountainous areas. The debris flow disease often occurs in the adverse geological zones, such as, the junction of the flood or landslide. Further, the damage caused by the debris flow is low, where the damage is limited to the regional surface vegetation. Therefore, a bypass scheme, is often used in the practice of highway route selection, however, in a situation where, a bypass scheme could not be built, the vegetation protection, waterproof, and drainage design should be strengthened, to control the risk of debris flow on a high slope from the source [6].



Figure 2. Photos of debris flow and collapse at the project site

4. Analysis on main inducement of high slope disease of expressway in mountainous area

There are many factors, such as, topographic and geological changes, design defects, unreasonable construction, and inadequate maintenance, which can cause high slope diseases of expressway in the mountainous areas, subsequently may have a direct impact on the operation safety of the expressway.

4.1. Topographic and geological reasons

In the process of expressway construction, the formation, and creation of slope is unavoidable, due to the geological conditions of mountainous area, especially, for expressway projects that are located in the special geological zones. In a karst landform, where the rock mass itself is not strong, where, the rocks and soil are broken, and there are many cracks in the landform. Further, the strength of the soil will gradually decrease when rainwater seeps along the cracks. Additionally, the karst landform can also be affected by the external factors such as exposure, weathering, and frost, therefore, the slope stability will further reduce, leading to serious diseases such as debris flow, collapse, and landslide [7-8].

4.2. Design reasons

During the construction of expressway project in the mountainous areas, the preliminary preparations, have an important impact on the overall quality of the construction project, therefore, the design unit should perform a comprehensive survey according, to the site geological conditions, before formally start the construction work for the project, and also understand the local hydrology, climate environment change, and the geological disaster distribution, by analyzing the local archives, to ensure the scientific and feasibility of the design scheme [9]. However, in an actual situation, the survey often is not sufficiently conducted, therefore, the prospecting construction work could not reflect the actual situation of the site, leading to the discovery of many local geological data inconsistent with the actual site during the construction process. Further, the bad geological areas frequently appear in the later stage of construction, because lack of geological risk assessment, and no advance formulation of an emergency treatment plan,

resulting in an increase in the safety risks of the construction work.

4.3. Reasons of the owner

Strengthening the quality control in the construction process, is the basic route to ensure that the disease risk of expressway in the mountainous areas can be effectively controlled. However, in order to meet the due date, and to control the cost, many construction enterprises, did not effectively built a strong high slope during the project construction, resulting in an increase in the high slope disease risk ^[10].

4.4. Construction reasons

During the construction work of excavation or unloading, the mechanical balance of the slope is damaged, coupled with the hardness of external irresistible factors, the stress in the slope changes, resulting in the loosening, and translation of the slope. Further, some construction enterprises blindly rush the construction period, reduced the cost, arbitrarily change the design slope rate, and do not strictly follow the requirements of the design specifications after the completion of the high slope, subsequently resulting in the damage of the slope quality, leading to a series of high slope diseases ^[11].

4.5. Reasons for curing

After the completion and delivery of the mountainous expressway, it needs a long-term maintenance treatment to ensure the overall safety, especially, in the high slope section, due to high risk of disease. If the mountainous expressway did not maintain for a long duration, the risk of high slope disease becomes greater, however, many enterprises did not give priority to the maintenance and management of the mountainous expressway, due to lack of understanding and knowledge of the hazards of high slopes. Therefore, the maintenance of the mountainous expressway did not perform properly, where some small diseases were not handled in time, leading to serious diseases broke out, which can be threatened to the driving safety ^[12].

5. Maintenance and management measures for high slope in the mountainous expressway area

Scientific and efficient maintenance management is an important way, to ensure the safety operation of the expressway, and to prolong its service duration. In the maintenance stage of the expressway high slope, it is essential to implement the maintenance inspection system, strengthen the prevention, and treatment of various early high slope diseases, establish a separate maintenance management account, establish a perfect emergency system, and give extra attention to the information related to the high slope maintenance technology, to improve the stability of high slope.

5.1. Implement the system and efficiently perform the maintenance, and inspection of the high slope of expressway in the mountainous areas

As mentioned above, high slope diseases of mountainous expressways have a significant characteristic of uncertainty and diversity. Therefore, when the expressways are delivered and starting its operation, a reasonable inspection system should be formulated in conjunction with the types, and characteristics of high slope diseases, further, responsibilities should be clarified, and implemented in the practice of high slope maintenance and management, to ensure the orderly progress of the inspection work. The patrol inspection of high slope maintenance can be divided into daily, regular, and special inspection ^[13]. The inspection practice, inspection methods, and the frequency of the inspection should be decided based on the different road sections, where the daily inspection is mainly for the road sections with low disease risk. The inspection personnel should use visual inspection, and relevant simple tools during the inspections. In the daily inspection work, there few things that should be performed as described below:

- (1) Strengthen the maintenance of the interception and drainage facilities: If the high side skin is eroded by rainwater, and the surface were covered with water for a long time, its stability, and anti-sliding ability will be inevitably decline. Therefore, during patrol inspection, it is essential to do a good job in the maintenance of drainage facilities, by cleaning the sundries in the equipment to ensure smooth drainage.
- (2) Weed removal: Weeds in the drainage can easily block, and cover the ditch, which can cause inconvenience to the later inspection work. Therefore, the weeds in the ditch, should be removed on time.
- (3) Remove suspended stones and pumice: Patrol inspectors should give special attention to the sections that are protected by the flexible protective nets, and the high slopes that are covered by climbing vines, to check if there is any are pumice or hanging stones. If there are any, they should be cleaned immediately to eliminate hidden danger.
- (4) Vegetation maintenance: The reason why green plants are planted on the high slope is to use the roots of the developed vegetation, to further stabilize the slope, and to reduce the risk of soil and water loss and also to avoid the occurrence of debris flow. For high slopes with poor geological conditions or poor construction anchor cables, the frequency of patrol inspection should be increased. In case of severe weather such as, typhoon, and rainstorm, the patrol inspection should be strengthened, and the inspection should be organized immediately after the rain.

Regular inspection refers, to the inspection conducted by patrol inspectors through visual inspection, and monitoring by using the professional equipment and instruments, which is generally performed not less than 2 times in a year. For the high slope disease prone section, the special inspection should be adopted, the cause of the disease breakout should be clarified with the help of relevant advanced testing equipment, and finally, targeted maintenance and management measures should be formulated, to ensure the overall quality of the mountain expressway is in accordance with the requirements of the highway safe operation [14].

5.2. Strengthen the prevention, and treatment of various early diseases of high slope

When it is found that there is an early disease risk in the co-promotion of the high-speed in mountainous areas, scientific methods should be taken on time, and related industry can be hired to evaluate, and formulate a scientific, and feasible prevention method. Meanwhile, if multiple diseases are found on the high slope, the disease severity shall be investigated in more detailed, followed by preventive treatment in a planned way according to the specific conditions of the disease. There is a popular saying in the industry where, ‘controlling slope and water first,’ which is sufficient to explain the impact of groundwater and surface water on the high side of expressway. First of all, the drainage design of surface water and groundwater of high slope should be improved to prevent the slope from being soaked by water, which can weaken the slope toe, leading to natural disasters such as landslide, collapse and debris flow. Secondly, the overall stability of the slope should be improved, by setting platform water distribution ditch, intercepting gutter, and planting vegetation, and finally, the reinforcement of the original slope [15]. The sliding, or hollowing slope body may cause slope filling, therefore, a steel wire should be installed on the outer surface to block, and to prevent the filler from falling, meanwhile, the slope with cracks should be repaired, and reinforced. Crack is a common high slope disease of mountainous expressway. Once, the crack problem occurs on the high slope of the expressway, and the deformation of slope structure occurs under the action of rainwater erosion, a scientific and effective technical means should be taken immediately to avoid the further expansion or progress of the disease. In the practice of mountainous expressway high slope maintenance, the repair scheme should be scientifically selected in the combination with the specific situation of crack, and the relevant materials with strong adhesion should be filled into the cracks, to avoid the continuous infiltration of the precipitation.

5.3. Establish maintenance management account

Establishing the maintenance and management account for high slope of mountainous expressway, is the most effective way to reduce the disease risk. After focusing on the troubleshooting of high slopes, the maintenance management personnel should establish maintenance accounts, according to the specific conditions of each high slope, by clearly marking the various basic information, and further, evaluate the inspection results, to fully understand the hidden dangers, and diseases of high slopes, as well to quickly formulate emergency the treatment plans ^[16].

Additionally, the expressway maintenance management unit should formulate, and divide a clear responsibility system to each personnel, to encourage the positive, and a responsible attitude, of the personnel when performing the daily and regular inspection, to ensure that the expressway is always safe and stable state to use.

5.4. Establish a perfect emergency system

To prevent being in a rush when an emergency occurs, the maintenance management unit shall establish a perfect emergency system, and rescue brigade, to deal with the emergency situation calmly. Further, sufficient emergency materials should be reserved, and keep to ensure the smooth traffic, and to ensure the availability of the essential rescue materials and mechanical equipment, so that help be called directly in the case of danger ^[17].

5.5. Pay attention to the information management of high slope maintenance technology

Modern expressway high slope maintenance needs to strengthen the application of scientific and technological informatization, and formulate scientific maintenance plan, further, implement it in the management procedure. Scientific and technological information technology can be used to collect, and to integrate data and to build corresponding technical platform, to promote the implementation of mountainous expressway development strategy ^[18]. While, the software and hardware construction of the information system, should be combine with the requirements of the network technology to ensure the compatibility of the platform, further promoting the smooth development of the expressway high slope maintenance and management. Additionally, the same time, the integration of information resources, and data sharing should be strengthened to break the status quo of information island of traditional technical personnel, centralized management of business, subsequently promoting the implementation of conservation work.

6. Conclusion

In summary, the expressway high slope maintenance, is influences by many factors, such as natural climate, self-weight, and vehicle load factors, resulting in the development of various high slope diseases, therefore, it is essential to give priority to the maintenance of the expressway high slope, thereby, improving its overall quality, and promoting the orderly development of expressway safety management.

Disclosure statement

The author declares no conflict of interest.

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