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HIGHWAY TUNNEL DISEASE RESEARCH

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***Abstract*--Mainly introduce the main type of tunnel disease and treatment plan, at the same time suggestions are given for the design and construction of existing tunnel. This can prevent the appearance of tunnel diseases and improve the service life of the tunnel.**

***Index Terms*— tunnel; disease; cracks ;Water seepage**

I. INTRODUCTION

1 Centralized type of tunnel disease

At present the most centralized type is the lining of tunnel cracks and water penetration.

1.1 Lining crack

Lining cracks mainly appears in the area of low foundation bearing capacity , the rock crushing, loess area and mining coal , as shown in figure 1. Cracks in tunnel lining, the increasing number and width of cracks will soon affect the safe operation of the tunnel.

Figure 1 lining crack of a tunnel (Mined out area in the low of the tunnel)

1.2 Tunnel seepage

Tunnel seepage is the most common tunnel disease. The water on the road not only affect driving safety , but also affect the stability of tunnel structure in a long term .Lining seepage causes lining freeze in the north , drop in the car or on the road as in figure 2 will cause a cash tragedy . Therefore, tunnel seepage in the north is particularly important.

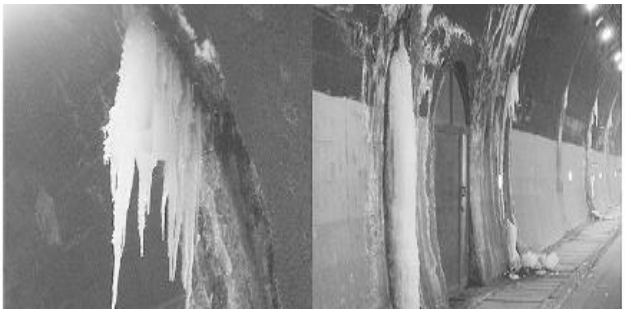

Figure 2 The lining freeze of a tunnel

2 Tunnel diseases cause analysis

2.1 lining crack

The emergence and development of tunnel lining crack is influenced by many factors[1].

2.1.1 construction

There are mainly three construction factors lead to tunnel cracks :the first one is lack of lining thickness that cause the growing pressure of the surrounding rock. The lining is not sufficient to support the pressure, leading to the lining cracking. The second one is that lining construction is not real. Concrete construction is not real near and both sides of construction joints , concrete blocks are rough. These make lining cracks near construction joints and cellular grinding on the lining concrete surface. The third one is that construction method is not reasonable and material properties of concrete itself and the outside temperature cause cracks near construction joints. Pouring arch department directly without handlling construction vault and these make a small gap between vault and arch waist that develop into the cracks finally.

2.1.2 design

Some tunnels have to pass the mined-out area during design considering terrain and construction cost. Mined-out area get treatment before tunnel construction . The distribution of mining goaf disorder and treatment effect is limited and thus bury a hidden danger to the tunnel disease development after. For example , in a coal dedicated highway tunnel disease treatment , serious deformation of tunnel lining and many occurred dislocation appear by the influence of mined-out area , and cracks more than 2 cm at its widest point . Serious lining block out appear in local vault and side walls , because maintenance management department did not handle in time[2].

2.1.3 geological factors

Geological factors in the tunnel disease is not very prominent . But there are special circumstances such as some bias area , biasing force change because of man-made or natural reasons after and lateral pressure grow , these cause change of lining stress of tunnel and lining cracks.

2.2 Seepage of tunnel lining

The main reason of the tunnel lining seepage is construction.

2.2.1 construction reason

At present, the construction process of the tunnel is extensive and management of important construction link in tunnel is not in place. These bury a hidden danger to later diseases. The influence of construction process is mainly in the following two aspects.

2.2.1.1 Management is not in place

The most likely appeared problem is welded joint of waterproof board and installation of the lining of the joint in installation of tunnel waterproof facilities. In the construction of these two weak links , there are less technical personnel of construction unit and supervision personnel side , and seldom go to check the construction quality after waterproof facilities installed . The steel nails or thin steel nail in waterproof board directly in order to facilitate central steel construction in subsequent secondary lining.That is to say waterproof board has been destroyed during construction. Some of the construction team do not install the water stop in lining construction joints .The drainage pipe is not closed on both sides of central inspection well and concrete flow directly into the drain because of the poor management , and thus the entire central drain is blocked[3]**.** Eventually leading to the water behind tunnel lining can not be discharged . As time passes, water seepage from the weakest area of construction eventually with elevated water level .

2.2.1.2 construction level is uneven

uneven technical level of construction team and low quality standards bury a hidden danger to tunnel seepage. Some of the construction team has just begun to engage in tunnel construction and workers is relatively unfamiliar on the construction process. These cause the randomness of the construction. There is a bubble at the seams of the waterproof board which form the passage of the post stream and such examples are too numerous to mention.

3 tunnel disease treatment

3.1 tunnel crack

Cracks appear in the tunnel and do not rush to treat. Use professional monitoring equipment such as crack detector for deformation monitoring . At the same time, the settlement observation points are set up in the vault and the side wall of the tunnel(The scheme is only used in the loess area,breaking area at the bottom of tunnel surrounding rock , and the area of the coal seam[4]). Methods are divided into the following several kinds of treatment.

A when Lining cracks no longer change , epoxy resin structure agent is only taken to block lining crack.

B Crack is still in low development, observation is recommended. Until cracks no longer develop and not affect driving safety , epoxy resin structure agent is only taken to block lining crack.

C Cracks develop fast , and will soon endanger traffic safety, disease treatment should be taken immediately. In the case of tunnel clearance permit, I-beam and reinforcement net is taken to reinforce and then spray concrete finally. At this time , encryption I-beam should be taken to avoid the reemergence of the lining cracks.When tunnel clearance is limited , colse the tunnel immediately and dismantle the original lining(temporary support should be done on both sides during dismantling and cross section is not too large), remake the tunnel lining and set up in the new I-beam lining when necessary.

3.2 Tunnel seepage

A To clear the surface and make a waterproof layer by clay to prevent surface water from sinking into the tunnel while seepage water come from surface.

B when seepage water come from underground, laying drainage pipe on tunnel lining and seal cracks at the same time for secondary lining of plain concrete, grouting and seal cracks and laying drainage pipe on tunnel lining for secondary lining of Reinforced concrete[5] . In the case of tunnel clearance permit, relay waterproof facilities is considered,when seepage is very serious.

Tunnel lining seepage is dual effects of surface water and groundwater. More than two kinds of roof and inside treatment plan can be used comprehensively.

In front of the tunnel water seepage treatment, detailed investigation should be made and the source of groundwater should be find out . In this way we can design plan of well directed disease treatment. For many domestic water seepage tunnel, in a short period of time, there is a seepage again after the completion of treatment, because the disease investigation is not exhaustive. This treatment is not only the economic waste and it will affect the stability of the tunnel[6]**.** In disease investigation, survey and design units should call more than some of the hydrogeological expert on-site guidance and some detection methods should be used to detect.

4 Advice

4.1 Suggestions for tunnel design

Recommend for easy to cracks, less bearing capacity in the area at bottom of tunnel , thickness of the inverted arch should be increased. In some of the goaf area, mining goaf treatment should be made before tunnel construction and during construction , secondary treatment should be made for the hole area that the

treatment effect is not good . If necessary, length of the tunnel radius is suggested to be increased by 30cm . Set of arch is the most effective solution ,once a larger tunnel lining cracking appear[7]**.** At present a lot of mined-out area on either side of the highway tunnel is still in exploration, according to the relevant specification, the safety of the tunnel line is given to ensure the safety of the tunnel during design.

Number of circumferential drainage pipe for that easy to appear serious water seepage of tunnel is suggested to be increasted. To prevent the limestone scale blocking pipe，diameter of circumferential drainage pipe ,longitudinal drainage tube and transverse water diversion pipe for gray area is suggested to be increasted. Plastic pipe plug is designed at both ends of the central drain pipe. To prevent the the same construction way , reasonable suggestions about antiglare facilities structural design, form selection, environmental applicability, and coordination of highway landscape are put forward from cost of whole life cycle, operation and maintenance and landscape design . So that function, landscape function of antiglare facilities are better reflected .

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