

# The Water Damage and Prevention Measures of Bituminous Pavement

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## Abstract

In recent decades, asphalt pavement has been widely used in many countries around the world because of its many advantages. However, in the course of operation, there are different degrees of water damage on asphalt pavement. It brings great challenge to the integrity of asphalt pavement and traffic safety. This paper introduces the background of water damage of asphalt pavement, including the mechanism, causes and prevention measures, and has a very important significance for engineering practice.

## Keywords

Asphalt, Pavement, Water damage.

## 1. Introduction

With the development of national infrastructure, and the successful practice of materials technology and construction projects, the asphalt pavement in our country has experienced a large scale construction in recent decades. Due to outstanding mechanical properties of asphalt pavement, sound absorption and noise reduction, the rapid construction of a series of advantages, such as the favor of the engineering industry. But the traffic volume increasing, the increase of axle load, vehicle channels, plus various temperature conditions, by the permanent deformation, low temperature and fatigue cracking caused by loss of pavement function leads to the reconstruction and maintenance costs also increased year by year. Especially in the asphalt pavement and after the operation of the process, there are different degrees of disease, these diseases form a different, through the study found that these diseases are related to the role of water. The water damage of asphalt pavement is greatly reduces the road performance, influence the way with good driving experience and driving safety. At the same time, these diseases also need to invest huge amounts of money, caused great social and economic burden. Therefore, it is necessary to study the water damage of highway asphalt pavement, and it is also a very theoretical and practical significance.

## 2. Research status at home and abroad

### 2.1 Current research situation in foreign countries

The water damage of asphalt pavement is a very common problem. At the beginning of the asphalt pavement, people begin to pay attention to this problem in engineering practice. The United States has been concerned about this issue from the beginning of 1930s, through the research and development of asphalt mixture of water damage experimental method, and has been a good application. In 1949, the effect of water on the bond performance of asphalt was further studied, and the relevant experimental basis (D1075 ASTM) was established, and the experimental method was modified in 1988. After the revision, the evaluation index was changed, and the evaluation method was the strength ratio of the water before and after immersion. For evaluating the effect of water on the spalling of asphalt film, in 1985, the United States adopted the D1664 ASTM experimental method. Through the determination of the coating and stripping of asphalt mixture, the effect of water on the asphalt coating was given. But because this method is too simple, the test accuracy is poor, so it is only used to determine whether the asphalt binder is qualified. In 1964, the national highway and Transportation Association (AASHTO) through the test shows that the surface structure of the road

after immersion in water, the damage to the pavement structure of the car to enhance the damage to more than 40 times. In 70s - 80s of the 20th century, in the National Cooperative Highway Research Program (NCHRP) and U.S. highway planning and research programs HP&R, United States Strategic Highway Research Program (SHRP) and the federal highway administration study contracts for water damage of asphalt pavement are extensive and in-depth research, these studies include damage mechanism, cause of formation, evaluation method and prevention and control measures, in a large number of experiments and obtained on the basis of sufficient data to support the, released many research reports.

## 2.2 Domestic research status

The study of asphalt pavement water damage in our country is late, in the early 1990s, in view of the anti water damage ability of the asphalt mixture, put forward the evaluation index of freeze-thaw splitting strength ratio and residual Marshall stability. The Chongqing Highway Research Institute of the Ministry of communications in detail introduced the United States commonly used 9 kinds of asphalt mixture water damage test method[1]. On the basis of this, the advantages, disadvantages and the application of various test methods are summarized, and the ASTM and D4867 AASHTOT-283 are recommended to be used as the experimental basis for the evaluation of water damage. The early water damage of asphalt pavement of semi rigid base course was studied systematically by academician Sha Qinglin of the Ministry of communications of Highway Science Research Institute[2]. Based on a large amount of water damage of asphalt pavement in our country and the experimental data, the influence factors of water damage are summarized. The main measures to prevent water damage are given from the point of view of design and construction:

- 1) The asphalt concrete with no more than 5% of the asphalt surface layer is not more than of the asphalt concrete.
- 2) Improve the bond strength of asphalt and mineral aggregate.
- 3) Improve compaction standards, increase the site air rate index.
- 4) A drainage layer or a waterproof layer is arranged in the pavement structure.

## 3. Water damage of Asphalt Pavement

### 3.1 Definition of water damage of Asphalt Pavement

Water damage of asphalt pavement refers to the surface water and rain water through the pore structure, and is attached to the boundary of asphalt and binding material after the opening of the project[3]. In the load and temperature together under the action of repeated, asphalt film with time gradually from, destroying the integrity of the structure, pavement structure carrying capacity declined, and the emergence of clamorous pulp, potholes and rut and disease.

### 3.2 Mechanism of water damage of Asphalt Pavement

The process of asphalt stripping from the aggregate surface is quite complex, although many scholars have a lot of experiments and data reference, but there is still no unified conclusion. In academic circles, it is in favor of the process that the spalling of asphalt film is the process of replacing the asphalt membrane with the water in the mixture. Its duration is characterized by the adhesion of asphalt and the ability of the mixture to resist water. Is R. Brown Lew through the test to get a similar conclusion. The asphalt mixture into the water for a period of time, the water will penetrate the asphalt surface, rely on their own penetration, gradually make the asphalt film off. The whole process is shown in figure 1. Frazier. Par-ker and J.J. Fromm, as well as H. P lancher et al. Research has also reached a similar conclusion.



Fig.1 Spalling process of asphalt film

The asphalt stripping process, the American asphalt Association (AI) conducted a more in-depth study. Taylor and Khosls, such as the stripping of asphalt film is divided into tear, replacement, instant emulsification, clearance pressure, hydraulic erosion, etc[4]. Specifically, there are the following models:

#### Asphalt membrane movement

After the water is immersed in the mixture, the structure forms a three phase system, which is composed of asphalt aggregate water. Under the influence of the external factors, the water is filled with the aggregate surface, which urges the asphalt film to fall off, and the final moisture completely.

#### Separation of asphalt membrane

Between the water between aggregate and asphalt, if eventually inside the pavement structure completely dry asphalt can still and aggregate is connected. But in the presence of water and asphalt pavement under various external effects will exacerbate the segregation of mixture, while undermining the overall structure of the asphalt mixture.

#### Asphalt membrane cracking

Asphalt film on aggregate coated is not absolutely uniform, in the set of edges and corners at material, the thickness of asphalt film will change, asphalt film from the aggregate surface glabrescent, once under the effect of repeated traffic loading, then aggregate near the edges and corners of asphalt film will rupture, water more easily enter and accelerate the process and has been circulating, until the asphalt pavement structural damage. This process as shown in Figure 2.

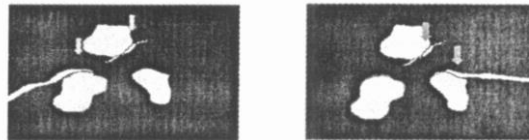


Fig.2 Cracking of Asphalt membrane

#### Foaming

At higher temperature, asphalt bonding ability will decline, at the same time, because of the role of water vapor in the pavement structure, pavement surface will form bubbles, while the water is easier to enter, caused by further asphalt off.

#### Bond failure

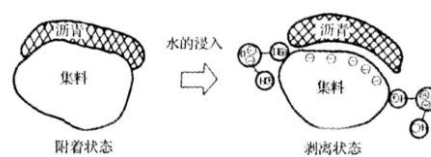


Fig.3 Loss of asphalt film

Water, destruction of the microstructure of the mixture. In the mixture of asphalt and aggregate and water, because water film and the asphalt membrane also negatively charged, asphalt film will get further rejection. This principle will accelerate the separation of the asphalt film until the bond force completely disappeared. At the same time, the mixture of water will and the degradation substances react, accelerated the asphalt aging, under the effect of repeated load, the mixture appears structural damage, and ultimately the loss of road function influence driving experience and security.

## 4. Prevention measures of water damage of Asphalt Pavement

The reason of water damage of asphalt pavement is various, the sustainable development of water damage will cause the structural damage of the asphalt pavement, and affect the safety of driving. Therefore, in the design of the mixture, the construction of asphalt pavement should be as far as possible to take all kinds of measures to alleviate the disease.

#### 4.1 Pavement structural measures

The root cause of water damage of road surface is the function of water, so it is no doubt that it is the most thorough measure to take proper engineering measures to separate water from water.

1) Road surface drainage is not the best way in the middle of the road or the edge of the edge of the stone, this kind of centralized drainage may be due to the obstruction of the road edge stone caused by poor drainage. More reasonable drainage system is on both sides of the road set hardening soil shoulder. The transverse slope of road surface water to be excluded from the scope of subgrade, this way more rapidly.

2) Open graded asphalt treatment of gravel as permeable base materials, it not only has high strength, good road use performance and durability, and larger void ratio and good drainage performance[8].

3) The following layer uses the water separating material as the water resisting layer to prevent the damage of the opposite layer caused by the water rising in the lower part of the structure.

4) To prevent water damage, still need to make the cut section, central zone of the drainage facilities, the establishment of a complete drainage system.

#### 4.2 Selection of asphalt and aggregate

In order to improve the water stability of asphalt mixture, the following measures are usually adopted:

1) Roughness and clean aggregates with less than 5% voids are used to form a rough surface structure and increase the coverage of asphalt.

2) As far as possible the use of alkaline aggregates and high adhesion of asphalt, do not use water sensitive aggregates and asphalt[9].

3) To control the amount of asphalt, a layer of uniform asphalt film is formed on the surface of the aggregate.

4) Pretreatment and adding anti stripping agent and other measures to the aggregate.

#### 4.3 Mix proportion of asphalt mixture

In order to have a good performance of dense water, we should use as much as possible the amount of asphalt, while increasing the amount of fine aggregate, so that the mixture has a higher density, resistance to water intrusion. The correct mix design can improve the water resistance. The asphalt mixture design and the actual porosity are the most important indexes in the gradation index of asphalt surface layer. In accordance with the United States on the Superpave and SMA comprehensive research on the highway asphalt mixture index requirements, the provisions of the target porosity control in about 4%. But it is generally believed that the design porosity control of asphalt mixture is suitable for the range of 3% ~ 5%, which can take into account the high temperature stability and water stability of mixture [10]. As for the contradiction between the void ratio and the structural depth, it can be considered that the asphalt mixture (SMA) and modified asphalt can be used in the same time.

### 5. Conclusion

The effect of water damage on asphalt pavement is particularly large. Therefore, in the design, construction and management of the process of water damage should be taken seriously. In each process, adequate and reasonable measures should be taken to reduce the impact of water damage. According to the different causes of water damage, we put forward to prevent the main, in order to treat as a supplement, the comprehensive management of the combination of prevention and control ideas, while the various processes are proposed to solve the corresponding measures.

Water damage is a widespread problem in the process of road construction and operation, but as long as the control of each link, so that the design, construction and management of a reasonable uniform, water damage problem can be effectively prevent.

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