

# *Study on the Basis of Selecting Antiskid Materials for Roads and Urban Roads in Northwest Arid Area*

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**Abstract:** In order to reduce the frequency of road skidding accidents in the northwest arid area, the selection of anti-skid materials shall be carried out according to the climate characteristics of the northwest arid area, such as small precipitation, large sandstorm and long sunshine, taking full account of the regional factors of the anti-skid road sections and adapting measures to local conditions. Taking road characteristics, locations and reasons prone to skidding, and construction difficulty of anti-skid operation as measurement indicators, specific anti-skid material selection analysis is carried out for roads and urban roads in the northwest arid area, providing a reliable basis for the selection of anti-skid materials for roads and urban roads in the northwest arid area, and breaking through the shackles that restrict the further development of road safety in the northwest. The correct selection of anti-skid materials can provide a safe and reliable driving environment for drivers and prolong the service life of roads. It is an effective way to solve the huge potential safety hazards caused by road slippage and has significant economic and social benefits.

## **1. Analysis of Regional Characteristics of Northwest Arid Area**

It is clearly stated in the outline for the construction of a transportation powerhouse that in the new period, we should focus on the transportation that the people are satisfied with, work hard to achieve safe and green transportation, and develop comprehensive transportation on the premise of ensuring traffic safety [1]. At the same time, we will implement the strategy of coordinated regional development, accelerate the development of remote and poverty-stricken areas, and strengthen measures to promote the large-scale development of the western region to form a new pattern. Therefore, in the northwest arid area, improving urban road traffic safety is the important content of promoting the new urbanization with people as the core, realizing the harmonious coexistence between man and nature and comprehensively promoting regional coordinated development. The majority of cities in the northwest arid region benefited from national western development opportunities and the Belt and Road strategy. They realized rapid urbanization in a relatively short period of time, and the urban appearance was new compared with the past. However, due to the relatively poor natural conditions, complex landforms, dry climate, sparse vegetation, and other factors that constantly restrict the development of the city, causing many traffic safety problems, the urban traffic safety level of this region is far lower than that of other provinces and regions in China

[2].

As the starting point and radiation area of the land Silk Road, the development of this area can bring valuable experience to the further deployment of the "Belt and Road" initiative [3]. At the same time, because the national culture of this region is basically the same as that of countries along the Silk Road, it can carry out multi-directional cooperation with countries along the Silk Road more efficiently. However, as a combination of the western region, the arid region and the ethnic region, the development of this region is restricted by the fragile ecological environment and the backward scientific and cultural level. This makes the urban roads and highways in the western arid region vulnerable to the influence of the external environment, resulting in frequent traffic accidents, so that the living standards of the people and the development of the regional economy are seriously restricted.

The ecological environment in the northwest arid area is relatively fragile on the whole. For a long time, the uniqueness, sensitivity and instability of the ecological system have determined that the urban road environment in the northwest arid area is unstable, prone to skidding, and the traffic safety level is weak. Through the research on the selection of anti-skid materials for roads and urban roads in this region, the road safety level in this region can be improved and the shackles restricting the further development of the northwest region can be broken [4].

### 1.1. Regional Characteristics

The Northwest arid area refers to the inland arid area to the north of 35°N and the west of 106°E, including the whole territory of Xinjiang, the Hexi Corridor of Gansu Province and the area to the west of Helan Mountain in Inner Mongolia. The land area of the northwest arid region is about one fourth of the total land area of China. The area includes 114 counties and cities, with a total land area of 2.905 million square kilometers. It is the northwest frontier area of the motherland. In the natural division, the northwest arid area refers to a high-level natural area with an arid climate and an extensive desert landscape. In a broad sense, the arid areas include Xinjiang, the Hexi Corridor, Beishan Mountain in Gansu, the Ningxia Plain, and the Heaton Plain, which are mainly characterized by arid and semi-arid climates, except for Karakorum Kunlun Mountain. This paper discusses the arid area in a broad sense, that is, the selection of anti-skid materials for urban roads and highways in the four northwest arid areas in Gansu Province [5].

The climate environment in the northwest arid area is characterized by low precipitation, strong winds and sand, long sunshine hours, etc. The annual precipitation is less than 150 mm in most areas, and the precipitation distribution is extremely uneven, with obvious seasonal characteristics and large changes. The precipitation gradually decreases from the southeast to the northwest, and the summer precipitation is highly concentrated, meaning the maximum precipitation will be concentrated on a certain day or a certain period of time. In addition, as for the characteristics of long sunshine duration, windy sand, and large temperature difference between day and night, these characteristics are mainly due to the continental climate in the northwest arid area, large weather changes, and large annual range. In the hottest month, the average temperature can reach 22-27 degrees Celsius, and in areas of extreme drought, such as the Hexi corridor, it can reach 35-40 degrees Celsius. Turpan has the highest temperature record of 47.6 degrees Celsius. The annual frost-free period in the northwest arid area is about 200 days. The northwest arid area is located in the middle latitudes and deep inland, where the main precipitation is very concentrated. In summer, the average precipitable amount in the northwest arid area is only 12 of that in North China, and even most of it reaches 13, which has a strong impact on the precipitation distribution in the northwest arid area. The altitude of Northwest China is generally higher, so the temperature in the northwest arid region is lower than that in the eastern region at the same latitude. For example, the annual average temperature of Lanzhou at the same

latitude is 9.1 degrees Celsius, which is 4-5 degrees Celsius different from Beijing. The annual average wind speed in the northwest arid area is between 2 and 3 meters per second. The annual dryness coefficient in general arid areas is 3.5-16.0, and the annual dryness coefficient, as an indicator to judge the annual precipitation, can directly reflect the poor climate conditions in the arid areas.

Limited by its geographical location, climate and environmental conditions, the northwest arid area has little precipitation and poor initial rain quality, which makes the visual effect of rainwater discharged on both sides of the road poor. At the same time, because the soil belongs to collapsible loess, the risk factors of collapse will be further increased after the rainwater is discharged into both sides of the road. However, the self-recovery ability of the ecological environment in Northwest China is weak. If the roads are spongy, it is easy to cause traffic safety accidents due to skidding. Improper handling will increase the frequency of traffic safety accidents [6].

## **1.2. Adaptability Analysis of Anti-skid Material Selection in an Arid Environment**

### **1.2.1. Color Antiskid Material**

Color anti-skid materials can play a great role in the road sections with frequent accidents. For example, when the vehicle passes through the road on rainy days, the use of colored anti-skid materials can increase the friction between the vehicle tires and the ground, thus preventing the vehicle from slipping. When the vehicle wants to make emergency braking, the braking distance can also be reduced through this anti-skid material, so as to enhance the braking performance of the vehicle and avoid some unnecessary traffic accidents. Moreover, the colorful materials, because of their bright colors, can make the drivers drive more carefully, remind the drivers to drive on the required road sections in different colors, and can also solve the traffic congestion problem to a certain extent, further prevent the occurrence of traffic accidents, and greatly improve the level of road traffic safety [7].

### **1.2.2. Snow Melting Anti-skid Material**

Chemical snow melting agents: Pre-wet salt, NaCl, CaCl<sub>2</sub>, MgCl<sub>2</sub> mixture, liquid snow melting agent, calcium magnesium acetate, ethanol snow melting agent, anti-skid material: Friction material, including sand, stone chips, slag, coal cinder, etc. [8]. When the outdoor temperature is low and the ice cannot melt, the anti-skid material and snow melting agent can be mixed to effectively prevent the occurrence of road traffic accidents on snowy days. However, the mixed use of this material will also have a certain negative impact on the surrounding environment. They will be discharged into the side ditch and drainage ditch with the melting of snow. If the snow is not cleaned in time, it will cause long-term accumulation. The snow melt will overflow the drainage ditch and wash the slope, causing secondary damage.

## **2. Highway Anti-skid Material Selection Criteria**

### **2.1. Highway Characteristics**

The highways are divided into two categories and five levels, namely, two categories of special automobile highways and general highways in China; Expressway, class I highway, class II highway, class III highway, and class IV highway. Each grade is divided into 14 technical index grades according to different terrain and vehicle speeds [9].

The annual average daily passenger car of class I highways is 10,000 to 25,000, which are characterized by four lanes or six lanes, with a central separation belt, with three speeds of 60kilometers per hour, 80kilometers per hour, and 100kilometers per hour, and a service life of 20

years.

On average, a Class II highway can accommodate 3000 to 7500 medium-sized trucks per day. It is characterized by having no central separation belt, with two speeds of 60 kilometers per hour and 80 kilometers per hour and a service life of 15 years.

On average, a Class III highway can accommodate 1000 to 4,000 medium-sized trucks per day. It is characterized by a separation belt, two lanes, and a service life of 10 years.

Class IV highways can accommodate 1000 to 4,000 medium-sized trucks per day. It is characterized by having no separation belt, two lanes, and a service life of 10 years.

## 2.2. Locations and Causes of Slipping

There are the following places and reasons for slipping on the highway:

1). When the snow on the road is rolled back and forth by vehicles, the gaps in the snow are extremely compressed to form snow stains, and then, through friction, the snow surface is very smooth and slowly forms ice [10]. After a long time of snow accumulation on the road surface and repeated rolling by a large number of traffic flows, it is very easy to slip near the ruts.

2). At the entrance and exit of each overpass, ramp, sidewalk, and other sections where vehicles travel slowly, the traffic is relatively increased, and it is easy to form ice.

3). Ice is more likely to form beneath the overpass. Because the temperature at the point of shadow under the overpass is low and the sun cannot be seen for a long time, the ice water dripping on the overpass is difficult to melt.

4). The bridge deck and culvert pavement are easy to freeze. The temperature difference between the bridge and the culvert is large, and the water in the air is easy to liquefy. In addition, if the weather is cold, the road surface is more likely to slip due to icing.

## 2.3. Antiskid Construction

The following points shall be paid attention to in the construction of anti-skid operation on the highway:

1). When anti-skid materials are applied to cement, asphalt, or other pavements, the surface of the pavement must be clean and free of foreign matter. If there is dust, sewage, etc., the construction shall be carried out after cleaning. When anti-skid materials are applied to the metal surface, anti-rust and anti-corrosion treatments should be carried out before sanding. After evenly mixing the mixture, it must be evenly applied to the pavement to ensure that the thickness is not too thick or too thin. After all of the mixtures have been evenly coated, the anti-skid mortar should be spread quickly and then allowed to harden. After hardening, the excess anti-skid mortar should be cleaned up. If it is to be constructed into a colored road surface, the short-hair roller can be used for painting. After completion, the color anti-skid pavement must be uniform, with a thickness greater than 3mm, an anti-skid value greater than 60 SRT, and a construction depth of approximately 1mm.

2). When the gradient is greater than 3.5 percent and the length is about 100m, three longitudinal slopes with a width of 1m and an interval of 5m are used as a group, with an interval of 11m for each group. Full paving is used on a longitudinal slope with a gradient greater than 5 percent and a length greater than 50m.

3). The interval line method is also adopted for curves with horizontal curve radius less than 1000m.

4). The entrance and exit of the tunnel extend 50m inside and out, respectively. The method of full paving is adopted. At the entrance of the tunnel, two groups of interval lines are added to the deceleration belt of the toll station, and three groups of interval lines are laid by the interval line method.

### 3. Selection Basis of Antiskid Materials for Urban Roads

#### 3.1. Urban Road Characteristics

Urban roads refer to roads with certain technical conditions and facilities within the city. Urban roads are classified into four types based on their traffic function: Expressways, trunk roads, secondary trunk roads, and branch roads [11].

Expressways are mainly set in megacities and big cities. They separate two-way traffic flow through the central separation belt. The main function of expressways is to connect urban areas with suburban areas and provide a convenient and fast channel for the transportation of passengers and goods. Compared with other roads, they have higher traffic capacity, and the traffic flow on the expressways can have higher speeds. Its design running speed ranges between 60 and 100 kilometers per hour.

As the skeleton of urban roads, the trunk road is responsible for connecting the residential areas, industrial areas, stations, and other parts of the city and is responsible for the main traffic in the city. It is generally composed of more than four motor lanes. There should not be too many entrances on both sides of the main road, otherwise it will directly affect the traffic flow on the main road and reduce the speed. The design driving speed of the main road is 40-60 kilometers per hour.

As an ordinary trunk road in the city, the secondary trunk road is mainly used to connect with the trunk road to form a traffic network and disperse the traffic flow of the main trunk road. Public buildings can be properly arranged on both sides of the secondary trunk road to attract passenger flow, and parking lots and other facilities should be built nearby. The design driving speed of the secondary trunk road is 30-50kilometers per hour.

The branch road is mainly used to connect the secondary trunk road with other streets and lanes. The branch road can bear a small traffic volume and should not be used as a road for cross-border traffic. In general, it is only allowed for traffic in the area. The design running speed of the branch road is 20-40 kilometers per hour.

#### 3.2. Locations and Causes of Slipping

When driving on urban roads, there are several places and reasons for skidding:

1). In rainy and snowy weather, combined with a large temperature difference between day and night in the northwest arid area, road icing is exacerbated, and traffic accidents caused by vehicle skidding are common.

2). In the uphill and downhill sections of the overpass, the large trucks and trucks travel slowly, so the ruts on the road surface will be very obvious after driving, which makes it easier to form ice. Therefore, skidding often occurs in this section. In addition, in winter, the sun is lower and cannot shine on all the roads of the bridge, so the temperature of some roads will be much lower than that of other roads, and it is easy to form ice and cause skidding.

3). At the upper and lower ramps of the urban expressway, the large turning sections, the entrance and exit of the tunnel, and the turn of the viaduct are all slippery sections.

4). Skidding accidents are common on road ramps, road bridge ground sections, large uphill and downhill sections.

#### 3.3. Antiskid Construction

The following matters shall be paid attention to in the construction of anti-skid operations on urban roads:

1). Examine the road surface to see if there are any cracks. If there are cracks, fill them first and

clean the dust and sundries on the road surface to ensure that the original old road surface is smooth and free of foreign matters before spraying.

2). The pavement quality is affected by two factors: One is its flatness, and the other is the smoothness of the pavement boundary. Therefore, before the formal pavement construction, the construction area shall be measured according to the requirements of the design drawings, and the construction area shall be demarcated and protected.

3). During material mixing, the proportion of each material must be mixed strictly in accordance with the requirements, and the total mixing time must be kept under control to avoid being too long.

4). The thickness and uniformity of the construction shall be strictly controlled when mixed materials are used.

5). The selection of aggregate must meet the requirements, and the coating can be carried out only after the construction of cement is completed.

6). After the mixed materials are completely hardened, the surplus mixture on the pavement can be cleaned and recycled. During the scraping process of the mixture, the spilled materials should be wiped in time to prevent pollution.

7). After the pavement construction is completed, ensure that there are no vehicles or pedestrians within 24 hours to avoid affecting the subsequent appearance and flatness of the pavement.

#### 4. Conclusion

The selection of anti-skid materials for roads and urban roads in the northwest arid area is related to traffic safety. The correct selection of anti-skid materials for construction can effectively reduce the accident frequency in the northwest arid area, provide a safe and reliable driving environment for drivers, and prolong the service life of roads. It is an effective way to solve the huge potential safety problems caused by road skidding, with significant economic and social benefits. But at the same time, there are many factors to consider when selecting anti-skid materials. First, according to local conditions, different road grades in different regions have a certain influence on the selection of anti-skid materials. Second, strengthen the anti-skid pretreatment of special road sections and adopt high-level anti-skid accident operations for the road sections with frequent accidents. Third, ensure that the anti-skid accident operation is carried out according to the regulations, and pay attention to different precautions when carrying out anti-skid construction on different roads.

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