

# The development and Research of Pavement Materials Literature Review

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## Abstract

The author introduced the development and research of highway pavement materials and pointed out the problems about highway pavement materials in pavement design and construction. In order to improve concrete performance, the article studies the concrete anti-sulfate erosion validity of high efficient water reducing agent, ganister sand, fly ash, expansive agent and other additive and mineral admixture. The experimental result shows that: admixing high efficiency water reducing agent into concrete can delay concrete erosion damage; adding ganister sand, fly ash and expansive agent into concrete can improve concrete anti-sulfate erosion ability. Finally, it studies the changing law of its anti-sulfate erosion coefficient. performance on Semi-flexible pavement under three different porosity of basic asphalt mixture was designed by the method of Coarse aggregate voids-filling method, experiment of evolution leakage and experiment of scattering. Comprehensive road performance was evaluated through the Marshal test, rutting test, fatigue test and so on. Results show that semi-flexible pavement materials is good at rutting resistance, water susceptibility and fatigue resistance performance.

## Keywords

Highway; Development; Pavement materials; Research

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## 1. Introduction

In recent years, due to the increasingly crowded traffic and the increase of vehicle axle load and the total amount, vehicle wheel pressure increase as well as the wheel contact area is reduced accordingly. In this way, As a result of personal transportation, commercial transportation and way of life, the amount of the transportation infrastructure in keeping the continuous high growth momentum.

## 2. The development of pavement materials

### 2.1 The development of pavement materials in China

The most used highway pavement in our country are cement concrete pavement and asphalt pavement.

Cement concrete pavement with suspended solid for carrying significant is of high speed, large density in the need of the highway transportation vehicles whose advantages are high strength, good stability in performance, long service life, low maintenance costs, etc. Therefore, in the world it is widely used in highway and city road engineering.

Through the efforts of nearly 20 years in highway asphalt pavement construction in our country, especially on aspect of the highway asphalt pavement construction, we have formed systematic technology in the core of road surface structure, material, design, construction and inspection.

The superior of asphalt pavement is widely used throughout the world because of its pavement performance of no juncture of continuous type pavement, its enough strength, which adapts to all kinds of vehicle load, and driving smooth, comfort, little vibration, low noise and easy maintenance characteristics and occupies a large proportion in the paving roadways.

## 2.2 The new development of pavement materials in the world

In recent years, countries have researched using asphalt hoof fat macadam mixture material (SMA), which is a very attractive new asphalt mixture known for its excellent rutting resistance and skid resistance performance. Inorganic binder aggregate the treatment become a kind of road paving materials widely used in our country as flexible pavement base and sub-base, for grass-roots is often more high-quality gravel layer. America, Australia and others use it for the best grading quality of gravel between semi-rigid base and asphalt road surface. As the measures to reduce the reflective crack of asphalt pavement, this kind of material and structure, is also applied in many large projects in our country, having achieved good results.

## 3. Pavement materials comprehensive classification

### 3.1 Classification according to the material composition pavement materials

Pavement materials according to the material composition can be divided into four major categories.

(1) Granular material and block material: ①water and gravel road surface;② mud and gravel road surface;③marl and gravel road surface;④ add gap dry crushed stone base;⑤graded gravel road;⑥ pieces of material surface: a. natural block pavement, b. mechanism block pavement material.

(2)Inorganic binder (stable) classes: ①lime stabilized class base (sub-base); ②on the base of the cement stable class;③industrial waste residue stability at the grass-roots level;④the cement concrete pavement.

(3) The organic binder (asphalt) classes:①asphalt concrete;②hot mix asphalt gravel;③emulsified asphalt macadam mixture asphalt penetration type;④asphalt surface treatment.

(4) new pavement materials:① the emulsified asphalt;②asphalt matrix mixture (sma);③super asphalt (superpave) : semi-rigid asphalt layer.

### 3.2 The concrete application of pavement materials

Asphalt hoof fat gravel mixture (SMA) is a very compelling new asphalt mixture appearing in the world in recent years, known for its excellent resistance to rutting lung can and anti-sliding performance .The first SMA pavement built in the mid - Germany is still of good use with more than 30 years of history, .

SMA is composed of asphalt, fiber stabilizer, mineral powder and a small amount of fine aggregate of asphalt hoof fat fill the gap grading of the coarse aggregate skeleton clearance of asphalt mixture. It is the basic composition of the gravel skeleton and asphalt hoof fat binder of two parts.

Superpave asphalt binder specification by limiting the asphalt binder is easy to form potential abilities of the asphalt pavement permanent deformation, cracking in low temperature and fatigue cracking , to achieve the purpose of improving the performance of pavement.

An important difference between current asphalt standard with Superpave asphalt specifications lies in the requirements of different formats.

Semi-rigid asphalt pavement surface is divided into two categories from the process. One is semi-rigid surface of mixing, another is semi-rigid asphalt layer in grouting method. The former is in asphalt concrete mixing matrix adding the right amount of cement mortar, which has advantages both the new type of flexible pavement road surface rigidity white and black pavement structure after condense sclerosis ;the latter is void fraction larger compacted asphalt mixture pavement as the

matrix, adding additives of cement slurry, and condense sclerosis after forming both rigid and soft than the pavement structure.

## **4. The problems of pavement materials**

### **4.1 The pavement material itself**

The features of crushed gravel pavement structural strength formation are: connection strength between mineral aggregate particles, generally much smaller than the strength of the material itself; Under the effect of external force, the material first will have a slip between the particles, and the displacement, losing its bearing capacity from damage. Therefore, this kind of pavement can only adapt to low traffic volume of highway.

Block pavement although solid durable, clean little dust, convenient maintenance and management, but the road must be paved by hand, it is difficult to realize mechanization construction, prone to loosening between block material, the shop is acted the role of collectors slow degrees, the high cost of construction.

Inorganic binder stability of pavement has good stability, strong antifreeze performance, full shu hook itself form board, etc, but its abrasion resistance is poor, so it is widely used in construction of the base and sub-base pavement structure. Inorganic binder stability of pavement is one of the important characteristics of strength and modulus increases with the increase of age growing, gradually has certain rigidity properties. Therefore, this kind of pavement construction more troublesome, ages curing is crucial, blocking traffic long time. And construction materials saved is also very important.

Bituminous pavement belongs to the flexible pavement of asphalt pavement, its strength and stability depends largely on the soil and characteristics of the grassroots. The asphalt surface bending strength is low, and therefore requires the road foundation with sufficient strength and stability. When construction must be fully grasp the characteristics of subgrade soil compaction. Low temperature, the asphalt surface deformation resistance is very low, in the cold area to uneven frost heaving soil base and make the cracking of asphalt pavement, need to set the anti-freezing layer. The permeability of asphalt pavement construction, due to its small, so that the temperature and the moisture inside the grassroots to discharge, in the wet pavement is used raw soil and soft at the grass-roots level, leading to damage.

Both in cement concrete pavement and asphalt pavement, there is crack diseases。

### **4.2 Deficiency in the design of mixture (mixture ratio, grading)**

Natural gravel materials used in the gravel base, although with no strict requirements, but in order to guarantee forming the dry stability and facilitating stability, for grading composition should be controlled appropriately. Particles of the natural sand gravel subgrade does not belong to the best gradation, and lack of bond, therefore its integrity is poor. Strength is not high, In order to improve the integrity and strength according to the traffic and road line (such as corners, steep slope), embedded in the surface of gravel or pave gravel transition layer.

Lime stabilized soil is composed of soil, lime and water. Mixture composition design includes: according to the strength standard, take appropriate soil through the experiment, must determine the lime dosage and the mixture of the best water content.

Lime dose has significant effects of lime soil strength and lime dose is low (less than 3% 4%), lime stabilizing effect, main, expansion, water absorbing capacity of soil plasticity decreases, make soil compactness, strength improved. With the increase of dose, strength and stability are improved, but the doses of more than a certain range, strength reduce instead. Therefore, the determination of dose should be according to the structure layers of strict technology for mixture design. Water is an important part of calcareous soil. It encourages calcareous soil physical and chemical changes, formation strength; Facilitate grinding, mixing and compaction of soil, and is helpful to health. The

calcareous soil of different soil has different optimum water content, to be determined by standard compaction test and water added to control the actual construction. Therefore, the influence of the nature of the water for this kind of material is very big, the water must be clean drinkable water, in today's severe lack of water resources, this camp is a waste. And in construction, compaction water content should be strictly controlled. Calcareous soil dry crack because of the excessive moisture content significantly, thus pressure real-time water content must not be greater than the best water content, the moisture content should be slightly less than the best water content.

Water has great influence on the strength of the soil along with the strength of cement stabilized soil. But too much cement dosage. Although gain strength increase, but not necessarily reasonable economically, in effect is not significant and easy to crack. Experiment and research shows that the cement dosage is 4% 8% more reasonable. Moisture content had a great influence for the strength of cement stabilized soil. When insufficient water content, cement can't completely hydrated and hydrolysis in the mixture, exert no effect on the stability of soil cement, influence the formation of bow to change ,less moisture content at the same time. Don't nephew U best water content also affects the degree of compaction of cement stabilized soil. Water content is J wire U the best water content, therefore, at the same time, also want to fully meet the cement hydration and water Angle at first with the need for good. So the cement in the cement stabilized soil agent shall strictly control the star fiber saliva dose, and since around the cement manufacturing materials, cement hydration water also have difference. Water requirement of normal cement hydration by about 20% cement town, for sand, a big, water is not completely rice China U most of the circle water content is the best density of small water content; In the case of cohesive soil, on the other hand.

Highways and roads smelly according to scoop of crushed value should be no greater than 30%, the maximum particle size of particles is not greater than 31.5 ~ (screen).Also require aggregate uniformity coefficient is not more than 10 (that is, through the amount for 60% of the screen hole size and throughput for the ratio of 10% of the mesh size).0 in the aggregate. Plastic particles under 6 ~ {index is not greater than 12.More than 2% organic matter content, sulfate content more than 0.25% of the aggregate unfavorable use.

High grade highway asphalt pavement due to improper pavement material mixing ratio or not uniform mixing may cause the reticular cracks; Due to the poor bonding between asphalt and mineral aggregate, will also produce asphalt loose flake; Aggregate quality of a material weakness. Lack of water chestnut, improper or mineral aggregate gradation, smaller size of coarse aggregate, fine aggregate, or the more the asphalt content too much can cause in the process of asphalt pavement in the use of surface polishing.

### **4.3 Mechanical properties and performance of pavement mixture**

Crushed gravel mixture is of much fine particle and low plasticity index, inefficient cohesive force. Growth of excessive or round, flat particles within the grain, small friction resistance, can't resist the wheel push. Vibration effect caused by the particles, and the strength of the roadbed is insufficient, can't resist road damage, or uneven strength, not a right, cause the formation of surface waves. This kind of road surface roughness is poor, easy to dust, easy to muddy clay and gravel pavement rainy day.

The strength of pieces of the material road surface, mainly is founded in bearing capacity and friction between the rocks and stones. When this two kinds of force is small, not enough to resist the wheel vertical load, settlement deformation will occur. Accordingly, to make the block pavement solid, the perimeter and the bearing capacity of soil base and spreading area of block stone, shall be as large as possible. If the perimeter of friction surface friction force is small, or the foundation and basic bearing capacity is insufficient, the pavement under wheel load, compression deformation will occur. If the compression deformation, the road is rugged, resulting in loose stone and pavement damage.

The wearing resistance stability of inorganic binder road surface is poor. Its stiffness is between flexible and rigid, as semi-rigid pavement. Cement stabilized soil is prohibited as highway or level of

highway road of the substratum, only as a sub-base. Neither the cement concrete soil should be at the grass-roots level under pavement of high grade highway.

Strength and deformation characteristics of asphalt mixture changes with the temperature rise or fall. Due to this change, the stability of asphalt pavement, and bad work condition, the use of performance will degrade.

Cement concrete pavement have juncture, these juncture not only increase the complexity of the construction and maintenance, and also easy to cause the bridge beating, influence the driving comfort, what the most is that juncture is the weak spot of the road, Therefor improper handling will cause the road edge and voids. Moreover, the road traffic will occur opening later, repairing difficulties, pavement, difficult excavation, then repairing workload is big, and the traffic.

#### **4.4 The development trend of pavement materials**

No matter what the material, for what purpose, development trend of road materials can be divided into the following several aspects:

(1) Traditional materials to improve its performance, and to improve its varieties. The traditional materials are mainly sandstone, limestone, cement and asphalt etc. The future development trend is how to better use their respective advantages and to improve its performance relatively weak, thus how to extend its application range, on the base of the existing varieties of materials to develop innovative new varieties of pavement materials.

(2) To develop composite materials and to increase the development of composite materials is another trend in the development of pavement materials in the future. In the current development of science and technology increasingly matures, the emergence of a completely new material is a very difficult thing. However, the existing material combination, foster strengths and circumvent weaknesses which do not break is a fast and effective method.

(3) The ecological environment as a guide is an important factor in the development of building materials which must pay attention to the following:

(1) Material harmony and production of green. There are some material harmony and production at the expense of the environment pollution, along with the progress of times, it is to be washed out after all. Material harmony and production of green full compliance with the requirements of The Times, is the embodiment of the social development.

(2) Environment coordinate material at the beginning of the construction in our country, under the condition of capital, technology, completely failed to keep pace with, seldom consider in highway construction and the environment coordination problems. However, after decades of development, our country's economy obtained the development which progresses by leaps and bounds, science and technology has made considerable progress. In this case, the project construction and the environment coordination problems will be as one of the indispensable factors, studying environment coordinate material is imminent considering the development.

(3) Biodegradable materials

It is a natural environment with the passage of time can be decomposed to absorb by nature, and not cause any pollution to the environment of the material. The use of this material for our children and grandchildren is undoubtedly a Gospel.

(4) Use of solid waste

Make full use of industrial waste residue instead of natural resources, the use of these residues can solve difficulties of road-building material source, reduce the cost of materials, is also a kind of protection of natural resources and the environment.

## 5. Conclusion

Pavement materials is the core of the development of road development. Along with the people living standard rising, people demanding for traffic conditions also have higher requirements, such as more comfortable, safer driving requirement, more environmental protection. it is to engage engineering and technical personnel in traffic on the front to has the higher expectations. There is reason to believe that in the near future, we will see all kinds, variety and service in the different requirements of the birth of pavement materials.

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