Study on the Application of Gangue Mixture in Road Engineering Based on Computer Technology

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Abstract. With the development of environmental protection in modern society, the concept of waste utilization has been put forward by researchers. Waste fuel and stone will pollute the environment. They also take up a lot of public resources. In an industry, they are useless. With the concept of waste utilization put forward, people think of many ways to deal with the corresponding waste materials. Coal gangue is a kind of industrial waste with the largest storage capacity. In the process of industrial production, gangue is useless. However, in road engineering, the combination of coal gangue and coal ash can be used as the base material of the road. This paper studies the application of coal gangue mixture in road engineering based on computer technology, and finally draws the corresponding conclusion.

Keywords: Computer, Gangue, Mixture, Road Engineering

1. Introduction

According to the statistics of industrial materials, coal gangue is the industrial waste with the largest storage capacity. People have a bad impression of coal gangue. In mining, gangue is also considered as a kind of waste. In the aspect of environmental protection, people don't like the strong pollution of coal gangue. The discharge of coal gangue will occupy land resources. Coal gangue will produce a lot of harmful gases after combustion[1]. These gases are harmful to human health. These gases can cause water pollution and soil pollution. In geology, excessive accumulation of coal gangue will cause landslides and collapses. What's more, it will cause debris flow.

Generally speaking, gangue is regarded as a kind of waste in many industries. After the concept of waste utilization was put forward by environmentalists, the value of coal gangue was really recognized. In road engineering, coal gangue mixture can be used as the base material of road construction. According to economics, environmental protection and social benefit, there is no doubt that the use of coal gangue in road engineering has broad prospects. Moreover, this situation also consumes a large
number of accumulated gangues and achieves real waste utilization\textsuperscript{[2]}.

2. Analysis of the performance of coal gangue as the material of road engineering

According to the relevant knowledge of industrial technology, we know that coal gangue is a kind of solid waste discharged by industrial equipment in the process of coal mining and washing. The carbon content of gangue is very low and its hardness is higher than that of common coal. According to the classification of appearance color, coal gangue is divided into black coal gangue, red coal gangue and gray coal gangue. The construction of subgrade is very important. In order to build high quality subgrade materials, we need to study the physical and chemical properties of coal gangue mixture.

2.1. Physical properties of coal gangue

According to the parallel test, the density of gangue is $2.49 \text{ g/cm}^3$. The density of gangue is $1.56 \text{ g/cm}^3$ (see Table 1).

| Option          | Situation | Test 1 | Test 2 | Test 3 | Average |
|-----------------|-----------|--------|--------|--------|---------|
| Density         | Normal    | 2.53   | 2.50   | 2.44   | 2.49    |
| Bulk density    | Normal    | 1.53   | 1.58   | 1.55   | 1.56    |

According to the screening test method of coal gangue and the results of particle grade accumulation curve, we can find that the particle grading of coal gangue mixture is excellent. It is easy to get more compactness\textsuperscript{[3]}. Its compressibility is relatively low. It's very strong. Generally speaking, its comprehensive engineering performance is excellent (see Table 2).

| Number | Original quality | Sieving quality | Crushing value | Average |
|--------|------------------|-----------------|----------------|---------|
| 1      | 2570             | 759             | 29.5%          |         |
| 2      | 2575             | 770             | 29.9%          | 29.6    |
| 3      | 2573             | 760             | 29.5%          |         |

According to the experimental results of the crushing value of coal gangue, we found that the average crushing value of coal gangue is 29.6, which means that coal gangue is easy to be crushed. The coal gangue which is easy to crush is very good as the filling material of roadbed. After a lot of experiments, we can find that the expansibility, liquid plastic limit and water absorption of gangue are suitable for road engineering.

2.2. Chemical properties of coal gangue

According to the analysis of chemical elements, gangue is composed of inorganic minerals, organic matters and some rare elements. According to the determination of chemical composition, coal gangue is composed of silica, alumina and Fe2O3. Therefore, we can judge that coal gangue is an inert material.
Moreover, due to the low carbon content of gangue, its loss on ignition is very small. The structure and water of compacted gangue can produce Pozzolanic reaction in the environment of specific temperature and proper water content. The products are tremolos’ calcium silicate hydrate and calcium aluminate hydrate. With the continuous chemical reaction, the water stability of coal gangue becomes better. Its strength is increasing. This situation means that the bearing capacity of gangue gradually increases (see Table 3)\cite{4}.

| Oxide | SiO₂ | Al₂O₃ | Fe₂O₃ |
|-------|------|-------|-------|
| Content | 66.15% | 22.42% | 4.82% |

### 3. Study on the application performance of coal gangue mixture in road engineering

#### 3.1. Make proper mixture ratio of gangue

Uniform designer is a kind of experimental design method commonly used by researchers. Through the theory of uniform design, two aspects should be paid attention to in the selection of coal gangue mixture proportion. One is the choice of mixture factor, the other is the choice of mixture level. The main factor of the mixture is the percentage of the content of fly ash, lime and cement to that of coal gangue. The selection of mixture level refers to the formulation of the mixing range of various materials (see Table 4).

| Component | Gangue | Fly ash | Quick lime | Cement |
|-----------|--------|---------|------------|--------|
| Content   | 83.51% | 5.85%   | 7.64%      | 3.01%  |

#### 3.2. Practical application performance of coal gangue mixture in road engineering

In order to study the application performance of gangue mixture in road engineering, we need to consider three reference values\cite{5}. They are unconfined compressive strength, resilient modulus and splitting strength (see Table 5). The formula of unconfined compressive strength is:

\[
f_u = \frac{P}{A}
\]  \hspace{1cm} (1)

- \(f_u\) is unconfined compressive strength of test piece.
- \(P\) is the maximum pressure when the test piece is damaged
- \(A\) is the sectional area of the test piece.

| Number | 1 | 2 | 3 | 4 | 5 |
|--------|---|---|---|---|---|

Table 3. Main chemical composition of coal gangue

Table 4. Specific mix proportion of coal gangue mixture

Table 5. Mean value of unconfined compressive strength
The formula of resilient modulus is:

\[ E_c = \frac{P_h}{l} \]  

(2)

\( P \) is calculated pressure, \( h \) is the height of the test piece, \( l \) is the spring back deformation of the test piece. The experimental results are shown in Table 6.

| Number | 1  | 2  | 3  | 4  | 5  |
|--------|----|----|----|----|----|
| Mpa    | 371| 421| 442| 331| 421|

The formula of splitting strength is:

\[ R = 0.004178P/h \]  

(3)

The experimental results are shown in Table 7.

| Number | 1  | 2  | 3  | 4  | 5  |
|--------|----|----|----|----|----|
| Mpa    | 0.2495| 0.2729| 0.3077| 0.2327| 0.3069|

4. Technical feasibility of application of gangue mixture in road engineering

As we all know, the base course of pavement should be built under the surface course and above the subgrade. Therefore, in physics, coal gangue mixture should bear the gravity of its own rock and soil and the gravity of the road surface. In the normal use of the road, it will also bear the gravity of the vehicle. In terms of chemistry, rainwater may penetrate into the base course of the pavement. The subgrade will be eroded by water. In addition, the cost of subgrade materials should not be too high.

The cost of gangue mixture as industrial waste is very low. Its source is very extensive. It's very strong. It's very rigid. Its water stability is very good. It can be seen that the water absorption, crushing value and loss on ignition of gangue meet the basic characteristics of subgrade construction materials. The chemical composition of coal gangue also meets the relevant requirements. Therefore, the gangue mixture can be widely used in the construction of road base[6].

5. Analysis of economic benefits of application of gangue mixture in road engineering based on computer technology

Through a large number of experiments and practical analysis, we can find that the mechanical properties of coal gangue mixture is very good. The unconfined compressive strength, modulus of resilience and splitting strength of the composite with appropriate proportion are enough to meet the mechanical requirements of subgrade materials. The stability of gangue mixture is very good. It can easily meet the quality requirements of road engineering.
The application of coal gangue mixture can save a lot of land resources and land acquisition cost. Its application can greatly reduce the pollution of coal gangue. The strength of coal gangue is higher than that of lime soil. Therefore, the structural performance of subgrade is good. The thickness of subgrade can be reduced to reduce the budget of road works. Generally speaking, the economic benefits of the application of coal gangue mixture in road engineering have obvious advantages.

6. Conclusion

In the field of industry and mining, coal gangue has been regarded as waste. It takes up a lot of land resources. It will pollute the air and groundwater. It is harmful to human health. However, as the material of subgrade, the application of gangue has produced good social and economic benefits. This phenomenon can find good application value of coal gangue. It also confirms the real role of waste utilization.

References

[1] WEI Bin. Study on the Durability of Steel Deck Pavement Asphalt Mixture Based on Rubber Powder and SBS Compound Modified Technology[J]. highway engineering, 2015.

[2] Sheng L , Ren-Jie Q . A Study on the Application and Construction Technology of Hard Asphalt Mixture[C] Measuring Technology and Mechatronics Automation, 2009. ICMTMA ’09. International Conference on. IEEE, 2009.

[3] Wang X , Qiu Y J , Xue S Y , et al. Study on durability of high-modulus asphalt mixture based on TLA and fibre composite modification technology[J]. International Journal of Pavement Engineering, 2018, 19(9-10):930-936.

[4] Chuang-Dan L , Zhen-Quan Z , Jun-Jie L I . Research on the application of color asphalt mixture engineering based on road performance[J]. Communications ence and Technology Hlongjiang, 2019.

[5] PAN Rongkun, YU Minggao, YU Shuijun. Study on Kinetics Characteristics of Coal Gangue Dump Explosion[C] International Symposium on Safety Science & Technology. 2008.

[6] Dongwei, Cao, Jie. Coal Gangue Applied to Low-Volume Roads in China:[J]. Transportation Research Record, 2018.