власники інфраструктури можуть з легкістю знаходити, ідентифікувати та оновлювати відомості про земельні активи на місцях. Система дозволяє прикріплювати додаткові файли, відомості, фото та відео місць встановлення. Передбачена можливість доступу за допомогою електронного цифрового підпису.

Запропонована система включає в себе геопросторові відомості, земельно- та цивільно-правову інформацію, зчитувачі, локатори та безпосередньо межові знаки. Так як програмне забезпечення має можливість використовувати віртуальні сховища даних, відомості, які були зчитані чи записані в полі, доступні в веб-додатку. Система реєструє інформацію про місцеположення, дату та ключові відомості для заповнення ГІС. Контроль доступу має резервні системи, що дозволяють адміністратору безперешкодно дізнатися, хто і коли зчитав інформацію, тощо. Відповідні відомості в чипах можуть зберігатися десятиріччями, доки не будуть затребувані.

УДК 625.825

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THE BASIC PROPERTIES OF LIMESTONE POWDER CONCRETE

The performance of concrete is a requirement in infrastructure with the development of China, there is a need to improve concrete as an

environmentally benign and sustainable material. Mineral mixture is a method that mixes fly ash or slag with concrete which is widely used in nowadays that can improve the performance of concrete and also cut costs.

Due to the shortage of fly ash caused by decrease of coal power enterprises, a material which is used for mix with concrete, limestone powder, widely distributed in China can replace fly ash and reduce pollution. In some developed countries, limestone powder mix with concrete is applied in many areas of engineering. In the 1990s, Japan has been widely used in high-fluidity concrete and high-performance concrete.The amount of limestone powder in the concrete of the pier cable anchor solid of Akashi Kaiju Bridge in Japan is 150 kg/m^3, accounting for 36,6 % of the total powder material.The aim of this paper is to review basic properties of limestone powder and its hydration effect, active effect and particle morphology effect mechanism, and limestone powder on the working performance of concrete, durability and the influence of mechanical properties.

The influence of limestone powder on the performance of concrete. Concrete workability. Working performance is an important index to evaluate concrete performance. Good working performance is the premise of high performance, safety and reliability of concrete. Concrete with good workability must have good fluidity and water retention, small slump loss and better segregation resistance. A large number of high-efficiency superplasticizer and mineral admixture make the cohesion and water retention of concrete and liquidity are often inversely proportional. Therefore, it is necessary to find better mineral admixtures or highly efficient water reducers with better adaptability to

solve this problem. Limestone powder, due to its accelerated hydration effect and particle morphology effect, can improve the working performance of concrete, improve the slump of concrete, reduce the slump loss, increase its cohesion and water retention.

Juanhong Liu studied the workability of concrete with limestone composite ultra-fine mineral admixture. It is found that the water consumption of concrete decreases with the increase of limestone powder content under the condition of similar slump. Limestone powder can reduce the water consumption of concrete, reduce the water-cement ratio, and ensure the workability of concrete. Hang Yuan replaced cement with limestone powder with a density of 2,6 g/cm^3 and 45 μm sieve residue of 0,6 % 4,6 % and 16,5 % respectively, and the replacement rate was 15 %.

The results show that the slump of the concrete mixed with limestone powder is greater than that without limestone powder, and the slump increases with the decrease of the fine-ness of limestone powder.

The above two studies demonstrate the effect of form effect and filling effect of limestone powder on concrete. On the one hand, limestone powder is dispersed among cement particles to disflocculate the «flocculation structure» formed in the hydration process and play the role of «ball» among cement particles, thus improving the fluidity of concrete. On the other hand, lime-stone powder requires less water than cement. Replacing cement can reduce the mixing water consumption of concrete and increase the slump of concrete.

Durability of concrete. The durability of concrete refers to its ability to resist chloride penetration, sulfate erosion, carbonization and freezing and thawing. In the use of concrete, water and air in the environment and their erosion medium often invade, produce physical

and chemical reactions and gradually deteriorate. Generally speaking, as long as the concrete has a low permeability, it has a good ability to resist the invasion of water and erosion medium. The permeability is related to the porosity and pore structure of concrete. The greater the porosity and the more connected holes, the worse the permeability of concrete. Therefore, when external deterioration conditions are unavoidable, the durability of concrete can only be improved to extend its service life. The main methods to improve the durability of concrete include:

– make the concrete itself compact without the generation of original cracks through technical means;

– after hardening volume stability without shrinkage crack;

– reduce the internal erosion of concrete components.

Effects of sulfate resistance. Yao Li et al. carried out sulfate erosion experiments on concrete with limestone powder with specific surface area of 2000 m^2/kg at 5 %, 10 % and 20 % substitution rates. The weight loss of each group of concrete shows a decreasing trend with the increase of limestone powder content, and the weight loss is lower than that of blank concrete. Mingnan Pan et al. used the same test method to reach a consistent conclusion under the same specific surface area and the same substitution rate. Through the above research, it can be concluded that the addition of ultra-fine limestone powder can greatly improve the resistance of concrete to sulfuric acid erosion.

Effects on frost resistance. The addition of limestone powder in an appropriate range can improve the frost resistance of concrete. With the increase of limestone powder content, the frost resistance of concrete decreases, even lower than that of benchmark concrete. Songqi Mei et al. concluded in the test that the concrete with 5 % limestone powder has the

best frost resistance, while the concrete with 20 % limestone powder has the worst frost resistance. Therefore, a small amount of limestone powder can improve the frost resistance of concrete, and a large amount of limestone powder (more than 10 %) is harmful to the frost resistance of concrete. However, Qingwei Sun et al. found that the frost resistance of concrete improved with the increase of limestone powder content, but the effect was limited. By reducing the water-cement ratio, the frost resistance of concrete can be significantly improved.

Influence on the permeability of chloride ions. At present, the influence of the addition of limestone powder on the impermeability of concrete is still controversial. Some people think that the filling effect of limestone powder improves the porosity and pore structure of concrete, so it improves the impermeability. Some researchers also think that limestone powder will reduce the chloride resistance of concrete permeability, but limestone powder and fly ash can certainly improve the chloride resistance of concrete permeability.

Dehui Wang et al. measured the diffusion coefficient of chloride ion with limestone powder with a specific surface area of 500 m^2/kg and 650 m^2/kg at different mixing amounts. When the specific surface area of limestone powder is 650 m^2/kg and the content is 15 %, the chloride diffusion coefficient of concrete is the smallest. Baosheng Zeng pointed out in the literature that in the concrete with a single mixture of limestone powder, the permeability of chloride resistance increases with the growth of concrete curing age. When limestone powder and fly ash are mixed, the chloride penetration resistance of concrete is greatly improved. S.Sivilis et al. found that the addition of limestone powder is conducive to improving the permeability of concrete, but not conducive to

improving the permeability of chloride ions. Therefore, it is necessary to study the chloride resistance and permeability resistance of the concrete with limestone powder.

Mechanical properties of concrete. Strength is one of the most important indexes to measure the quality of concrete. The basic strength indexes of concrete mainly include compressive strength, tensile strength and shear strength. With the needs of engineering and the development of science and technology, concrete strength index has developed rapidly. The influence of limestone powder on concrete strength is mainly manifested through three major effects. Fei Xiao, Hongtao Cui et al., with a contrast surface area of 2000 cm^2/g, 12000 cm^2/g and 21000 cm^2/g, respectively conducted strength tests with three dosages of 5 %, 10 % and 20 %. The results show that the fineness and admixture of limestone powder have great influence on the mechanical properties of concrete. When the surface area is 2000 cm^2/g, it is not conducive to the growth of compressive strength of concrete, and the effect of compressive strength is not significant. When the specific surface area is 12000 cm^2/g and 21000 cm^2/g, and the mixing amount is 5 % and 10 %, the early and late strength of concrete is improved. Although with the increase of surface area, the later strength of concrete increases more obviously. When the content is 20 %, the compressive strength of concrete is lower than that of blank specimen. With the admixture of 5 %, 10 % and 20 %, the bending compression ratio of concrete for 28 d is higher than the blank time. This shows that adding limestone powder with certain fineness can reduce the brittleness of hardened concrete and increase the toughness of concrete to some extent.

Yuxia Guo et al. also found that when limestone powder is added, the strength of concrete at each age increases first and then decreases with the increase of adding amount. When the admixture is 20 %, concrete 3 d, 7 d and 28 d have the highest compressive strength. However, when the limestone powder content exceeds 20 %, the compressive strength of concrete decreases. This is due to the excessive amount of limestone powder, unreasonable concrete gradation, the content of coarse aggregate is relatively reduced, the skeleton effect is weakened. When limestone powder is added, the strength of concrete decreases obviously with the increase of the quality of limestone powder replacing cement. When the content is 10 %, the strength decreases significantly with the increase of age, indicating that the early strength loss of concrete is less when limestone powder replaces cement.

УДК 625.7

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DIFFRACTION BY DOUBLY-CONNECTED CAVITIES OF GENERAL FORM IN CASE OF NON-DESTRUCTIVE DIAGNOSTICS OF ROAD STRUCTURES USING GEORADAR

Scattering of acoustic and electromagnetic waves by bodies of revolution (BOR) has been in a focus of numerous investigations for a long time. One of the reasons for the long-standing interest in this problem is the practical need for improvement to the reliability of the georadar target recognition (such as the pavement structure). Along