ANALYSIS OF MECHANICAL PROPERTIES OF SHELL AGGREGATE CONCRETE

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Annotation. In this paper, the shell aggregate concrete is analyzed, and the sand aggregate is replaced by shell under different particle gradation, and the method of mechanical property test research is adopted for concrete blocks under different sand and gravel replacement rates, and the bending resistance, compression resistance and frost resistance of the block are analyzed, and finally the shell aggregate also has good mechanical properties and solidity, and adding shell aggregate in a certain proportion can bring considerable social and economic benefits.

1. Introduction.

With the innovation of science and technology, the overall progress of society, sustainable development plays an increasingly important role in the research of modern scientific researchers, sustainable development emphasizes the coordination and balance of environmental, social and economic aspects, and now architecture has become one of the important symbols of human social development. The growing demand for construction in human society has made concrete the world's most important building material, and the most widely used type of construction engineering in all buildings, including infrastructure, low-rise and high-rise buildings, and domestic development [1]. Among them, aggregates are an important part of concrete, however, due to the consumption of high-quality primary aggregates and the improvement of environmental protection awareness, the practice of continuing to widely extract sand and gravel aggregates has been questioned. In order to establish environmental sustainability, it is very desirable to use some agricultural wastes and industrial by-products from different industries as building materials, and has certain economic and social benefits [2]. Therefore, the possibility of replacing traditional sand and gravel aggregates with shell aggregates has gradually been proposed.

2. The performance of shells.

2.1 Composition of shells.

The shell is mainly composed of inorganic phase and organic phase, the inorganic phase is about 95~99.9 % $CaCO_3$ (calcite, aragonite, coccoliite and amorphous), and the organic phase is composed of about 0.1~5 % organic matter. Generally speaking, the basic structure of the shell is mainly divided into three parts, the outermost layer is the stratum corneum composed of hard protein; the middle is a prismatic layer composed of calcite or aragonite crystals, which mainly provides hardness and dissolution resistance for the shell; the innermost layer is the nacre, which mainly provides hardness and toughness for the shell, generally composed of $CaCO_3$ minerals such as calcite or aragonite (inorganic phase) and organic matter (organic phase).

2.2 Properties of shells for concrete aggregates.

When replacing traditional sand and gravel aggregates, shells have higher strength than sand and gravel, and also have good mechanical properties and solidity, which can withstand the load and stress in concrete and ensure the safety and stability of concrete structures; have lower water absorption and adsorption, reduce the loss and evaporation of cement slurry; have lower alkali activity and harmful substance content, and avoid reaction with the alkali in cement, resulting in concrete cracking. In addition, studies have shown that the replacement of fine aggregates with appropriate proportions of shells can fill material pores, improve overall compactness, reduce absorption rate, improve compressive strength, and improve mortar workability, strength and durability [3]. Therefore, when replacing traditional aggregates, shells have sufficient rationality and feasibility.

3. Experimental design.

3.1 Experimental process.

According to the characteristics of shells, the basic idea of shell addition in this study is to add shells step by step according to the gradient under different particle gradation, with the addition rates of 10 %, 20 % and 30 %, respectively, replace the traditional sand and gravel aggregate in concrete, pour the block on this basis, and test the bending resistance, compression resistance and frost resistance of the block after the final setting of the block, so as to further discuss the influence of shell aggregate replacement on the mechanical properties of concrete.

3.2 Experimental materials.

The cement used in this study is R45. The experimental blocks were divided into standard group and reference group, and the material ratio of the standard group was: cement 0.5 kg, water 250 ml, sand 0.6 kg, stone 0.9 kg. On this basis, shells are added to concrete according to 10 %, 20 %, 30 % and other mass substitute stones, and cubic specimens of 40 × 40 × 160 mm are formed.

Conclusion: According to the research of scholar Yong, when the shell is incorporated in a certain proportion, the crack resistance and impact resistance of the cementitious material system can be improved [4].Experiments have shown that in the performance test of concrete using shells as aggregates, the strength of the block does not decrease at 28d,in addition, some scholar Martínez studied the compressive strength of ordinary mortar and shell mixtures in different proportions, and when the content of shell powder increased to 40 %,the compressive strength did not change significantly [4]. This shows that the crushed shell as aggregate does not cause the early strength of concrete to decrease, it not only maintains the advantages of ordinary concrete, but also has the advantages of waste utilization. Ez-ZakiExperiments found that broken shells (0/5 mm grade) can be used as a fine aggregate for self-compacting mortar, which does not affect the basic properties of mortar [6]. The microstructure test shows that the adhesion between the shell and the cement slurry is good, and the irregular shape of the shell significantly improves the distribution of the latter in the cement matrix, which fully indicates that the shell is used as a fine aggregate, compared with the traditional aggregate, and even significantly enhances the workability of concrete.Therefore, under the premise of reducing primary aggregate consumption and environmental protec-

tion, the use of shell aggregate does not affect the construction quality and can significantly reduce the price of building materials, so the use of shell aggregate can produce considerable social and economic benefits.

References

1. Ma H L, Cui C, Li X, et al. Study on mechanical properties of steel fiber reinforced autoclaved lightweight shell-aggregate concrete[J]. Materials & Design (1980–2015), 2013, 52: 565–571.

2. Khaldoun Rahal,Mechanical properties of concrete with recycled coarse aggregate,Building and Environment,Volume 42, Issue 1,2007, 407–415.

3. ZHAO Hui, XUAN Weihong, FENG Jiarui, et al. Research Progress on Recycling Technology of Waste Shells[J]. Journal of Jinling Institute of Science and Technology, 2019, 35(1): 34–39.

4. Yoon G L, Kim B T, Kim B O, et al. Chemical–mechanical characteristics of crushed oyster-shell[J]. Waste management, 2003, 23(9): 825–834.

5. Martínez-García C, González-Fonteboa B, Martínez-Abella F, et al. Performance of mussel shell as aggregate in plain concrete[J]. Construction and building materials, 2017, 139: 570–583.

6. Ez-Zaki H, Diouri A, Kamali-Bernard S, et al. Composite cement mortars based on marine sediments and oyster shell powder[J]. Materiales de construcción, 2016, 66(321): e080–e080.

EVALUATION OF GRAPHENE CONCRETE IN A GREEN ENERGY ECONOMY

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Annotation. This paper discusses the development of graphene concrete and the composition and mechanical application properties of graphene concrete and evaluates its economic sustainability based on its basic properties of green energy.

After the global financial crisis of 2008–2009, the concepts of "low carbon economy", "new green economy" and "green economic growth" have received increasing policy and media attention due to the gradual reduction of non-renewable energy sources and the diminishing value of the economy. concepts such as "Low Carbon Economy", "New Green Economy" and "Green Economic Growth" are receiving more and more policy and media attention. In the coming years, graphene oxide may have a huge impact on the concrete and construction-related industries. Due to the oxidizing ability associated with the aromatic structure, it has improved dispersion in mixtures compared to other graphene-based materials. Therefore the huge green energy economic benefits of graphene concrete are significant. How to turn graphene concrete