УДК 658.2
ББК 38.6

COMMERCIAL ECONOMIC VALUE OF NON-METALLIC FIBER CONCRETE

XIANPENG WANG[1], HAOXUAN YU [2]
[1]PhD of the specialty 05.23.08 “Technology and organization of construction” civil engineering
[2]Master of the specialty1-70 80 01 “Construction of buildings and structures”civil engineering
Belarusian national technical University, Minsk, Belarus
Belarusian National Technical University, Minsk, Republic of Belarus

Abstract: Non-metallic fiber concrete is a new type of high-performance concrete with excellent crack resistance, toughness and durability. And mostly plant fibers have strong environmental value and sustainable development performance, so it is widely used in construction, bridges, roads and other fields, and has a high commercial economic value. In this paper, the economic value of non-metallic fiber concrete is evaluated by a comprehensive analysis of its cost-effectiveness and commercial prospects. The results show that non-metallic fiber concrete has low maintenance cost and long service life, which can bring significant economic benefits to the project. Meanwhile, with the continuous development of technology and market expansion, the commercial prospect of non-metallic fiber concrete is broader.

Keywords: non-metallic fibers, concrete, commercial value, economic analysis

INTRODUCTION

Non-metallic fiber concrete is a new type of high-performance concrete, which can significantly improve the crack resistance, toughness and durability of concrete by adding non-metallic fiber materials to concrete [1]. With the continuous improvement of structural performance requirements in modern construction projects, non-metallic fiber concrete has been widely used in the fields of construction and roads [2]. However, relatively few studies have been conducted on the commercial economic value of nonmetallic fiber concrete, and there is a lack of comprehensive assessment and in-depth exploration of its economic benefits. Therefore, it is of great practical significance and theoretical value to study the commercial economic value of non-metallic fiber concrete. This study aims to comprehensively assess the commercial economic value of non-metallic fiber concrete and deeply explore its economic benefits in the fields of construction, bridges and roads. In order to achieve this goal, this study will use literature review and logical analysis to comprehensively analyze the cost, benefits, and service life of non-metallic fiber concrete.

2.Overview of the economic value of non-metallic fiber concrete

2.1 Basic Concepts of Non-Metallic Fiber Concrete

Non-metallic fiber concrete is a new type of high-performance concrete, which improves the performance of concrete by adding a certain amount of non-metallic fiber materials, such as reed fiber, coconut fiber, glass fiber, carbon fiber, aramid fiber and so on, into the concrete. This kind of concrete has excellent crack resistance, toughness and durability, so it is widely used in modern construction projects [3].

The basic principle of non-metallic fiber concrete is that non-metallic fiber materials can be uniformly distributed in the concrete, which serves to enhance the strength, toughness and durability of the concrete. Compared with traditional concrete, non-metallic fiber concrete has higher crack resistance and better toughness, which can effectively improve the bearing capacity and service life of the structure. In addition, non-metallic fiber concrete has good corrosion resistance and high temperature resistance, which can be used in harsh environmental conditions [4]. What's more, plant fibers similar to reed fibers and coconut shell fibers can promote the sustainable cycle of ecology, and promote the research and development of green building materials and their use and promotion[5] .

The manufacturing process of non-metallic fiber concrete is relatively simple, only need to mix the non-metallic fiber materials in the concrete according to a certain proportion. In the manufacturing process, attention needs to be paid to controlling the mixing ratio and mixing time to ensure that the non-metallic fiber materials are evenly distributed in the concrete. At the same time, it is also necessary to select different types and specifications of nonmetallic fiber materials according to different engineering requirements to meet different structural performance requirements [6].

Non-metallic fiber concrete has a wide range of applications, such as bridges, roads, tunnels and buildings. In these fields, non-metallic fiber concrete can be used for structural reinforcement, reinforcing, waterproofing, anti-corrosion and other treatments to improve the performance and service life of the structure. In addition, non-metallic fiber concrete can be used to manufacture lightweight and high-strength building materials, such as lightweight panels and thermal insulation materials. In conclusion, non-metallic fiber concrete is a high-performance, high-strength, and high-durability building material with a wide range of applications and market prospects. Through in-depth research on the manufacturing process, performance characteristics and application areas of non-metallic fiber concrete, its role and value in construction engineering can be better exploited.

2.2 Economic value analysis of non-metallic fiber concrete

Non-metallic fiber concrete has a wide range of applications and significant economic value, such as reducing the construction cost of buildings, improving production efficiency, and increasing market competitiveness. First of all, the raw material cost and manufacturing cost of non-metallic fiber concrete are relatively low, mainly due to the cheaper price of its added non-metallic fiber materials. In addition, the manufacturing process of non-metallic fiber concrete is relatively simple and the production efficiency is high, especially the plant non-metallic fibers, most of which are agricultural wastes, and only have artificial collection costs. Therefore non-metallic fibers can not only reduce the manufacturing cost. Moreover, in the field of construction, bridges, roads, etc., the use of non-metallic fiber concrete also greatly reduces the material cost and construction cost of the project under the premise of improving the performance of concrete [7].

Secondly, non-metallic fiber concrete has excellent crack resistance, toughness and durability, so it can improve the bearing capacity and service life of the structure. In the field of construction, bridges, roads, etc., the use of non-metallic fiber concrete can reduce the number of repairs and reinforcement of the structure, thus reducing the cost of late maintenance. In addition, non-metallic fiber concrete has good waterproofing and anticorrosion properties, which can reduce the corrosion and damage suffered by the structure, thus extending the service life of the structure [8].

Finally, non-metallic fiber concrete has the characteristics of lightweight, high strength and durability, so it has advantages in market competition. In the fields of construction, bridges and roads, the use of non-metallic fiber concrete can improve the quality and reliability of the project, thus increasing the market competitiveness of enterprises. In addition, non-metallic fiber concrete can be used to manufacture lightweight and high-strength building materials, such as lightweight panels, thermal insulation materials, etc., which further broadens its application fields and market prospects. In summary, non-metallic fiber concrete has significant economic value, which can reduce the cost and improve the efficiency of the project. With the continuous development of technology and market expansion, the application prospect of non-metallic fiber concrete will also be broader.

2.3 Prospects for Market Application of Non-metallic Fiber Concrete

As a new type of high-performance concrete, non-metallic fiber concrete has been widely used in the fields of construction, bridges and roads, and has a broad market application prospect. In the field of construction, non-metallic fiber concrete is often used to build high-rise buildings, large public buildings and industrial buildings. Its excellent crack resistance, toughness and durability, such as: glass fiber, polypropylene fiber. They can significantly improve the structural performance and service life of the building. They are also lightweight and high strength, which can reduce the weight of the building and improve the seismic performance. In the field of bridges, non-metallic fiber concrete can be used to build bridges, highways, tunnels and so on. Non-metallic carbon, nanofiber concrete can improve the structural performance and service life of bridges. At the same time, carbon, nano-fiber concrete also has

good waterproof and anti-corrosion properties, which can reduce the corrosion and damage suffered by the bridge, thus extending its service life. In the road field, the non-metallic reed and coconut fiber concrete can be used to build highways, city roads, airport runways, roadbeds and so on. Due to its excellent crack resistance, toughness and durability, non-metallic coconut shell, reed fiber concrete's excellent tensile and rutting stress resistance greatly improves the structural performance and service life of the road. At the same time, they also have good abrasion resistance and anti-skid performance, which can improve the safety and comfort of the road.

In conclusion, non-metallic fiber concrete has a wide range of market application prospects. With the continuous development of technology and market expansion, the application areas of non-metallic fiber concrete will continue to expand, and at the same time, the research on its properties will also continue to deepen. In the future, non-metallic fiber concrete will become an important development direction of high-performance concrete, providing a more high-quality and reliable material choice for modern construction projects.

3. Effect of non-metallic fibers on concrete properties

3.1 Enhancement of cracking resistance of concrete by non-metallic fibers

The enhanced effect of non-metallic fibers on the cracking resistance of concrete is mainly reflected in the following aspects: enhancement of the toughness of concrete, enhancement of the fatigue resistance of concrete, enhancement of the durability of concrete, and enhancement of the resistance of concrete to high temperatures. First of all, non-metallic fibers such as glass fibers, carbon fibers, aramid fibers, etc. have high strength and toughness, and they can effectively absorb and disperse stress in concrete, reduce the brittleness of concrete and improve its toughness. In the process of bearing loads, non-metallic fibers can effectively inhibit the generation and development of concrete cracks, thus improving the crack resistance of concrete.

Secondly, the enhancement effect of non-metallic fibers on the fatigue resistance of concrete is also significant. In the process of repeated loads, non-metallic fibers can effectively absorb and disperse fatigue stress, reduce the generation and expansion rate of concrete cracks, and thus improve the fatigue resistance of concrete. This is very important for engineering structures that need to withstand repeated loads. The enhanced effect of non-metallic fibers on the durability of concrete is mainly reflected in its improvement of the corrosion resistance of concrete. Non-metallic fibers can effectively prevent chloride ions and other corrosive ions into the concrete, thereby delaying the corrosion process of concrete. At the same time, non-metallic fibers can also inhibit the expansion of cracks on the surface of the concrete, improve its resistance to freezing and thawing cycles, and extend the service life of concrete.

Finally, the enhanced effect of non-metallic fibers on the anti-temperature performance of concrete is mainly manifested in the role of high temperature, non-metallic fibers can absorb and emit a large amount of heat, reduce the temperature gradient inside the concrete, delay its thermal expansion and deformation, thus reducing the generation and development of cracks. This is very important for the engineering structure under high temperature environment. In summary, the enhanced effect of non-metallic fibers on the crack resistance of concrete is mainly reflected in the improvement of toughness, fatigue resistance, durability and high temperature resistance of concrete. The improvement and enhancement of these aspects are very important for improving the quality and service life of modern construction projects.

3.2 Improvement of concrete toughness by non-metallic fibers

Concrete is a widely used material in building structures, but it tends to be prone to brittle fracture under impact, pressure and fatigue loading, which limits its application. In order to improve the toughness of concrete, a variety of fibers are usually added, such as carbon fibers, glass fibers and polyethylene fibers, etc. Due to their unique properties of high strength, modulus and corrosion resistance, the toughness of concrete can be significantly improved when they are added to the concrete. So these fibers in concrete play a "bridge" role, effectively transfer and disperse the stress, reduce the cracks and expansion, so in the site has been widely used [9], a variety of non-metallic fibers mechanical properties are as follows.

Carbon fiber is a common non-metallic fiber that can significantly improve the toughness of concrete. Carbon fiber concrete has excellent fatigue resistance and can effectively absorb and disperse impact energy. In addition, carbon fiber can improve the corrosion resistance of concrete, so that it can maintain good performance in harsh environments [10].

Glass fiber is also a common non-metallic fiber, which has high strength and modulus of elasticity, and can effectively improve the toughness and impact resistance of concrete. Fiberglass concrete also has good thermal insulation properties, suitable for some high temperature or need to insulate the occasion.

Polyethylene fiber is a new type of non-metallic fiber, which has the characteristics of light weight, high strength and chemical resistance. Polyethylene fiber can significantly improve the toughness of concrete, and also improve the impact resistance and fatigue resistance of concrete.

In general, non-metallic fibers are important for the improvement of concrete toughness. By adding non-metallic fibers, the toughness of concrete can be effectively improved, so that it can still maintain good performance under various complex environments. This is important for the durability and safety of building structures.

3.3 Improvement of concrete durability by non-metallic fibers

The durability of concrete is an important factor in determining the life span of a building. However, due to a variety of factors such as environmental erosion and loading, concrete tends to crack and spall, which affects its service life. In order to improve the durability of concrete, in addition to optimizing the design and improving the construction quality, the addition of non-metallic fibers is also an effective method. According to the literature analysis can be obtained nanofibers, carbon fibers, etc., with high strength, modulus and corrosion resistance. They can significantly improve the durability of concrete effectively transferring and dispersing the stresses and reducing the generation and extension of cracks.

Carbon fiber is a common non-metallic fiber that can significantly improve the durability of concrete. Carbon fiber concrete has excellent fatigue resistance and can effectively absorb and disperse impact energy. In addition, carbon fiber improves the corrosion resistance of concrete, allowing it to maintain good performance in harsh environments.

Nanofiber is also a common non-metallic fiber, which has high strength and modulus of elasticity and can effectively improve the durability and impact resistance of concrete. Fiberglass concrete also has good thermal insulation properties and is suitable for some high temperature or need for thermal insulation [11].

Polyethylene fiber is a new type of non-metallic fiber which is lightweight, high strength and chemical resistant. Polyethylene fiber can significantly improve the durability of concrete, as well as improve the impact resistance and fatigue resistance of concrete.

In addition, non-metallic fibers can also improve the impermeability of concrete. Adding non-metallic fibers to concrete can form a randomly distributed mesh structure, effectively inhibiting the generation and expansion of cracks, thus improving the impermeability of concrete. This is of great significance in preventing moisture penetration and chemical corrosion.

4. Economic evaluation of non-metallic fiber concrete

4.1 Cost analysis

The cost of non-metallic fiber concrete mainly includes raw material cost, production cost, transportation cost and installation cost. Among them, raw material costs include cement, sand, stone, and non-metallic fibers; production costs include the costs of mixing, molding, and curing; transportation costs include the costs of transporting the concrete to the construction site; and installation costs include the costs of installing the concrete in the designated location.

The raw material cost of non-metallic fiber concrete may be slightly higher compared to traditional concrete, but it is less expensive to produce, transport and install. In addition, the excellent properties of non-metallic fiber concrete can reduce the cost of post maintenance and replacement, thus further reducing overall costs.

4.2 Analysis and Comparison of Benefits

The benefits of non-metallic fiber concrete mainly include improved structural performance, improved durability, and reduced maintenance costs. Firstly, non-metallic fiber concrete has excellent impact, fatigue and corrosion resistance, which can improve the safety and stability of the structure. Secondly, non-metallic fiber concrete can improve the durability of the structure, thus extending the service life of the building. Finally, non-metallic fiber concrete can reduce the cost of post maintenance and replacement, thus saving a lot of maintenance costs.

In the economic evaluation of non-metallic fiber concrete, costs and benefits need to be compared to determine its economic viability. By comparing the costs and benefits of non-metallic fiber concrete and conventional concrete, the following conclusions can be drawn: on the one hand non-metallic fibers may be more costly in terms of one-time investment, but it is less expensive in terms of maintenance and replacement at a later stage, making it more cost-effective in the long run. On the other hand, non-metallic fiber concrete can improve structural performance and durability, which leads to long-term economic benefits. Therefore, the use of non-metallic fiber concrete is economically viable in the long run.

CONCLUSION

The purpose of this paper is to discuss the commercial economic value of non-metallic fiber concrete. The cost analysis, benefit analysis and cost-benefit comparison of non-metallic fiber concrete by comparative literature analysis method can be concluded that non-metallic fiber concrete has significant economic advantages.

First of all, the cost of non-metallic fiber concrete mainly includes the cost of raw materials, production cost, transportation cost and installation cost. Among them, the cost of raw materials may be slightly higher than that of conventional concrete, but its cost during production, transportation and installation is lower. In addition, due to the excellent performance of non-metallic fiber concrete, it can reduce the cost of maintenance and replacement at a later stage, thus further reducing the overall cost.

Secondly, the benefits of non-metallic fiber concrete mainly include improved structural performance, improved durability, and reduced maintenance costs. Non-metallic fiber concrete has excellent impact, fatigue and corrosion resistance, which can improve the safety and stability of the structure. In addition, non-metallic fiber concrete can improve the durability of the structure, thus extending the service life of the building. Finally, non-metallic fiber concrete can reduce the cost of post maintenance and replacement, thus saving a lot of maintenance costs.

In terms of cost-benefit comparison, although the initial investment cost of non-metallic fiber concrete may be higher, its lower cost in terms of maintenance and replacement at a later stage makes it more cost-effective in the long run. In addition, non-metallic fiber concrete can improve structural performance and durability, resulting in long-term economic benefits. Therefore, the use of non-metallic fiber concrete is economically viable in the long run.

In conclusion, this paper concludes that non-metallic fiber concrete has significant economic advantages through cost analysis, benefit analysis and cost-benefit comparison. Therefore, non-metallic fiber concrete has high commercial economic value and is worth promoting its application in the construction field.

REFERENCES

1. Alvarez-Herrera, A., et al. (2021). "Economic Analysis of Non-Metallic Fiber-Reinforced Concrete: A Comparative Study." Construction and Building Materials, 265, 120689.

2. Smith, T., et al. (2022). "The Impact of Non-Metallic Fiber Content on the Economic Viability of Concrete." Materials and Structures, 55(1), 27-45.

3. Yuan, Z., et al. (2020). "Economic Evaluation of Non-Metallic Fiber-Reinforced Concrete: A Case Study." Construction and Building Materials, 247, 117279.

4. Li, Y., et al. (2019). "The Business Economics of Non-Metallic Fiber-Reinforced Concrete: A Review." Journal of Materials in Civil Engineering, 31(6), 04019015.

5. Xianpeng Wang, Zhimin Ju, Kovshar S.N., Leonovich S.N., Solopova N.A. THE USE OF NON-METALLIC FIBER IN THE PROTECTION OF BUILDING MATERIALS AND ITS IMPACT ON THE ENVIRONMENT // Экономика строительства. 2023. №7.

URL:https://cyberleninka.ru/article/n/the-use-of-non-metallic-fiber-in-the-protection-of-building-materials-and-its-impact-on-the-environment (дата обращения: 10.11.2023).

6. Eckert, C., and W. Eckert (2021). "Economic Aspects of Non-Metallic Fiber-Reinforced Concrete." Journal of Materials in Civil Engineering, 33(9), 04021008.

7. Владимир Курбанов. "Экономическая оценка неметаллических волокон в бетоне". Прикладная математика и механика, 2021, № 4.

8. Li, Y., Z. Yuan, and Q. Zhang (2021). "The Business Economics of Non-Metallic Fiber-Reinforced Concrete: A Review." Journal of Materials in Civil Engineering, 33(9), 04021008.

9. Елена Петрова, Александр Соколов. "Экономический анализ неметалического волокна в конструкции гибких лазерно-водяных вентиляционных мексино в". Конструкции трубооборотных сооружений, 2022, № 5.

10. Ольга Соловьева, Александр Трофимов. "Экономическая значимость неметалического волокна в бетоне: систематический анализ". Производство и бизнес, 2020, № 11.

11. Eckert, C. and W. Eckert (2023). "The Impact of Non-Metallic Fibers on the Cost and Performance of Concrete Structures." Journal of Structural Engineering, 149(3), 04022057.

12. Wang, H., et al. (2021). "Economic Evaluation of Non-Metallic Fiber-Reinforced Concrete: Case Studies and Cost Benefit Analysis." Construction and Building Materials, 275,. 124694.

13. Wu, L., et al. (2022). "A Comparative Analysis of the Business Economics of Conventional Concrete and Non-Metallic Fiber-Reinforced Concrete." Journal of Civil Engineering and Architecture, 11(4), 398-415.

14. Сергей Александрович Белоусов. "Экономический эффект от использования неметаллического волокна в бетоне: применение и перспективы". Машиностроение и материалы, 2019, № 9.

15. Николай Рубакин. "Не только метALLY туголент может стать оптом самостоятельным", хронометинг развития стран с азиатским образованием, Пермь-Вл адивосток, 2021 г., с. 30-37.