Research on the Performance of Straw Fiber Concrete

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Abstract. With the development of technology and economy, environmental protection is an important issue in all industries. Straw fiber is used in construction industry, which is a kind of green material. On the one hand, it can reduce the environmental hazards of crop burning. On the other hand, it can save construction cost according to the requirement of national related buildings. The fiber reinforced concrete has high strength and meets the need of heat insulation by adjusting the relevant mix proportion design.

1. Introduction
With the development of economic and technology. Concrete is paid more and more attention in the construction industry due to its high strength, low cost and simple production process. However, there are some deficiencies in the construction of concrete. First, ordinary concrete is a brittle material. Brittle failure is easy to occur when the force is large. Second, due to the heavy use of concrete, more resources will be consumed and more construction waste will be generated. So the research on concrete continues. Due to the change of architectural environment, environmental protection should be paid attention during the construction process. The northeast region is rich in rice, and the yield of straw is considerable. But it can cause environmental damage because of its improper handling. It is considered that straw can be added to concrete to improve the performance of concrete.

The study found that the improvement of material strength is not obvious by adding straw fiber, but the other performance of concrete can be enhanced by controlling the length and amount of straw fiber. The application of straw fiber concrete not only effectively solves the problem of waste disposal, but also adapts to the sustainable development of national construction in promoting economy. It has greatly promoted the development and application of economical and efficient building products.

2. The advantages of straw fiber concrete

2.1. Crack resistance effect
Shrinkage and creep can be generated due to the combination of molding process and maintenance. The concrete materials will appear some internal and surface size of crack and the crack seriously affect the concrete strength and beauty. It can effectively reduce the cracks by adding straw fiber in the concrete. The straw fiber has the effect of reinforcement.
2.2. Increase the intensity
There are tiny cracks in the concrete structure before adding straw fiber which have a strong impact on its strength. The structure will be brittle fracture under very small tensile force when the concrete structure is pulled. After adding straw fiber, it can effectively reduce the production of cracks, control the development of cracks and improve the internal defects of the materials. So, enhance the tensile, pressure and anti-folding properties of the materials.

2.3. Enhanced toughness
Due to the straw fiber, the concrete internal structure is more density. The straw fiber acts as a reinforcement forming a dense structure form. When the structure is stressed, the straw fiber concrete can withstand the large shear and bending moment. The material will not be destroyed immediately before the ultimate load reached due to the straw fiber which will give people enough reaction and processing time.

2.4. Environmental protection
Straw fiber is very good building material, because it is easy to use, the price is low and its production is consistent with our country's building policy. The reuse of abandoned building materials avoids the waste of materials and the environmental problems caused by combustion which is in line with the green environmental protection theme advocated by China.

3. Physical and mechanical performance

3.1. Construction and facilitation
The study found that the slump of concrete decreased with the proportion of straw fiber increased. The smaller the diameter of the straw fiber, the smaller the slump of the concrete. Through the research analysis, the smaller the diameter of straw fiber, the better in water absorption. Straw fiber can absorb moisture from the concrete when the straw fiber are putted into the concrete and reduce the amount of free water in the concrete.

In order to ensure the material workability in the process of construction, we must control the content of free water ensuring the good construction workability by increasing the dosage of the water or control the content of straw.

| Amount of admixture (%) | 0  | 1  | 2  | 3  | 4  | 5  | 6  | 7  |
|-------------------------|----|----|----|----|----|----|----|----|
| Slump(mm)               | 90 | 81 | 75 | 62 | 54 | 48 | 41 | 38 |

3.2. The strength
It can be draw the conclusion that the strength of concrete can not improve obviously by increasing the straw fiber. With the increase of dosage of straw, the strength of the straw fiber concrete decreased. On the one hand, there are many gaps between straw fiber content which will decrease the strength of concrete. On the other hand, straw fiber is a kind of natural plant fiber. There are many organic materials on the straw fiber surface which can stop the better bonding with the concrete.
Table 2. Flexural strength and compressive strength value of Straw fiber concrete (MPa)

| Amount of admixture (%) | Flexural strength (7d, 14d, 28d) | Compressive strength (7d, 14d, 28d) |
|-------------------------|-----------------------------------|-------------------------------------|
| 0                       | 3.24, 3.76, 4.28                  | 25.6, 29.7, 35.1                    |
| 1                       | 2.62, 2.83, 3.18                  | 23.8, 28.6, 31.5                    |
| 2                       | 2.38, 2.74, 3.04                  | 17.5, 20.3, 25.8                    |
| 3                       | 2.24, 2.71, 2.99                  | 14.1, 18.5, 20.7                    |
| 4                       | 1.99, 2.58, 2.77                  | 11.3, 14.2, 15.6                    |
| 5                       | 1.80, 2.54, 2.51                  | 9.9, 11.2, 13.7                     |
| 6                       | 1.52, 2.31, 2.30                  | 8.9, 10.9, 11.9                     |
| 7                       | 1.46, 2.04, 2.29                  | 8.0, 9.8, 10.8                      |

3.3. The shock resistance

The shock resistance of concrete is the ability to prevent external forces from being damaged by lots of rapid external forces. The American concrete association recommend drop weight method as the way to take the shock resistance of concrete which is widely accepted. It can be observed through the research that the shock resistance of rice straw fiber concrete gradually strengthened when straw fiber content gradually increased. The analysis shows that straw fibers can absorb a certain amount of energy when the ball impact the specimen. So straw fibers can improve the shock resistance of the material. Compared with ordinary concrete the rice straw fiber concrete impact resistance is obviously improved and its damage process is plastic which can avoid rapid and fragmentation damage caused by ordinary concrete during impact damage.

Table 3. The number of hits to the concrete before the first crack

| Amount of admixture (%) | 0  | 1  | 2  | 3  | 4  | 5  | 6  | 7  |
|-------------------------|----|----|----|----|----|----|----|----|
| the number of hits to   | 85 | 149| 168| 182| 215| 239| 247| 256|
| the concrete before the |    |    |    |    |    |    |    |    |
| first crack             |    |    |    |    |    |    |    |    |

3.4. The thermal performance

In the northeast region, the temperature is low in winter. So, the building materials are required to have a good thermal insulation performance. Increasing the thermal resistance of building materials is an application in engineering practice to improve the thermal insulation performance. The studies showed that straw fiber concrete has better heat preservation effect compared to ordinary hollow brick. Heat transfer coefficient of material is reduced and the heat preservation performance increased with the increase of straw fiber dosage ratio. The thermal insulation performance of the material get stronger when the diameter of straw fiber get smaller.

![Figure 1. General concrete block thermal](image-url)
Figure 2. Straw fiber concrete block thermal performance curve performance curve

4. Conclusion
Straw fiber can effectively improve the material construction workability, but it cannot increase strength. Rice straw fiber can obviously increase the toughness by a suitable amount range. Its insulation performance is better than hollow concrete brick. The smaller the diameter of straw fiber the better the insulation effect. Straw fiber concrete has good impact resistance and can improve its toughness effectively. The higher the content of straw fiber in a certain range, the better the material toughness. The content of straw fiber should be between 5% and 7% considering the strength, toughness and self-weight of straw fiber concrete.

Acknowledgments
The authors gratefully acknowledge the financial supported by the Jilin province 13th five-year plan important project of educational science: Practical training course construction of civil engineering specialty in applied undergraduate colleges (ZD17122), and Jilin province department of education science and technology research projects (JJKH20180305KJ).

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