Research on Fatigue Performance of Palm Fiber Mattress

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Abstract: The palm fiber mattress is made of palm fiber and natural latex material. In recent years, with the society's environmental protection requirements and the sustainable development of resources, more and more researches on its performance have been made. In this paper, through the compression fatigue test of the palm fiber mattress test block, simulate the impact of human sleep on the mattress under 8 hours a day, study the fatigue performance of the palm fiber mattress under different loads, and analyze the experiment to find that the palm fiber mattress The stress-strain curve of the fiber mattress test block and the deformation of the mattress test block. Finally, the obtained results were subjected to finite element simulation and linear fitting, and the calculated results were consistent with the experiments, which proved the validity of the experimental data.

Keywords: palm fiber, finite element simulation, numerical simulation, compression fatigue, composite material

1. Introduction

As the pace of life accelerates, people's work efficiency begins to improve, and people's sleep quality will have a certain impact on their own life and work. Insufficient sleep can lead to low work efficiency during the day, reduce people's physical functions and even cause serious diseases [1]. The mattress industry is developing rapidly, and people are beginning to explore and use better mattresses. The material, hardness, air permeability and moisture permeability of the mattress will affect the quality of human sleep. Studies have found that different mattresses have a greater impact on the quality of human sleep [2]. Natural fiber composite materials can be used to make mattresses, and natural fiber reinforced components can replace any other material components, because in addition to environmental protection performance, it also has higher mechanical properties[3]. The material of the mattress will affect the comfort of human sleep, and proper support is essential for human sleep. There are many types of mattresses used by people around the world, and the former composite mattresses occupy most of the market. Nowadays, traditional composite mattresses are gradually being abandoned and replaced by natural mattresses with better performance and environmental protection. Among them, palm fiber mattresses are favored by people because of their good elasticity and good environmental performance.

The current production of the palm fiber mattresses is mainly made by bonding natural palm and natural latex, and its manufacturing process is healthier and environmentally friendly. The natural latex in the palm fiber mattress is a new type of adhesive, with pure natural characteristics, will not cause any toxic substances to the human body, and can meet the national environmental sanitation requirements, while the performance is relatively stable. Palm fiber is a kind of reticulated palm fiber, which is mainly formed in the outer leaf sheath of the palm trunk. It has good toughness, high strength, good elasticity, and good air and moisture permeability [4]. The composite material made by mixing the fiber ratio has good tensile and compressive strength. When the palm fiber fiber ratio is 28% [5], the material performance is the best. It can be seen that palm fiber as an important part of composite materials can play a great role. The improved palm fiber and polyester composite material have good mechanical properties and bending properties [6]. The polyester composite material composed of palm fiber and phenolic resin has an important fiber water absorption rate for the dynamic performance of the composite material. Influence [7]. Palm fiber has a wide range of applications in the field of building materials, among which palm fiber can be used to reinforce building mortar [8-9] and asphalt pavement [10]. When
palm fiber and glass fiber [11] make composite materials, the effect is more in line with actual needs.

The structure of the mattress has a significant impact on the sleep of the human body. A reasonable arrangement of the structure of the mattress has a more even distribution of human support, which is also the significance of studying the structure of the mattress. With the widespread use of palm fiber mattresses in people's lives, people's research on its performance has also become a scientific and technological hotspot in recent years. In terms of mechanical properties, some scholars took the lead in determining the maximum tensile stress of palm fibers [12], and some studies combined the Weibull distribution model to predict the strength of palm fibers [13], and the tensile properties of palm fibers [14]. Conducted research, it seems that palm fiber meets the requirements as a mattress material. The force of the human body on the mattress is determined by different sleeping postures, and the pressure distribution of the human body will have a long-term impact on the performance of the mattress [15]. Wu proposed a viscoelastic shear lag model, which uses three-dimensional scanning technology and similarity measurement theory to evaluate sleep. And proposed a method to evaluate the human sleep comfort [16], Zhang determined the five material parameters of the transversely isotropic palm mattress through tensile, compression, and shear experiments, and established the stiffness matrix and constitutive equation of the palm fiber/natural latex composite mattress [4].

When the human body is lying flat, it will generate external force on the mattress, causing the mattress to be repeatedly loaded by external force for a long time, causing damage to the interior of the mattress, resulting in structural instability and causing the mattress to sag. This kind of external force when the human body is lying flat will compress the mattress for a long time and cause fatigue damage. The mattress is subjected to long-term repeated compression, which causes the mattress to undergo permanent deformation, which involves the life of the mattress and damage detection problems. However, there is currently no in-depth research on this aspect at home and abroad. In this paper, the palm fiber mattress is regarded as an isotropic material and a transversely isotropic material for compression fatigue experiments. Repeated compression is performed on the mattress test block by applying the same load as the weight of the human body, and the stress-strain curves of palm fiber mattresses of different sizes are obtained. Finally, use ANSYS workbench for modeling calculations, and compare the simulation results with experimental data to discuss its credibility.

2. Materials and equipment

2.1 Materials

There are four main procedures for the processing and production process of Palm Palm Mattress: palm leaf pretreatment, spraying and pressing, vulcanization and shaping, and cooling and cutting. The process flow chart is shown in Figure 1. The raw material of the palm fiber mattress material is the leaves of palm plants, and the material is pretreated first. The palm fiber filaments are extracted from palm leaves as raw materials, and the palm filaments are screened. Then through high-temperature cooking and sugar-removing and degreasing processes, some of the water and sugar contained in the palm fiber are removed. The next step is to spray glue and press to break up the combed palm fiber fiber ropes and use the all-directional airflow of the equipment to make the fiber ropes cross each other. Then, spray natural latex to make the nodes between the fibers adhere to each other to make a bare board. After that, the matting is carried out, and the single reticulated palm fiber sheets are layered layer by layer to form a mat of a certain area and quality. Finally, a hot press is used to heat-press and preliminarily shape the stacked mats with a certain thickness. Then, after the initial setting of hot pressing, the palm mat needs to be vulcanized. Put the palm mat into a vulcanizing tank and add sulfur as a cross-linking agent and vulcanize at a certain temperature and pressure. The vulcanized palm mat is then heat-pressed and shaped, and the palm mat is pressed into the required thickness.
2.2 Equipment

In the experiment, the laboratory’s MTS810 universal material testing machine (Figure 2) is used. It has high accuracy and is recognized globally. The testing machine has a sophisticated automatic control and data acquisition system to realize the data acquisition and control process. Digital adjustment. Especially in the process of tensile, compression and fatigue experiments, the MTS testing machine can instantly measure the material's load-bearing tensile force or loading pressure, tensile deformation or compression deformation, and automatically calculate tensile strength, elongation and other related data. For the compression fatigue test of the palm fiber mattress test block, the MTS810 universal material testing machine can meet the test requirements.

3. Methodology

3.1 Material parameters

Due to the good elasticity of the sample, the porous structure makes it have more gaps, the palm fiber fiber test block in the experiment is compressed in the vertical direction, and the deformation amount of the test block in the horizontal direction will be relatively small, so it can be measured with a vernier caliper. Before and after the experiment, use a vernier caliper to measure the actual size of the palm fiber mattress test block of different thickness, and then perform the weighing record and number of the test block. The size number of the palm mattress test block is shown in Table 1. A total of 18 test pieces were used in the experiment, including 10 130 mm thick test blocks, 4 90 mm thick test blocks, 3 85 mm thick test blocks, and 1 70 mm thick test block.

In order to improve the accuracy of the experiment and avoid the influence of the unbalance of the
In the experimental area, the test block is placed on the custom-made flat fixture before the experiment, and the centering adjustment is performed. As shown in Figure 3, the upper and lower flat fixtures and the palm fiber mattress test block are set. In the position just touched. Simulating the state of the human body lying on the mattress when lying supine, the palm fiber mattress specimen is subjected to a full compression force in the experiment.

### Table 1 Dimension parameter of experimental materials

| Number | Serial number | Length/mm | Width/mm | High/mm | Weight/kg | Volume/m$^3$ |
|--------|---------------|-----------|----------|---------|-----------|--------------|
| 1      | 130-1         | 200       | 200      | 130     | 0.5264    | 0.0052       |
| 2      | 130-2         | 200       | 200      | 130     | 0.5534    | 0.0052       |
| 3      | 130-3         | 200       | 200      | 130     | 0.5568    | 0.0052       |
| 4      | 130-4         | 200       | 200      | 130     | 0.5229    | 0.0052       |
| 5      | 130-5         | 200       | 200      | 130     | 0.5617    | 0.0052       |
| 6      | 130-6         | 200       | 200      | 130     | 0.5254    | 0.0052       |
| 7      | 130-7         | 200       | 200      | 130     | 0.5715    | 0.0052       |
| 8      | 130-8         | 200       | 200      | 130     | 0.5864    | 0.0052       |
| 9      | 130-9         | 200       | 200      | 130     | 0.5727    | 0.0052       |
| 10     | 130-10        | 200       | 200      | 130     | 0.5208    | 0.0052       |
| 11     | 90-1          | 200       | 200      | 90      | 0.3638    | 0.0036       |
| 12     | 90-2          | 200       | 200      | 90      | 0.3693    | 0.0036       |
| 13     | 90-3          | 200       | 200      | 90      | 0.3606    | 0.0036       |
| 14     | 90-4          | 200       | 200      | 90      | 0.3693    | 0.0036       |
| 15     | 85-1          | 200       | 200      | 85      | 0.4534    | 0.0034       |
| 16     | 85-2          | 200       | 200      | 85      | 0.4425    | 0.0034       |
| 17     | 85-3          | 200       | 200      | 85      | 0.4348    | 0.0034       |
| 18     | 70-1          | 200       | 200      | 70      | 0.2824    | 0.0028       |

**Fig. 3 Compression Fatigue Diagram**

### 3.2 Experiment content and method

This compression fatigue test is divided into four groups to study the influence of loading speed on the palm mattress, the thickness change after repeated compression of the mattress, the compression fatigue performance of mattresses of different thicknesses, and the compression fatigue performance of mattresses under different loads. The displacement load data of the palm fiber mattress test block is obtained by the MTS810 testing machine, and the vertical thickness change of the palm fiber mattress before and after the test is measured with a vernier caliper. The three different loads selected in the experiment are 0.6 kN, 1 kN, and 2 kN, respectively, to simulate the weight of a single person or the weight of multiple persons acting on the mattress.

The first set of experiments investigates the influence of different loading speeds on the experiment of the palm fiber mattress. In the experiment, the palm fiber mattress test pieces with size numbers 130-1, 130-2, 130-3 were selected, and the 130-1 palm fiber mattress test piece was loaded at a speed of 0.001 kN/s, and the 130-2 palm fiber bed was loaded. The cushion test piece is loaded at a speed of 0.01 kN/s, and the 130-3 palm fiber mattress test piece is loaded at a speed of 0.1 kN/s. The displacement load data is obtained by the system and processed into a stress-strain curve. To analyze the impact of different speeds.

The second group of experiments studied the thickness changes of palm fiber mattresses after repeated compression. The thickness of the palm fiber mattress test blocks used in the experiment were 130 mm and 90 mm, and their size numbers were 130-4, 130-5, 130-6, and 90-1, 90-2, 90-3. The
experiment adopts the full-plane compression loading method to carry out the compression experiment. The loading speed is set to be constant at 0.001 kN/s, until the compression load reaches 1 kN, and the experiment ends after the load is maintained for 8 h. Use a vernier caliper to measure the thickness of the material before and after the start of the experiment, measure it again after 8 hours, and finally unload. The unloading speed is 0.1 mm/s. The splint returns to the original position and stops, and the system automatically records the load and displacement. The next experiment was carried out after 16 h. The thickness of the material was measured with a vernier caliper before and at the end of the experiment.

The third group of experiments studied the compression fatigue performance of palm fiber mattresses with different thicknesses. In the experiment, different thicknesses of palm fiber mattress test pieces were selected, which were 130 mm, 90 mm, and 70 mm palm fiber mattress test pieces, and the size numbers were 130-7, 90-4, and 70-1 palm fiber test pieces. Set the loading speed to 0.001 kN/s. When the compressive load is 1 kN, keep the load unchanged for 8 hours, and finally unload. The unloading speed is 0.1 mm/s. The splint returns to the original position and stops, and the system automatically records the load and displacement. The next experiment was carried out after 16 h. The thickness of the material was measured with a vernier caliper before and at the end of the experiment.

The fourth group of experiments studies the compression fatigue performance of palm fiber mattresses under different loads. (1) Three palm fiber mattress test blocks with a thickness of 130 mm are selected for the experiment, and the test block numbers are 130-8, 130-9, and 130-10 respectively. The 130-8 test block was loaded with a load of 0.6 kN at a loading speed of 0.001 kN/s, and the holding load was carried out for 8 h. After 16 h, the second experiment was carried out, loaded with the same force, and the load was held for 8 h. The third experiment was carried out after 16 h. For the 130-9 test block, a compression load of 1 kN is used, and the experiment procedure remains unchanged. The 130-10 test block was loaded with a compression load of 2 kN, and the experimental procedure remained unchanged. Before and after the experiment, use a vernier caliper to measure the thickness of the material, record the respective experimental data, and repeat the experiment for three days. (2) Three palm fiber fiber test blocks with a thickness of 85 mm are selected for the experiment, and the test block numbers are 85-1, 85-2, and 85-3 respectively. The loading speed is 0.001 kN/s. The 85-1 test block is loaded with a load of 0.6 kN, the 85-2 test block is loaded with a load of 1 kN, and the 85-3 test block is loaded with a load of 2 kN. The holding load is carried out for 8 h, then Unload the load, perform the next experiment in 16 hours, record the respective time displacement curves, and repeat the experiment for three days.

4. Results and discussion

4.1 The influence of different loading speeds on palm fiber mattresses

From Figure 4, it can be found that the stress-strain curve trends of the palm mattress under the compression load at the three different loading speeds are consistent. The 130-3 mattress test piece was loaded at a speed of 0.1 kN/s, and the resulting stress peak value was greater than the stress value set in the experiment. Excessive compression of the mattress makes the mattress compact and affects the performance of the mattress. The 130-1 mattress test piece was loaded at a loading speed of 0.001 kN/s, and the peak stress produced by the test piece was close to the stress value set in the experiment, which had the least impact on the experiment and met the expected conditions. Therefore, a loading speed of 0.001 kN/s was selected for subsequent experiments.

Fig. 4 Stress-strain curves of three different loading rates
4.2 The size change law of palm fiber mattress

Fig. 5 130 mm block thickness curve

Fig. 6 90 mm block thickness curve

Fig. 7 Deformation rate of 130 mm test block
Fig. 8 Deformation rate of 90 mm test block

Figures 5 and 6 show the changes in the thickness of the mattress test block under different experimental times. It can be seen from the figure that in the first two experiments, the thickness change of the fiber mattress test block is greater than that of the third test, and the thickness of the palm fiber mattress material of the mattress test block changes after the third test. Tend to a stable value. The 90 mm specimen was finally stabilized at a deformation of 85 mm, while the 130 mm specimen was deformed at 120 mm. The change of the mattress with a large thickness was greater than that of the specimen with a small thickness. After many experiments, it has been shown that the thickness of the palm fiber mattress after three compressions can reach a stable state, and when it is loaded with the same force, its thickness can finally return to its original state, indicating that the mattress has reached a stable state. Therefore, the final stability value of the thickness of the palm mattress can be measured in the experiment under the same conditions for three days, which provides a basis for the fatigue analysis of the mattress.

Figure 7 and Figure 8 show the deformation rate of the two sizes of mattresses in the repeated compression experiment (the ratio of the thickness after this compression to the thickness before the first compression). Under the same external load for multiple compressions, the deformation rate of the mattress increases with the number of compressions, and the deformation rate increases, and the deformation rate of the mattress does not change after the third experiment. The deformation rate of the 130 mm thick mattress test block is 7.7 to 8.4%, and the 90 mm thick mattress test block deformation rate is 5.5%, indicating that the thick mattress has greater deformation under the same experiment. The final deformation rate remains unchanged, indicating that the mattress has reached the compression fatigue limit. Under the same external force, the compression of the mattress remains unchanged.

4.3 Performance analysis of palm fiber mattress test blocks with different thicknesses

After applying a certain load to study the performance of different thicknesses of the palm fiber mattress test block under the action of a stable load, the displacement load data is obtained through the MTS810 device, and the stress-strain relationship curve is obtained by conversion, and the stress obtained in the experiment The trend of the strain curve remains unchanged. The single compression fatigue test process of the palm fiber mattress test block is divided into three stages (Figure 9), namely the loading stage, the maintaining load stage and the unloading stage. In the loading stage, the palm fiber fiber mattress test block was loaded at a speed of 0.001 kN/s. As the stress increased, the strain also changed correspondingly. In the load-maintaining stage, a stable and unchanging load is applied to the palm fiber mattress. During the process, the stress does not change, while the strain of the test block will slowly increase to a certain value and finally remain unchanged, indicating that the thickness of the test block will change under the continuous action of external force. Slowly be compressed, and finally reach the maximum strain. When the applied load is released during the unloading stage, the strain of the test block becomes smaller, but the original thickness cannot be restored.

Fig. 9 Three stages of compression fatigue test

Figure 10, Figure 11 and Figure 12 show the stress-strain curves of three palm fiber mattresses with different thicknesses under a load of 1 kN. Three stress-strain curves of different colors represent the mattress stress-strain curve of the mattress test block under the same load under the first, second, and third compressions. With the increase of the number of compressions, the stress-strain curve of the palm fiber mattress test block Shifting to the right, the strain of the palm fiber mattress test block continues to increase, indicating that the thickness of the palm fiber mattress has been deformed under multiple
compressions. This deformation is irrecoverable. This change occurs in a bed with a large thickness. The pad test block is more obvious.

The stress-strain area generated in the first experiment is the largest, indicating that the mattress has the best energy consumption capacity in the initial state. As the number of experiments increases, the area of the stress-strain curve becomes smaller and the energy consumption capacity decreases. Comparing the stress-strain curve areas of mattresses with three thicknesses, the stress-strain area of 70 mm size is the largest when the mattress is first loaded, indicating that it has a strong ability to absorb compressive energy, and has good compressive fatigue resistance and energy consumption.

![Fig. 10 70-1 block stress-strain curve](image1)

![Fig. 11 90-4 block stress-strain curve](image2)

![Fig. 12 130-7 block stress-strain curve](image3)
4.4 Performance analysis of palm fiber fiber mattress test blocks under different loads

Fig. 13 0.6 kN load 130-8 block stress strain curve

Fig. 14 1 kN load 130-9 block stress-strain curve

Fig. 15 2 kN load 130-10 block stress-strain curve
Figures 13, 14, and 15 show the stress-strain curves of the 130 mm thick palm fiber mattress test block under repeated compressions of 0.6 kN, 1 kN, and 2 kN, respectively. Figure 16, Figure 17, Figure 18 show the stress-strain curves of the 85 mm thick palm fiber mattress test block under repeated compressions of 0.6 kN, 1 kN, and 2 kN, respectively. From Fig. 13, Fig. 14, Fig. 15, Fig. 16, Fig. 17, and Fig. 18, it can be seen that under the same thickness of the palm fiber mattress specimen, the three different loads are respectively subjected to the stress and strain after three compression experiments. The trend remains unchanged, indicating that the palm fiber mattress can reach a stable thickness under
repeated and continuous action of different external forces. The greater the applied load, the greater the strain of the palm fiber mattress test block, and the greater the thickness change in the vertical direction. Under the same load, the 130 mm mattress test block is better than the 85 mm mattress test block. Produce greater strain.

Under repeated compression fatigue experiments, the energy consumption of the mattress is significantly reduced with each load. At the same time, the stress-strain curve shifts to the right, and as the load increases, Strain increases accordingly. The area enclosed by the stress-strain curve is reduced and the energy consumption capacity is reduced. Comparing the stress-strain curves of test blocks with 70, 85, 90, and 130 mm thickness, the 70 mm test block has the largest area surrounded by stress and strain when it is first loaded, which can absorb compression energy well, and the mattress has better compression fatigue resistance.

5. Analysis of compression fatigue performance

Palm fiber mattress has undergone many compression fatigue tests, and the degree of fatigue damage can be expressed by permanent compression. For four palm fiber mattresses of different sizes after multiple compression fatigue experiments, the relationship between the thickness and the compression amount can be obtained from Figure 19, Figure 20 and Figure 21, and the following relationship can be obtained after linear fitting:

\[
0.6 \text{ kN}: \quad y=0.11x-5.25 \quad (1)
\]

\[
1 \text{ kN}: \quad y=0.12x-5.50 \quad (2)
\]

\[
2 \text{ kN}: \quad y=0.14x-2.79 \quad (3)
\]

Where \( y \) is the amount of deformation after repeated compression, and \( x \) is the thickness of the mattress.

For palm fiber mattresses of different sizes, the fatigue relationship can be expressed from this, and the thickness relationship is positively related to the permanent deformation of compression fatigue. According to Figure 19, the compression fatigue of the palm fiber mattress under a load of 0.6 kN can be obtained, and the relationship between thickness and compression deformation can be obtained. In the same way, the deformation law of palm fiber mattresses of different thicknesses under compression fatigue can be predicted under the same load, to test the compression fatigue performance and quality of the mattress, and to judge the dent damage of the mattress.

\[\text{Fig. 19 Linear fitting of compression of test blocks with different sizes under 0.6 kN}\]
Comparing Figure 19, Figure 20 and Figure 21, it can be found that under the repeated action of the same load, the 130 mm thick mattress has the largest amount of permanent deformation, and the 70 mm thick mattress has the smallest amount of permanent deformation. The slope of the relationship curve between the thickness and the compression deformation obtained increases with the increase of the applied load, and the mattress is more prone to deformation and depression under the long-term larger load. It can be seen from Figure 22 that as the load increases, the repeated compression deformation of the 70 mm and 130 mm thick mattress test blocks also increases. The 130 mm mattress test block is larger.
than the 70 mm thick mattress test block. The trend of compression change is more significant, indicating that 130 mm mattresses are more prone to permanent deformation under the action of external forces, and the compression deformation amplitude is greater than 70 mm thickness mattresses. It shows that the 70 mm size mattress has better anti-compression fatigue performance during long-term use.

6. Finite element analysis

6.1 Build a finite element model

In order to verify the accuracy of the experimental data, the Ansys workbench finite element software was first used to model the palm fiber mattress. According to the experimental data and material model parameters [4], the finite element parameter table used is shown in Table 2. Then, the isotropic material model and the transversely isotropic material model of the palm mattress were established respectively for subsequent analysis and comparison. Then, use the statics simulation module in Workbench to simulate and check the two material models. Set the stress and boundary conditions, compare the simulation results of the two finite element material models, and verify the accuracy and reliability of the material model.

Take the 85-2 palm fiber mattress test block as the finite element simulation model, use the Solidwork software to build the model, and then import it into Ansys workbench. Set the materials to be isotropic and transversely isotropic materials with two different properties. The model thus established is meshed with 23667 nodes and 5200 elements. The selected mesh is shown in Figure 23. In order to simulate the impact of the human body lying on the mattress on the performance of the mattress, an external load was applied to the model, the load size was 1 kN, and the bottom fixed boundary condition was applied, and the mattress test block model was given two different material properties, and obtained The corresponding stress-strain curve.

| Material parameters | Isotropic material | Transversely isotropic material |
|---------------------|---------------------|---------------------------------|
| $E_z$               | 0.070MPa            | 0.070MPa                        |
| $v_{zx}$            | 0.024               | 0.024                           |
| $E_x$               | 0.07MPa             | 10.151MPa                       |
| $v_{zx}$            | 0.024               | 0.424                           |
| $G$                 | 0.032MPa            | 0.107MPa                        |
| $\rho$              | 162.6kg/m$^3$       | 162.6kg/m$^3$                   |

Fig. 23 Finite element gridding of Palm Mattress Test Block

6.2 Finite element calculation of simulated compression fatigue experiment

According to the results of the finite element simulation calculation, the finite element simulation results of the properties of the isotropic material and the transversely isotropic material are the same, indicating that the mechanical properties of the mattresses with the two properties of material properties are consistent under compression. Because the stress state of the finite element model is uniaxial compression, the elastic modulus in the Z direction has a greater influence on the data. The elastic
modulus parameters of the two material models obtained from the experiment are the same, so the simulation results of the two are consistent. Using Origin software, linear fitting was performed on the finite element calculation data and the compressed experimental data respectively, and the results of the fitting straight line are shown in Table 3.

It can be seen from Figure 24 that the comparison between the linear fitting of stress and strain data of the 85-2 palm fiber mattress in the experiment and the linear fitting of the finite element simulation data shows that the fitting error of the two materials is 2.657%, which confirms the experimental results. The validity indicates that the material properties of the mattress set in the simulation are more in line with the actual situation and can simulate the stress and strain of the palm fiber mattress.

**Table 3 Comparison of linear fitting between experiment and finite element simulation**

| Isotropic material | Transverse isotropy | Experimental data | Error |
|--------------------|---------------------|-------------------|-------|
| $\delta = 0.07\epsilon$ | $\delta = 0.07\epsilon$ | $\delta = 0.06813\epsilon$ | 2.657% |

![Fig. 24 Comparison diagram of linear fitting of experimental data and finite element data](image)

7. Conclusion

(1) Based on the same size, different loading speeds will have different effects on the palm fiber mattress specimens. A larger loading speed will produce greater stress, and the stress value acting on the mattress will be greater than the expected stress value. Affect the performance of the mattress. The lower the loading speed of the compression fatigue experiment, the less the stress in the compression fatigue experiment will be affected, and the data obtained can better reflect the stress and strain of the mattress. It is further explained that the external force at a certain speed will affect the performance of the mattress.

(2) After 8 hours of continuous compression and then 16 hours of recovery, the thickness of the palm fiber mattress will be reduced to varying degrees before the comparison, and after three compressions, the thickness of the palm fiber mattress after compression keep at a stable value, that is, it can be restored to the stable thickness after compression. 90 mm and 130 mm thick mattresses have undergone multiple compression fatigue experiments, and the deformation rate of the two mattresses remains unchanged. The deformation rate of the 130 mm thick mattress test block is 7.7 to 8.4%. The 90 mm thick bed the deformation rate of the cushion test piece is 5.5%, and the deformation range of the 90 mm test piece is smaller under compression fatigue.

(3) In the compression fatigue experiment, the stress-strain curve is obtained under the action of the same load three times. In the first load, the 70 mm area of the stress-strain curve is the largest, indicating that the energy dissipation capacity is strong, and it has good compression fatigue resistance and energy absorption ability. The 130 mm stress-strain curve area is the smallest, indicating that the energy consumption capacity is relatively poor. The stress-strain area of the subsequent two experiments decreased in turn, indicating that the mattress’s energy consumption capacity will be reduced under the continuous external force. Therefore, with mattresses of different thicknesses loaded with the same load, 70 mm mattresses have better compression fatigue resistance and energy consumption.

(4) For mattresses of the same size under repeated compression fatigue under different loads, the slope of the relationship curve between size and compression increases with the increase of the applied...
When the load is 0.6 kN, the compression of a 70 mm mattress is 2.5 mm, and the compression of a 130 mm mattress is 9 mm. When the load is 2 kN, the compression of a 70 mm size mattress is 7 mm, and the compression amount of a 130 mm size mattress is 16 mm. When the mattress is subjected to a long-term larger load, the 130 mm is more prone to deformation and irreversible depression, and the 70 mm mattress has less deformation and better resistance to compression fatigue.

(5) By comparing the linear fitting of the finite element data and the experimental data, the result shows that the final difference is 2.657%, indicating that the experimental data has a certain degree of reliability and accuracy. The validity of the experiment is proved, indicating that the properties of the mattress material set in the simulation are more in line with the actual situation. Under compression fatigue, the isotropic model and transversely isotropic material can well simulate the stress and strain of the palm fiber material test block, which can provide experimental guidance for the future mattress parameter design.

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