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Article

The integration of biomechanics and the application of green materials in the construction of sports facilities under environmental sustainability

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Abstract: With the in-depth implementation of the Scientific Outlook on Development, in order to implement the national basic energy-saving policies and various emission reduction mechanisms, as well as the demonstration and promotion role of universities in energy conservation and emission reduction, the state has put forward the idea of further supporting the construction of energy-saving campuses in higher education and universities. This paper delves into the application of green and environmentally friendly materials in the construction of sports facilities, not only from the perspective of ecological sustainable development but also in close connection with the field of biomechanics. Biomechanics plays a crucial role in the design and use of sports facilities. When applying green materials, it is essential to consider how these materials interact with the human body's mechanics during sports activities. For example, different sports demand specific mechanical properties from the facilities, such as the right amount of elasticity, friction, and shock absorption. Green materials, when selected and designed with biomechanics in mind, can enhance the performance and safety of athletes while maintaining environmental friendliness. To assess the feasibility of green materials in this context, this paper presents an evaluation method that integrates the Analytic Hierarchy Process (AHP) and information entropy. This approach incorporates biomechanical factors into the index system. By doing so, the combined weight value of each component in the system can more accurately reflect the real-world situation. Compared to traditional evaluation methods, this integrated approach effectively mitigates the subjectivity in determining weight coefficients. It also ensures that the significance of each evaluation index, especially those related to biomechanical performance, is fully considered. The experimental results in this paper show that the use of AHP to evaluate the advantages of green environmental protection materials, the average weight reaches 0.8275. This finding strongly suggests that the application of green materials in sports facilities construction is highly viable. These materials not only contribute to environmental protection but also offer biomechanical advantages, ensuring the long - term sustainability and functionality of the facilities for athletes.

Keywords: environmental protection material; analytic hierarchy process; sustainable development; sports facilities; Biomechanics

1. Introduction

As one of the important symbols of human civilization, architecture is also a unique commodity, which has a very complex process in the production process. In recent years, university buildings have become an important object of energy consumption. Due to the increase in the number of operating institutions, the construction area of many universities has increased significantly, and the cost of building energy consumption has also continued to increase. More than half of the energy used by colleges and universities is utilized to power buildings, so colleges and universities will focus on saving energy by reducing building energy consumption. Colleges and universities should have systematic and reasonable campus strategies, put forward building energy-saving design guidelines, give priority to protecting campus ecological environment and improve resource utilization. The mainstream direction of its ecological building design should also be environmentally sustainable development.

With the progress of the economy, the problems of environmental pollution and excessive energy consumption are constantly emerging around the world. Human beings also pursue energy conservation and environmental protection in housing construction. Requiring buildings to satisfy the needs of human beings in terms of material life and the spiritual dimension. Therefore, the application of green materials has gradually become a trend. There is a dual role relationship between architecture and ecological environment. Nowadays, people are facing a deteriorating ecological environment. Buildings are an important component of consuming natural resources, the consumption of such resources requires contemporary architects to reflect. Architecture is the carrier of human expectations for a better living environment, so we must always follow the main line of environmental protection and ecological goals. The innovation of this paper is tantamount to propose a green material based on sustainable development. And the AHP method is used to estimate whether it can be scientifically applied in the construction of sports facilities.

2. Related work

At present, green, energy-saving and environmental protection have become the main driving forces for the development of major industries in the 21st century. Under this trend, traditional energy-intensive and polluting buildings are also slowly deepening reforms with the support of the state, moving towards a low carbon, environmentally friendly sustainable development path. An and Zhang [1] take the community sports culture as the research object and adopts the method of comprehensive assignment to conduct a study. Built on the analysis of the reality of community sports culture, he proposed a new model of community sports culture construction. Malone [2] found that a university's new $270 million stadium needed to be based on the shores of the lake, including two adjacent facilities, providing academic and professional development support services to more than 500 student-athletes. Caulfield [3] found that the most expensive stadium ever built was planned to open 4 miles from Los Angeles International Airport, a facility that could be expanded to 100,000 seats for major events such as the Olympics. Darf and Belkin [4] found that from layout to implementation, high-quality construction became the main goal, which is why he emphasized the concept of building quality and its particular importance in the design strategy of sports facilities. Capasso et al. [5] pointed out the need to meet hygiene requirements with particular attention when constructing and maintaining sports facilities. The nature of landscaping and the area of green space as well as the level of noise intensity are very important. Scholars found that in the construction of sports facilities, many important factors should be paid attention to, and environmental protection building materials should be used to ensure that sports facilities will not have a negative impact on people's health, but they did not mention specific environmental protection materials.

Green environmental protection materials have the characteristics of low-carbon, energy-saving and environmental protection, buildings built with this material can improve the human environment. Jeong et al.'s [6] research aims to conduct a multi-criteria analysis of self-consumption strategies in the building industry, taking into account the energy generation, economic and environmental impacts of the system simultaneously during the planning and design phases. He selected educational facilities, sports facilities and residential facilities as target facilities. Hangzhou Asian Games venues use a lot of green building materials, such as Fuyang Water sports Center adopts green energy saving design, sky garden to improve the greening rate, rainwater recycling system to save water resources. Gongshu Canal Sports Park stadium complex uses light guide devices to meet the needs of daytime lighting and save energy consumption. Herzanita [7] believes that WBS (Work Breakdown Structure) plays an important role in every construction project. WBS is a hierarchy of decreasing scope of work that makes the project management and control process easier. Failure to comprehend the importance of WBS in construction projects will result in suboptimal project performance, especially in terms of cost and time performance. Kolak et al. [8] found most of his existing research proposes evaluation methods using simulation tools to assess the sustainability of different transport policies. Kumar et al. [9] pointed out that although there have been some research examples on the relationship between attitudes to environmentally sustainable products and purchase intentions, there are limited studies on the relationship between environmental knowledge and purchase intentions of environmentally sustainable products. Scientists have concluded that there is a growing focus on developing renewable energy and efficient energy conversion and storage technologies to address global climate change and energy supply shortages. Green materials are critical to alleviate the conflict between energy production and demand.

3. Feasibility evaluation of environmental protection materials in sports facilities based on AHP

Major universities have put forward green campus initiatives, which is intended to enhance human health, productivity and safety through intelligent building design and campus planning, and enhance the health and safety of university sports facilities [10,11]. Environmental sustainability factors should be examined in the construction, use and operation of campus facilities. Green environmental protection material refers to green environmental protection building materials, which is a branch of building materials science under ecological architecture after the intersection of ecology and architecture. The application of environmental protection materials in sports facilities is shown in **Figure 1**:

Figure 1. Environmentally friendly material applications in sports facilities.

As illustrated in **Figure 1**, compared with traditional building materials, environmentally friendly materials are brand-new materials that upgrade traditional materials through artificial secondary processing. Artificial re-processing can endow traditional materials with new functions, and also provide architectural designers with an infinite space for imagination. It is worth noting that while seeking innovation, we must rely on empirical material properties [12,13].

Taking the application of bamboo materials in China as an example, bamboo materials have been applied to build houses in southern China for a long time and experience. This is precisely because of the high-quality characteristics of bamboo that will be widely and long-term application [14]. The physical properties of bamboo are that the growth cycle is short and the reliability is extremely strong. Bamboo products are also environmentally friendly materials used instead of wood in southern China. The use of unconventional materials can be viewed in many cases. For instance, **Figure 2** is a work made with paper-based environmentally friendly materials.

Figure 2. Works made from paper-based eco-friendly materials.

As illustrated in **Figure 2**, the building material used in the figure is indeed a paper product that can be seen every day. This building uses paper materials in the post-holiday frame and the main hall of the building. This material comes from the waste pulp of recycling processing plants [15]. After being reinforced by a special process, a visible mesh-like green material with high-strength bearing capacity and support is formed. At the same time, this material also has intense hardness and good water resistance. As the architectural finish of the exterior wall and roof, it can act as sunshade and rain protection. Another advantage is that it allows natural light to enter the room through the tissue paper, producing dim indoor light and reducing artificial lighting in disguise. After the World Expo, all materials will be recycled and reprocessed, and they can also be used as writing exercise books for students, so that the entire recycling system can be recycled from waste paper materials—paper construction—stationery—waste paper, realizing the ecological concept of “zero waste” and “low consumption and low energy”.

3.1. Evaluation of environmental protection materials based on AHP

In order to understand the feasibility of environmental protection materials in the construction of sports facilities, it is necessary in order to conduct a comprehensive evaluation of them before they can be applied to the construction of facilities. In this paper, the analytic hierarchy process (AHP) was chosen to evaluate ecological protection materials [16,17]. Currently, weighted indices are usually calculated using a composite weighting method. The weighting method is combined with the objective weighting method to harmonize subjectivity and objectivity by enhancing attributes. In this paper, the subjective and objective methods are coupled, which can enhance the strengths and avoid weaknesses.

Parallel research methods that combine the AHP (hierarchical analysis) evaluation method with information entropy include the entropy method, principal component analysis and AHP hierarchical analysis. The information entropy method combines subjective judgment with empirical data to improve the accuracy of evaluation. AHP (hierarchical analysis) and information entropy evaluation method can compensate for the shortcomings of a single method and improve the comprehensiveness and accuracy of evaluation.

Form 5–10 experts in relevant fields such as sports facility construction, material science and environmental science, use Likert scale or other quantitative scoring methods (e.g., level 1–9) to develop detailed scoring guidelines, and the experts use anonymous scoring and fill in judgment matrices. The scoring results of all experts were collected to form a preliminary judgment matrix.

The consistency of the judgment matrix is then verified by consistency validation: the consistency ratio (CR) of each expert’s judgment matrix is calculated using AHP software or manual calculation, and the consistency of the judgment matrix is verified. The CR value should be less than 0.1 to ensure that the judgments are reasonable and reliable. If the CR value exceeds 0.1, it should be powered back to the corresponding expert for adjustment until the consistency requirement is met.

In order to assure the systematicness of the index system, a construction principle must be followed when constructing the urban green transportation evaluation index system. A proper evaluation principle can make the whole index system achieve the maximum evaluation effect with partial index.

(1) System principle: when determining evaluation indicators, the integrity of sports facilities should be considered, indicators in different aspects should be reviewed, and representative indicators should be selected to guarantee the complexity and reliability of evaluation.

(2) The principle of scientific objectivity: when constructing the evaluation index system, the principle of scientifically is to require the concept of indicators to have clear scientific connotations. When selecting evaluation indicators, the function and function of each evaluation indicator should be fully understood, and the collection of indicator data should be reliable and accurate when collecting data.

(3) Consistency principle: The purpose of establishing the evaluation index system is to better comprehensively evaluate the research objects. Therefore, the content of each index should be consistent with the comprehensive evaluation goal, and the index with low correlation with the evaluation object should be excluded as much as possible, so as to keep the goal consistency of the comprehensive evaluation index system, as shown in **Figure 3**:

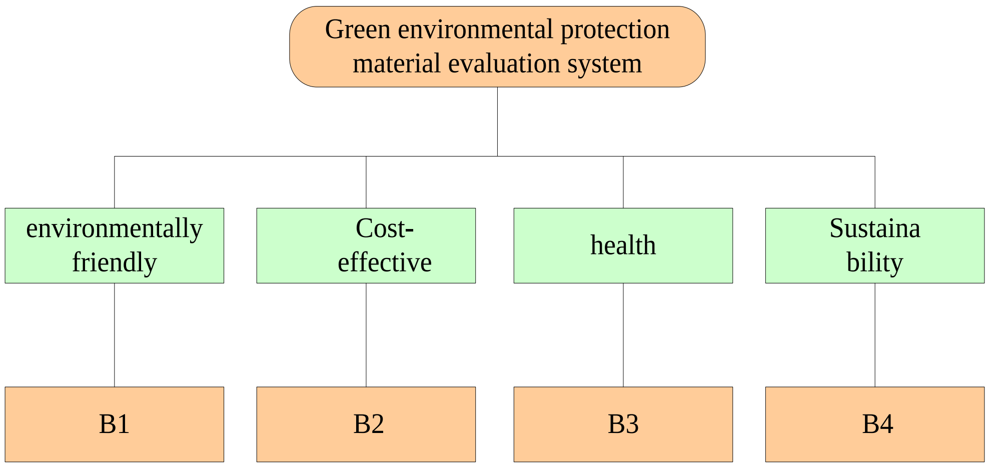


Figure 3. Evaluation index system diagram.

As shown in **Figure 3**, in the calculation process of AHP, it should start from the second layer of the hierarchical model, using the numbers 1–9 and their inverse values as scales, to build a pairing matrix for each factor belonging to the top layer in the same layer [18]. Among them, with A as the target, the judgment matrix B can be composed of a_{nn}, that is, there is Equation (1):

$$B = \begin{bmatrix} a_{11} & a_{12} & a_{1n} \\ a_{21} & a_{22} & a_{2n} \\ a_{n1} & a_{n2} & a_{nn} \end{bmatrix} \quad (1)$$

The first-level evaluation should calculate the weights according to the evaluation matrix, in order of importance of each factor related to the current level and the previous level. The purpose is to calculate the maximum self-power and corresponding self-vector for each pair of decision matrices using the summation method or the power-of-two method. This work is processed by the quadratic power method, and the specific calculation steps are as follows:

Calculating the sum M_i of the elements of each row of matrix B according to

Equation (2) to get:

$$M_i = \prod_{j=1}^{n} a_{ij}\ (i = 1,2,\ldots,n) \quad (2)$$

Calculating the nth root of M_i, we get Equation (3):

$$\bar{W_i} = \sqrt[n]{M_i} \quad (3)$$

By normalizing the vector W_i, the weight can be obtained as Equation (4):

$$W_i = \frac{\bar{W_i}}{\sum_{i=1}^{n} \bar{W_i}} \quad (4)$$

Then $\sum_{i=1}^{n} \bar{W_i}$ is the desired eigenvector.

The purpose of the consistency check is to evaluate whether the calculated self-vector can synthesize the judgment matrix. If the test result is within the allowable range, the classification result is valid, otherwise the mathematical judgment needs to be readjusted until it is suitable [19]. The specific methods of consistency control are as follows:

Calculating the maximum self-matrix value according to Equation (5):

$$\lambda \frac{1}{n} \sum_{i=1}^{n} \frac{(BW)_i}{W_i}_{max} \quad (5)$$

Sample λ_{max} should have the largest self value of decision matrix *B*, n is the number of paired reference factors, W_i is the quality value of the corresponding element in a row; W is the corresponding normalized self vector. Among them, see Equation (6),

$$BW = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ a_{11} & a_{11} & \cdots & a_{11} \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{bmatrix} \begin{bmatrix} W_1 \\ W_2 \\ \cdots \\ W_n \end{bmatrix} \quad (6)$$

Calculating the concordance index for *CI* and find the *RI* concordance index according to Equation (7):

$$CI = \frac{\lambda_{max}}{n-1} \quad (7)$$

The larger the *CI*, the worse the consistency of mathematical judgments; when *CI* = 0, the judgment matrix is completely consistent. Searching the table to determine the corresponding mean random *RI* agreement index, compare the *CI* to the *RI* to check whether the evaluation matrix is consistent, and calculate the agreement as shown in Equation (8):

$$\mathrm{CR} = \frac{\mathrm{CI}}{\mathrm{RI}} \quad (8)$$

Report to subjective weighting methods such as AHP and expert weighting method, the information entropy method has more advantages [20]. The higher the balance of the data, the smaller the role (dominance) played in the comprehensive evaluation, and the smaller the weight. On the contrary, if the information entropy of an index is smaller, it indicates that the index provides more information, plays a larger role in the evaluation, and its weight is greater.

Normalizing the data matrix, Equation (9) shows the entropy of the larger the better [21]:

$$b_{ij} = \frac{a_{ij} - min(a_{ij})}{\max(a_{ij}) - min(a_{ij})} \tag{9}$$

Equation (10) shows the entropy of the smaller the better:

$$b_{ij} = \frac{max(a_{ij}) - a_{ij}}{max(a_{ij}) - min(a_{ij})} \tag{10}$$

Among them, $max(a_{ij})$ and $min(a_{ij})$ represent the maximum and minimum values of the j-th column of data matrix A. This is because the entropy value of the calculated weights is not used to evaluate the actual entropy value (informativeness) of the indicator, but to reflect the role of the corresponding evaluation indicator in the established evaluation system [22].

Calculating the entropy value of each evaluation index according to Equation (11):

$$H_j = -\frac{1}{Inn}\sum_{i=1}^{n} a_{ij}\, Ina_{ij} \tag{11}$$

Among them, a_{ij} is shown in Equation (12):

$$a_{ij} = \frac{b_{ij}}{\sum_{i=1}^{n} b_{ij}} \tag{12}$$

Calculating the evaluation index weight according to Equation (13):

$$w_j = \frac{1 - H_j}{n - \sum_{j=1}^{m} H_j} \tag{13}$$

For the sake of simplicity, calculation of the combined weights is done by giving equal importance to the objective weighting method and the subjective weighting method. Therefore, the weight values calculated by the objective and subjective weighting methods are combined and calculated by the linear weighting method, i.e., Equation (14):

$$\bar{W_i} = K_1 W_{i1} + K_2 W_{i2} \tag{14}$$

In the formula, W_{i1} and W_{i2} respectively represent the index weight obtained by the objective weighting method and the subjective weighting method; $\bar{W_i}$ represents the combined weight; K_1 and K_2 represent the weighting parameters.

The comprehensive evaluation model was established by the ample index evaluation method. The composite index method disproportionately treats indicators of different quality categories and transforms them to obtain the customary shape of each indicator. The quantified value of the conversion indicator is between 0–100. The calculated comprehensive index is obtained by the numerical weighted superposition of each index, and this method is suitable for a multi-factor comprehensive evaluation structure system. The established comprehensive evaluation model is Equation (15):

$$Z = \sum_{i=1}^{n} W_i F_i \tag{15}$$

Among them, Z represents the comprehensive index of green transportation; W_i represents the weight value of each evaluation index; F_i represents the standardized assignment of each index. According to the AHP and information entropy method, the weight of each index to the target layer A is obtained, and then the final combination weight of each index is obtained by the method of averaging, as shown in **Table 1**:

Table 1. Final weights of each indicator combination.

Index	Index	Parameter	Weights
Target Layer (A)	Environmentally friendly	B_1	0.85
	Cost-effective	B_2	0.81
	health	B_3	0.83
	Sustainability	B_4	0.82

As indicated in **Table 1**, the weight of environmental friendliness is 0.85, the weight of cost performance is 0.81, the weight of health is 0.83, the weight of sustainability is 0.82, and the average weight is 0.8275. Most organic building materials use advanced manufacturing techniques. In the production process, a production system that utilizes waste for cleaner production is adopted, so that the generated waste is converted into energy and can be recycled. This not only saves one lot of resources, but also reduces waste generation and reduces environmental pollution. For example, Ketian adopts advanced water-based technology, and its water-based polymers are non-toxic, odorless and non-polluting, which is one of the principal directions for the development of polymer materials.

3.2. Significance of green environmental protection materials to the construction of energy-saving campus

With the rapid development of science and technology, people's living standards have improved greatly, people's pursuit is not only limited to material life. 21st century, the level of engineering construction has been rapidly improving green energy saving materials have gradually become the theme of engineering construction. Because the progress of engineering construction to a certain extent on today's ecological environment and social environment has a huge impact. A series of social problems such as various environmental pollution, waste of resources, and climate warming have covered the global scope, so the research on energy-saving, environmental protection, and green and pollution-free engineering construction has gradually been carried out to a deeper level, as shown in **Figure 4**:

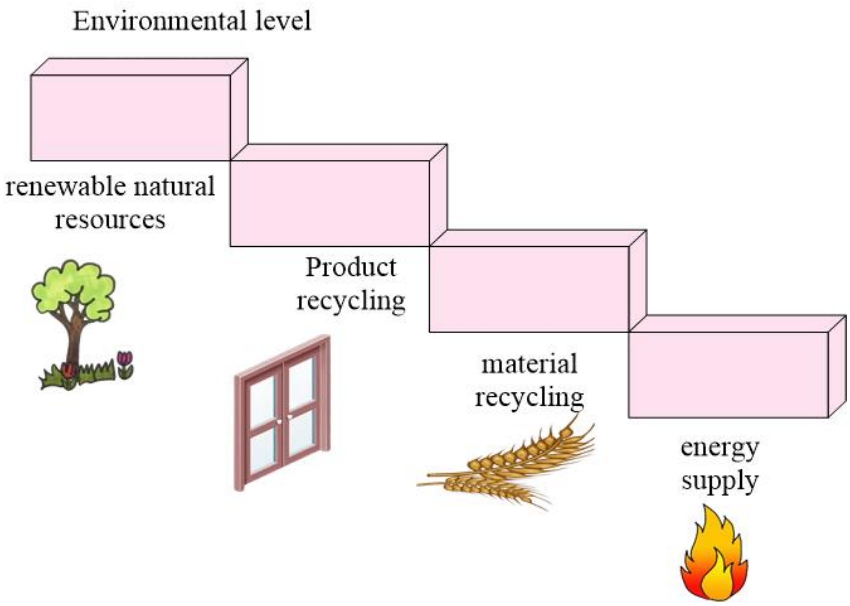


Figure 4. Development of environmentally friendly materials.

As seen in **Figure 4**, there is a big difference between traditional building materials and high-tech environmental protection materials. The concept of sustainable development is the top priority, it is determined to the sustainable development of each factor to achieve a harmonious and consistent purpose. It requires attention not only to the use of raw materials but also to the control of costs, to maintain the basic form of construction and the use of environmentally friendly materials at all times, and to consider the balance between the human environment and the natural ecology.

(1) Green and environmentally friendly materials are beneficial to students' health and learning outcomes

The quality of the built environment on campus is closely related to student health, attendance and learning efficiency. The auditory environment, visual environment, wind and indoor air quality on campus will have a major impact on student learning and health. Therefore, constructing green materials on academic soil and providing students with a healthy and comfortable educational environment are the goals that should be expected to continue in the construction of economic campuses.

(2) Green environmental protection materials provide materials for environmental protection, energy saving and sustainable development education

Colleges and universities have considerable space and population, and the consumption of energy and resources can be said to be very considerable. Some scholars have done a survey and found that if water-saving facilities are used, the school can save tens of thousands of tons of water every year through water utilization and shortening the time each time students take a bath.

If the open space campus is to protect biodiversity, greenery and water supply, this will undoubtedly help optimize the overall community environment in which the school is located, while creating a safe educational environment. The use of green and environmentally friendly materials in buildings allows students to learn from practice, making energy saving and environmental protection a profound experience in life and learning, and can play an advertising role for about 7 million higher education graduates.

(3) Green environmental protection materials can bring long-term economic benefits to colleges and universities

The high cost is often the reason why people refuse to choose green materials. However, through the construction of green and environmentally friendly buildings, the school can achieve a win-win situation in many aspects such as student progress, environment and economic benefits, which is conducive to the sustainable development of the school itself. Campus green materials are undoubtedly the proper concept for the development of economical campuses.

(4) Specific practical suggestions for green materials in the construction of sports facilities in colleges and universities

Green materials for the construction of sports facilities in colleges and universities is recommended: use environmentally friendly plastic runway materials to protect students' health and safety; strengthen the greening and beautification of the sports ground to enhance the campus aesthetics; pay attention to the energy saving and recycling of sports facilities, reduce energy consumption and water consumption, and realize the recycling of resources.

4. Investigation on the application of environmental protection materials in sports facilities

4.1. Investigation on the development of environmentally friendly materials and traditional materials

The total energy consumption of buildings in China continues to grow. There are about 40 billion square meters of buildings in China, most of which are high-energy-consuming buildings. This ratio reached 90%, which is very shocking and could easily result in an energy crisis. China is in a stage of rapid development of industrialization and urbanization, and the rapid progress of construction projects requires the consumption of large amounts of resources, which destroys the ecosystem and pollutes the environment to a large extent. The consumption of building materials in 2015–2019 is shown in **Figure 5**:

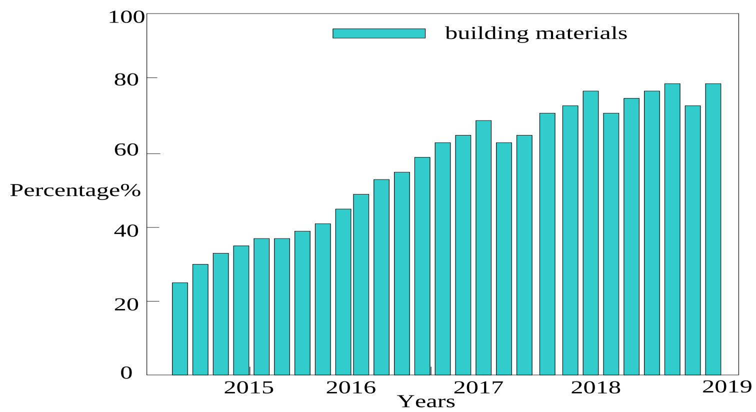
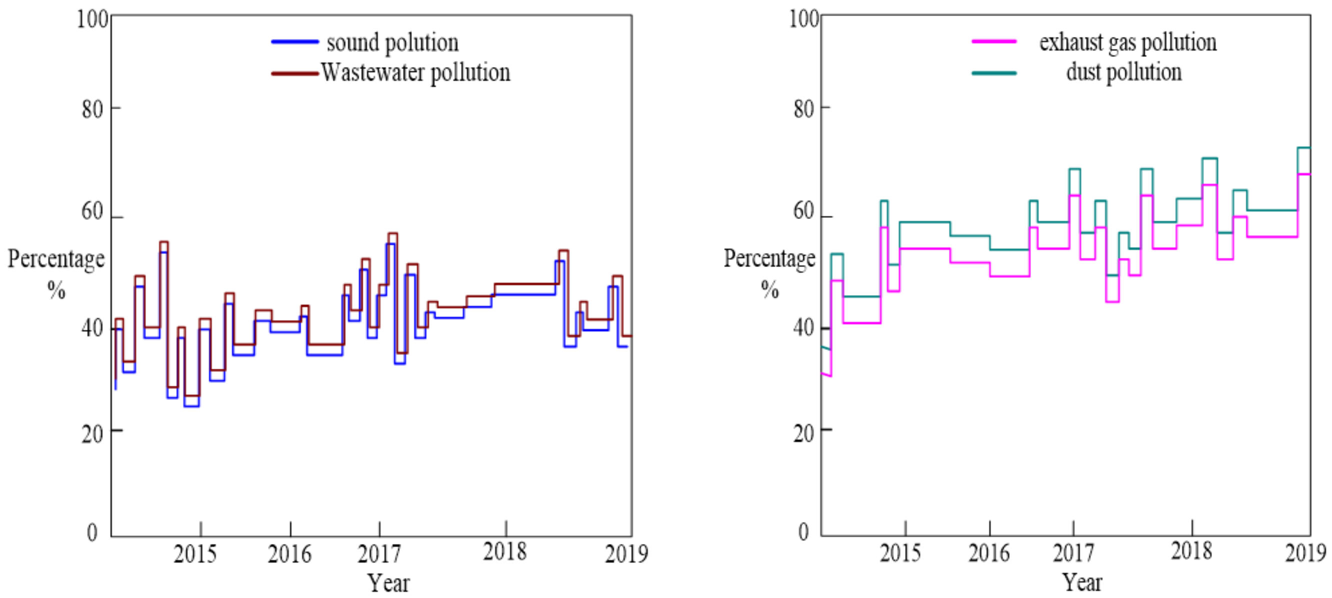


Figure 5. Consumption of construction materials, 2015–2019.

As seen in **Figure 5**, the consumption of building materials continued to increase from 2015 to 2019. Since the beginning of the modern century, human beings have been pursuing high-speed urban development and forced the ecological balance to be seriously damaged. People gradually realized the importance of environmentally friendly materials after they over-cultivated land and resources. The waste used by construction consumption is no longer part recycled, which will have serious damage to the ecology. People should expand the creative development and research development direction, to promote a recyclable and renewable and less environmental pollution direction to move forward. It can be observed that the energy of the construction industry is very important to the whole society. Only by solving the energy consumption dilemma of the construction industry can we better create an energy-saving and green society.

Traditional building materials not only consume fast, but also bring a lot of pollution. The pollution caused by traditional building materials is shown in **Figure 6**:



(a) **(b)**

Figure 6. Types of pollution from traditional building materials.

As seen in **Figure 6**, the pollution caused by traditional building materials includes noise pollution, waste water pollution, exhaust gas pollution and dust pollution. Energy, and the design and construction of building projects have gradually begun to develop in the direction of energy saving, emission reduction, and improved functionality. Green and environmentally friendly materials began to take root in people's minds. The birth of green and environmentally friendly materials points out the development direction of green building, and also points out the development direction for the current engineering construction.

Green materials have gradually become mainstream. Green materials represent the trend of the times is likewise a symbol of the civilization of the times. The use of green materials is the trend of social progress. Both traditional materials and environmentally friendly materials have their advantages. This paper invited 5 architectural experts to rate traditional materials (full score is 10 points), as shown in

Table 2:

Table 2. Traditional materials.

Expert	Breathability	Strong flexibility	Regulate temperature	Save resources
1	9.0	8.5	4.7	4.9
2	8.9	8.4	5.3	5.2
3	8.5	8.8	4.9	5.0
4	8.6	9.1	5.0	5.1
5	8.7	8.2	5.5	5.3

As shown in **Table 2**, the advantages of traditional materials are: good air permeability and strong flexibility. However, the use of traditional building materials cannot meet the needs and needs of human beings for environmental protection materials.

Outdated materials are still in the stage of continuous exploration, and a lot of artificial transformation and formal upgrades are still needed. This forces the new material to have a robust development space, and at the same time, it will also create more environmentally friendly and ecological building skin designs. Specific data on the performance of green materials: Strict control of hazardous substances, heavy metals (e.g., lead ≤ 50 mg/kg, cadmium ≤ 10 mg/kg, mercury ≤ 5 mg/kg), VOC (< 500 μg/m^3), formaldehyde (< 30 μg/m^3), sulfur (< 500 mg/kg) and other substances. Ecological protection characteristics: use of non-toxic and harmless raw materials, recyclable, low pollution. Physical property data: good resilience, effectively reduce the impact of movement; high strength, wear-resistant, not easy to crack or damage; high flatness through precision construction. Other properties: excellent anti-skid performance; a certain degree of flame retardant properties; bright and long-lasting color, strong weather resistance, not easy to fade or aging.

This paper invited 5 construction experts to rate environmental protection materials (full score is 10 points), as shown in **Table 3**:

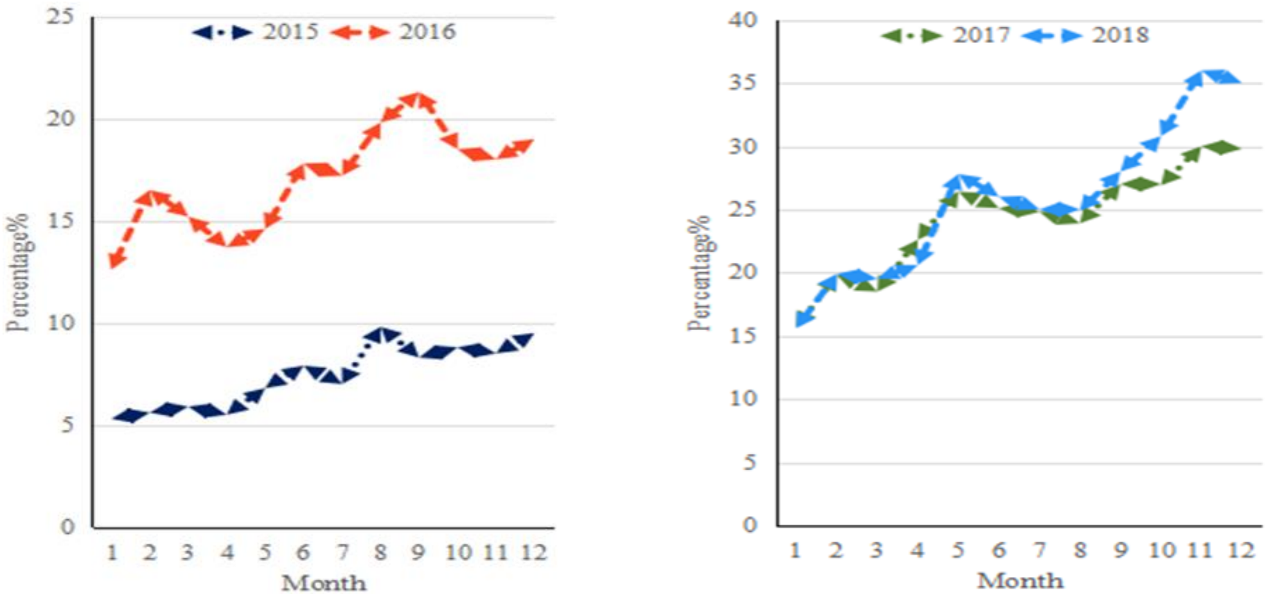
Table 3. Environmentally friendly materials.

Expert	Breathability	Strong flexibility	Regulate temperature	Save resources
1	7.5	7.7	8.6	8.5
2	7.7	7.3	8.9	8.8
3	7.6	7.1	8.7	8.6
4	7.3	7.8	9.2	9.1
5	7.0	7.6	9.0	9.2

As shown in **Table 3**, the new material has the advantage of durability. It can adjust the indoor temperature, save resources and reduce energy consumption as the external environment changes, so that heat can be transmitted in two spaces while maintaining the original heat. It can also exclude the medium of indoor heat source heat, and the building surface can adjust automatically by adapting to climate change. Through the sublimation and transformation of the physical properties of the material, some advanced technologies are integrated to ensure coordination.

4.2. Application of environmental protection materials in university buildings

The progress from traditional materials to environmentally friendly building materials shows the progress of society. Building environmental protection materials can sustainably develop, meet today's environmental needs with the least energy consumption, and have the advantage of recyclable utilization of resources, enabling people to coexist and develop with the environment. The application and development trend of environmental protection materials in university buildings is shown in **Figure 7**:



(a) **(b)**

Figure 7. Application and development trend of environmental protection materials in university buildings from 2015 to 2018. **(a)** The development trend of environmental protection materials in 2015–2016; **(b)** the development trend of environmental protection materials in 2017–2018.

As shown in **Figure 7**, it can be seen from **Figure 7a** that the environmental protection materials increased from 5% to 21% in 2015–2016; and from **Figure 7b**, it can be seen that the environmental protection materials increased from 15% to 36% in 2017–2018. The development of architecture makes campus buildings take into account the increasingly open and comprehensive functional characteristics, the architectural forms of sustainable development culture and environmental protection concepts have become diversified, and the building technology and materials are developing towards the trend of green and informatization.

In recent years, the words environmental protection and ecology have frequently appeared in the progress of emerging production capacity ecological industries. As an environmentally friendly material that can be recycled continuously, it complies with the sustainable development strategy that China has pursued for a long time. This paper invited ten experts to score the use of traditional materials and the use of environmentally friendly materials for the construction of sports facilities. The scores are shown in **Figure 8**:

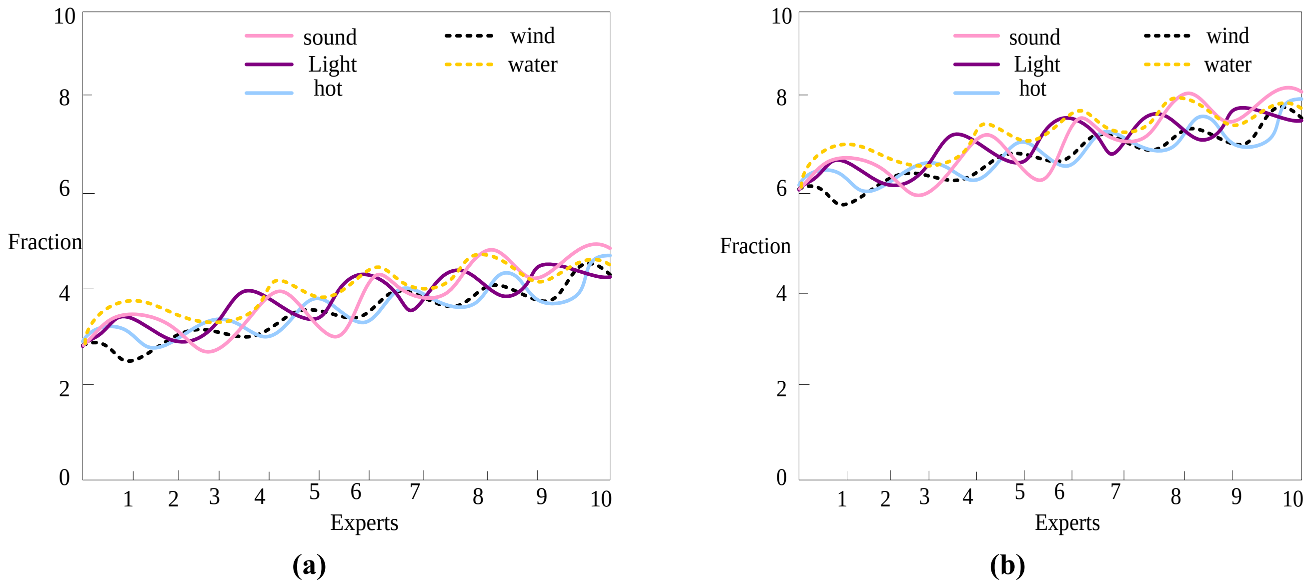


Figure 8. Scores of traditional and eco-friendly materials in sports facilities. **(a)** Scoring of traditional materials in sports facilities; **(b)** scores of environmentally friendly materials in sports facilities.

As shown in **Figure 8**, it can be seen from **Figure 8a** that in the sports facilities built with traditional materials, the scores of sound design, light design, thermal design, wind design and water design are all below 5 points; and from **Figure 8b**, it can be seen that in the sports facilities built with environmentally friendly materials, the scores of sound design, light design, thermal design, wind design and water design are all above 6 points. More people creatively recognize the leading position of environmental protection materials, choose environmental protection materials with regional characteristics, and be able to create additional green environmental protection materials with the lowest resource consumption.

4.3. Advantages of green materials in the construction of sports facilities

Green materials reduce pollution, save resources, and are in line with the concept of sustainable development; they have better thermal insulation and heat preservation performance, reducing energy consumption; they use non-toxic and harmless materials, protecting human health; and they can improve the comfort of sports and the aesthetics of venues. In order to realize sustainable development, it is necessary to take into consideration environmental protection, economy and technological innovation.

4.4. The impact of green materials on the long-term operation and maintenance of sports facilities

Energy-saving building materials, renewable materials and other green materials can effectively reduce the energy consumption of sports facilities, reduce operating costs; improve operational efficiency; significantly improve the service life of sports facilities, reduce the frequency of maintenance; improve the quality of service of sports facilities; and can show the enterprise's awareness of environmental protection and enhance the social image.

4.5. Recommendations for life cycle environmental impact assessment of green materials

Green materials such as building materials are comprehensively evaluated with reference to the American Green Evaluation Standard System (LEED). The above assessment can more comprehensively demonstrate the sustainability of green materials, provide scientific basis for material selection, product design and policy formulation, and advance the healthy development of green materials industry.

5. Conclusions

Owing to the development of China's construction industry, people attach great importance to the impact of buildings on the environment, and it is crucial to use innovative and environmentally friendly materials that are energy-efficient for upper buildings. In addition to reducing the resource cost of construction units, new energy-saving and environmentally friendly materials can also ensure the reasonable and orderly progress of construction and decoration projects, which can not only reduce construction time but also reduce resource consumption, and play an active role in supporting construction. The application of green environmental protection materials in the construction of sports facilities can not only reduce the harm of traditional building materials to the human body, but also has a high cost performance and saves a lot of costs. The concept of sustainable development contained in it can subtly influence students and establish their values of sustainable discovery. In order to prove that it is feasible to apply green environmental protection materials to the construction of sports facilities, this paper combines AHP and information entropy evaluation method to evaluate the characteristics of green environmental protection materials. The results show that the weights of the evaluation indicators of green environmental protection materials are all lofty, indicating that the feasibility is also high. In the experiment, this paper investigates the development trend of sports facilities in recent years and the requirements for the construction of sports facilities, compares traditional materials with environmental protection materials, and finds that environmental protection materials are more in line with the concept of sustainable development in all aspects. However, in the experiments, no explicit application of environmentally friendly materials in sports facilities was analyzed, which should be noted in future work.

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