Sustainable Development of Urban Environment and Building Material

Part 1

Edited by
Hui Li, Yan Feng Liu, Ming Guo,
Rui Zhang and Jing Du

TRANS TECH PUBLICATIONS

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Edited by

**Hui Li, Yan Feng Liu, Ming Guo,
Rui Zhang and Jing Du**

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Preface

The 2011 International Conference on Technology of Architecture and Structure is holding in Xi'an, China in 22～24 September, 2011, sponsored by Division of Civil, Hydraulic and Architecture Engineering of Chinese Academy of Engineering, China Civil Engineering Society and hosted by Xi'an University of Architecture & Technology. The theme of this conference is "Innovation, Security and Sustainable Development", which provide a communicative platform for all those engaged in civil engineering and related discipline research workers and engineering technicians.

All papers included in this book have been peer reviewed through processes administered by the scientific committee before accepted for publication. These papers recorded valuable explorations of the authors in relative fields of innovation of structure system and disaster prevention of engineering structure, architecture innovation, sustainable development of building energy and environment and innovation and application of building materials. Hot topics and frontier views related to sustainable development in civil engineering are presented in the papers.

We would express our gratitude to many prominent experts who in reviewing the papers gave their suggestions upon the proceedings and technical views exchanging during the conference which gave us great help in organizing the conference. We are also very thankful for all the conference participants in civil engineering for their time and supports. We are confident that by promoting of the concept of innovation, security and sustainable development, civil engineering technology will be further improved.

Wish the 2011 International Conference on Technology of Architecture a great success.

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Table of Contents

Chapter 2: Efficient Architecture Equipment, Ventilation, Air Conditioning and Refrigeration Technology

Chapter 3: Efficient Energy-Saving Building Sanitary Equipment and Systems

Chapter 4: Water Purification and Wastewater Treatment

Chapter 5: Air Environment Control and Architectural Environment Improvement Techniques

Chapter 6: Technology for Preparing Building Material Environmental Friendly

Chapter 7: New Building Materials

Chapter 8: Recycling and Reusing of Building Material

Chapter 9: New Technology for the Preparation and Construction of Building Materials

Chapter 10: Innovative Structures: Technologies and Applications

CHAPTER 1:

Sustainable Utilization of Building Energy and Resources

Advanced Materials Research Vols. 374-377 (2012) pp 3-7

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The financing decision research of entropy proportion in Water-recovery engineering

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Key words: Water-recovery, Entropy weight theory, Financing decision

Abstract. Water-recovery is very useful for ease water shortages in our country cities. But this engineering's investment is huge and capital pay back is very long. This type of environmental engineering depends on the government investment primarily, but now financial only from the government already cannot satisfy needs. In order to reduce the government's financial burden, we should expand more financial channels. Therefore, this kind of project financing decision is becoming more and more important. This paper puts forward a method considering policymakers experience combine with objective date. This Information entropy theory model can order according to approach degree in order to select the best scheme, which can provide a kind of subjective and objective for project financing decision combined with decision making method, making the decision more reasonable.

Introduction

According to statistics, more than 60% of more than 600 cities in China face a problem of inadequate water supply, among which more than 100 cities face more serious water shortage. As a good substitute for natural water sources, reclaimed water is getting attraction. Also, the city managers have great expectations on its potential. Just as many environmental projects, government and public departments play a main role in investments in recycling reclaimed water. However, the limited financial resources of governments at different levels, together with the long period of payback, lead to the serious shortage of investment and financing. Therefore, it is urgent for social participation to address the financing shortfall in reclaimed water recycling projects.

In addition to government financing support, there are many financing methods, for example, bank loans, stocks, bonds, finance leases and overseas financing. Alternatively, you can use BOT, TOT and other financing models, which can make the implementation of the project faster, and the government can use the recovered fund into new construction projects, speeding up the flow of financial funds. Therefore, the financing decision-making on reclaimed water recycling projects is particular important.

The current financing decision-makings usually use analytic hierarchy process and fuzzy set theory which are based on the subjective judgments of decision makers. Such methods have positive effects, but require higher abilities of decision-makers. Decision-makers must have high professional quality and overall control ability, and also the full participation. However, not all decision-makers have this ability or energy to complete the work, and the different preferences of decision-makers will also affect the results of the decision. Based on the entropy, this paper puts forwards the entropy decision method which combines the objective judgments of the decision-makers and experts with subjective conditions, provides a new way of thinking and methods for financing decision.

Project financing decision-making model using entropy theory

The principal. Entropy is the quantitative measure of the system state being uncertainty.

Additivity: With the probability attribute, the system entropy equals entropy of each state.

Non-nagative: Cause the probability of system in all kinds of states is between 0 and 1, so the entropy of system is always non-nagative.

Extremality: If$p_i = \frac{1}{n}(1,2,\ldots n)$, the maximum of entropy$E_{max} \le E\left(\frac{1}{n},\frac{1}{n},\ldots,\frac{1}{n}\right) = \ln n$

Symmetry: Entropy has nothing with the order of the probability its status occuring.

Additivity:E(A), E(B) stand for the entropy of A, B,if A and B is independentGet：E(AB)= E(A)+E(B)

Entropy is the method of determining the index weights based on the original value of each index, in which the entropy is not the index factor attached importance in a practical sense of decision problem, but the index of relative competition intensity sense under the index value determined circumstances in a given object. It is not simply built on the basis of probability, it makes the subjective judgments of decision makers and the inherent information of the object to be organic combination to achieve the unity of subjective and objective based on pre-established preference weights given by decision-makers.

Suppose there are n indexes in evaluation project to be evaluated and m alternatives. Thus the evaluation matrix form,

$$R = (x_{ij})_{m\times n} \quad (1)$$

The greater the gap between the value indexes, the greater the function to decision makers. Otherwise the least function.

Standardize the original evaluation matrix.X_{ij}---- The estimate of index i which belongs to the pending case j.

Xi*----The ideal value of index i

$$X_i^* = \begin{cases} \max\{X_{ij}\}, & \text{The return index i, the bigger the better} \\ \min\{X_{ij}\}, & \text{The loss index i, the less the better} \end{cases} \quad (2)$$

Define Xij to Xi*as its closeness

$$F_{ij} = \begin{cases} \frac{X_{ij}}{X_i^*}, & \text{The return index i, the bigger the better} \\ \frac{X_i^*}{X_{ij}}, & \text{The loss index i, the less the better} \end{cases} \quad (3)$$

For better applied, normalize F_{ij}

$$f_{ij} = F_{ij}/\sum_{i=1}^{n}\sum_{j=1}^{m} F_{ij} \quad (4)$$

Fulfil $0 \ll f_{ij} \ll 1, \sum_{i=1}^{n}\sum_{j=1}^{m} f_{ij} = 1$

The project financing decision-making model based on the entropy. Suppose the system has n different states $y_1,y_2,\ldots,y_n$,p_i is the probability the system in y_i state (i=1,2,…n), we can get the entropy:

$$E(p_1, p_2, \ldots p_n) = \sum_{i=1}^{n} p_i \ln p_i \quad (5)$$

Fulfil $0 \ll p_i \ll 1; \sum_{i=1}^{n} p_i = 1$

According to the entropy extremality, we can define:e_i

$$e_i = -\frac{1}{\ln m}\sum_{j=1}^{m}\frac{f_{ij}}{f_i}\ln\frac{f_{ij}}{f_i} \quad (6)$$

Fulfil $f_i = \sum_{i=1}^{n} f_{ij}, i = 1,2,\dots,n$

The entropy proportion is of relative competition intensity sense under the index value determined circumstances in a given object.

If the Entropy proportion is large, that means the objects are clearly different in the indicator and we should be focus of investigation. The smaller the entropy proportion is , the less important indicator is. If the entropy proportion is zero, it shows that the index does not provide any useful information to decision makers , you can consider removing the index.

Normalize (1-e_i),get

$$\omega_i = \frac{1-e_i}{n-E'} \quad (7)$$

ω_i should fulfil $0 \ll \omega_i \ll 1, \sum_{i=1}^{n}\omega_i = 1, E' = \sum_{i=1}^{n} e_i$

Sj means the closenessof the decision scheme and the ideal.

$$S_j = 1 - \sum_{i=1}^{n}\omega_i(f_i^* - f_{ij}) \quad (8)$$

f_i^* is the optimum of f_{ij} obviously ,the larger S_j is,the closer the decision scheme and the ideal,the more superior the case is.

Applied Case

One City plans to build a water reuse project, but it needs for community financing due to financial funding constraints, and the alternative modes of financing are bank loans, stocks, bonds, financial leasing and so on. These financing models have different combinations, making use of entropy method to make decisions on the project financing.

Project evaluation index. The water reuse project funding sources are: financial allocation, bank loans, stocks, bonds, financial leasing. Since equity financing is complicated, multi-constraints, and future projects will involve the control of problem, so this approach is excluded. And financial allocation is fixed in each program, which means each program does not have any difference in the index, so the indicator can be canceled. Meanwhile, the total financing will affect the scale of project construction more or less, thereby affecting the length of the construction period. In addition, financing costs and risks of project financing is an important indicator to consider.

Therefore, the final evaluation indictors of the project are: the amount of bank loans, total bonds, the total finance lease, the total financing, financing costs, construction period and financing risks. In view of the present financing situation and government credit guarantees, we can deem that the former four indicators of the above seven indicators belong to the return, the bigger the better.and others belong to the loss, the less the better.

The financing of the project has four combinations, and the original data matrix of indicators is show in table 1.

Table 1 Original data matrix of indicators

	A	B	C	D
bank loans	5000	4000	6000	1000
total bonds	1000	3000	4000	5000
total finance lease	2000	3000	1000	1500
total finacing	8000	10000	11000	7500
finacing cost	15	30	60	50
construction period	2	2. 5	3	2
financing risks	1	4	7	9

The unit of bank loans, total bonds, total finacing lease and finacing cost are ten thousand. And construction period's unit is year. The scores of financing risks are rated by experts. And 9's mean is high risk, in turn decreasing the risk, 0 denotes risk-free.

Here we can know the original evaluation matrix is the transpose of the above one according to (1).

Standardize the original evaluation matrix. According to the (2) and (3) formula,we getF_{ij}

$$\begin{vmatrix} 0.833 & 0.2 & 0.667 & 0.727 & 1 & 1 & 1 \\ 0.667 & 0.6 & 1 & 0.091 & 0.5 & 0.8 & 0.25 \\ 1 & 0.8 & 0.333 & 1 & 0.25 & 0.667 & 0.143 \\ 0.167 & 1 & 0.5 & 0.682 & 0.3 & 1 & 0.111 \end{vmatrix}$$

On the basis of formula (4), get unitary matrix:

$$\begin{vmatrix} 0.048 & 0.012 & 0.039 & 0.042 & 0.058 & 0.058 & 0.058 \\ 0.039 & 0.035 & 0.058 & 0.005 & 0.029 & 0.046 & 0.014 \\ 0.058 & 0.046 & 0.019 & 0.058 & 0.014 & 0.039 & 0.008 \\ 0.010 & 0.058 & 0.029 & 0.039 & 0.017 & 0.058 & 0.006 \end{vmatrix}$$

Calculate entropy and entrop proportion. According to formula (6) and (7), get the result. The result is show in table 2.

Table 2 Entropy and entrop proportion

	Bank loans	bonds	finance lease	total finacing	finacing cost	construction period	financing risks
Entropy(e_i)	1.740	1.761	1.814	1.659	1.700	1.904	1.342
Entrop proportion(ω_i)	0.150	0.155	0.165	0.134	0.142	0.184	0.070

The entropy proportion of each indictor reflects how important the decision of the project is. Table 2 shows, decision-makers must consider all the indicators to make scientific judgments on the project, because lacking any indictor will affect the result. It also shows the selected indictors can correctly reflect the true situation.

Calculate the closeness of the decision scheme and the ideal. According to formula (8) we can know the closeness of the decision scheme and the ideal. It's show in table 3.

Table 3 The closeness of the decision scheme and the ideal

	A	B	C	D
Closeness (S_j)	0.9995	0.9905	0.9918	0.9894

Financing decision. Table 3 shows, A's closeness is the nearest to the ideal.Therefor we select A as the final plan of the water reuse project.

Conclusions

For the same project, different experts or decision-makers may have disagreements on the indicators because of their different experiences or different approaching angle. These make the indicators in uncertainty. To solve this problem, the paper introduces the entropy theory for decision-making. The entropy, as a measure of uncertainty, can determine the weight value of the entropy through the original matrix, at the same time, taking the experience of experts or decision-makers into account. Therefore, this decision making method combines the objects with the subjects, making the decision more scientific and reasonable. Also it is a powerful tool for decision makes with great practical value.

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The Analysis and Research on Electromagnetic Radiation Pollution of High Voltage Transmission Line

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Keywords: High voltage transmission lines; Electromagnetic radiation; Pollution; Urban environment.

Abstract. With the development of China's power industry, many cities had renovated, expanded electricity power network ,110, 220 kV and above the high voltage overhead transmission lines all around the urban areas and residential areas. As the electromagnetic radiation of high-voltage transmission lines inevitability pollute on urban environment, according to the Investigation, monitoring[1] and analysis of high voltage, based on national standard of electromagnetic radiation, this paper proposed the controlling measures and recommendations of electromagnetic radiation. Therefore, the research that the electromagnetic radiation impact on the environmental has a very high value and academic significance.

Introduction

As the accelerated pace of urban construction, 110kV and the other higher than 110kV 's high voltage overhead transmission line and substations are expanding the scale of their construction. High voltage transmission lines and substations bringing electromagnetic radiation inevitably cause pollution to the environment. This paper based on the work that is at home and abroad, it Conduct relevant research on the electromagnetic radiation of contemporary high voltage transmission lines, and put forward proposal on urban planning and transformation of high voltage transmission line. The main works and conclusions of this paper can be listed as follows:
(1)Analyzing the principles and hazards of the electromagnetic radiation.(2)Describing the electromagnetic radiation measuring instruments, measurement methods, measurement environment, domestic and international commonly criteria and standards commonly used in China.(3) Some calculations of high voltage transmission lines' electromagnetic radiation.(4)Analyzing the present pollution situation of electromagnetic radiation and proposing protective measures, and putting forward reasonable proposals on transformation the lines and urban planning.

Principles of electromagnetic radiation

Transmission lines on the basis can be divided in the three of high voltages (220kv), super high voltage(330kv-750kv) and special high voltage (1000kv above), the frequency of AC transmission is 50Hz (frequency). When transmission lines work, the voltage on the transmission line will generate the electric field around the space, but its frequency is very low, so the electrostatic field can be used to understand the general concept.

Electric Field Properties. Electric field intensity is proportional to the voltage of voltage transmission line; field in conductive objects (buildings, trees, etc.) will transform seriously the electric field and generating a certain shielding. Three-phase AC transmission lines arranged in different ways, electric field strength are different (wires horizontal, the maximum field strength of the range. equilateral triangle arrangement is second. inverted triangle is minimum). Improve the

height of transmission line can reduce electric field intensity of the ground. Generally the maximum electric field intensity under the ground of EHV transmission lines(1m height above the ground) is about 5kV/m-10kV/m [2]. The electric field strength of transmission line is much larger than that of nature and the everyday environment [3].

Magnetic properties. When current flows through the wire of transmission line, it will generate magnetic field in the surrounding. Magnetic field has some different characteristics from electric field: the size of the magnetic field strength only has a relationship with current, and without voltage. 50Hz power frequency magnetic fields pass through most of the objects (such as buildings and people) easily, and it will not be Interfered by these objects [4].

Corona properties. When the surface electric field of wire transmission lines is over the air puncture intensity, The wire surface will produce the phenomenon of corona discharging. If you want to generate corona phenomenon, the surface of the electric field strength is to achieve 30kV/cm or more generally. Usually the wire surface of transmission lines only has such a large electric field intensity, so the main corona discharging phenomena all in transmission lines. The corona discharging of transmission lines is mainly affected by characteristics of their own. For example: the higher the line voltage, the stronger the corona discharging. The larger the diameter of the wire is, the weaker corona discharging. The higher smoothness of wire surface is, the weaker corona discharging also. In areas of poor air quality and the relatively poor weather, the corona discharging phenomenon of transmission lines is always strong [5].

Safety standards of electromagnetic radiation

We often contact with frequency range from the 30MHz of short wave band to 3000MHz of frequency microwave band, their wavelength range from 10m to lm. That is to say based induction of nearly field (also known as the induction field) and based radiation of far field (also known as the radiation field). The measuring instruments are divided by measuring purpose into non-selected frequency Broadband radiation and selective frequency radiation. Other a non-selected frequency type of broadband radiation measuring instrument or a type of frequency selective radiation measuring instrument, basic structures is composed of two parts which are sensors and the host system [6].

National standard fixing, when the body frequency of electromagnetic radiation is below 300MHz, The workplace should be measured respectively the electric field and magnetic field intensity. When the body frequency of electromagnetic radiation is above 300MHz, you can only measure the electric field intensity. 300MHz frequency is corresponded with wavelength lm. λ / 6 is 16cm and outside of 16cm the radiation field has advantage. If 3λ is as the division boundaries, beyond 3m from the radiation source can be considered far region field.

China, there have no environmental protection regulations and standards on state grid at present. The state clearly defined the distance from the transmission line to the residents of housing. The minimum vertical distance between110 kV wires and buildings is 5 meters and 6 meters of 220 kV, 9 meters of 500 kV. China recommended standards of electromagnetic radiation is the 90th international standard of 20th century at present, but much severer than electromagnetic radiation provided by some developed countries. In 1990, the International Radiation Protection Association Committee on Non-Ionizing Radiation (IRPA/INIRC,1990) 50/60Hz frequency electromagnetic fields on the emission limits shown in Table 1;

Table 1, The 50/60Hz frequency of field radiation limits

	Exposed objects	Electric field intensity/(kV.m-1)	Magnetic field intensity/(mT)
Profession public	Whole working days	10	0.5
	Within short time	30	5
	Limited to the limbs	—	25
	Within 24h/d	5	0.1
	Within nh/d	10	1

The calculations on electromagnetic radiation of high-voltage transmission line

Frequency electric field of high-voltage lines is a quasi-static electric field, so some of its effects can be generally analyzed by electrostatic field. The field is generated by the charge to high-pressure device. When the wire is live, the charge distribute on the surface of the overhead wires. The electric field is only a manifestation of the charge effect at a distance and the effect should comply with the Coulomb's law.

Calculating the Equivalent Charge of Unit Length Wire. The equivalent charge of high-voltage transmission line is the line charge. As radius of the high-voltage transmission lines is much smaller than the height of the overhead wires, the location of the equivalent charge can be considered to be the geometric center of power transmission wires. Assuming that electric transmission line is an unlimited length and parallel to the ground, Ground can be regarded as a good conductor and using the image method to calculate the equivalent charge on the wire.

To calculate the equivalent circuit of multi-wire cable, we can write the following matrix equation:

$$\begin{bmatrix} U_1 \\ \vdots \\ U_n \end{bmatrix} = \begin{pmatrix} \lambda_{11} & \cdots & \lambda_{1n} \\ \vdots & \ddots & \vdots \\ \lambda_{n1} & \cdots & \lambda nn \end{pmatrix} \begin{bmatrix} Q_1 \\ \vdots \\ Q_n \end{bmatrix} \tag{1}$$

Where:[U] for the single matrix of the wire-to-ground voltage.

[Q] for the single matrix of the equivalent charge on each wire.

[λ] for n-order of matrix composed of potential coefficient of each wire (n is the number of wires).

[U] matrix could be determined by voltage and phase of the transmission line, consideration to environmental protection we could regard the 1.05 times of rated voltage as the calculation of voltage. By the three-phase 500kV (line voltage) loop each phase and component, as is shown in Figure 1, we can calculate voltage of the wire-to-ground.

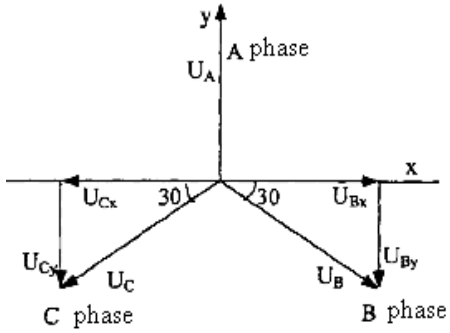

Figure 1, The calculation of Three-phase 500kV voltage

$$|U_A\|U_B\|U_C| = \frac{500 \times 1.05}{\sqrt{3}} = 303.1KV$$

The voltage components of wire-to-ground:

$$U_A = (303.1 + j0)KV$$
$$U_B = (-151.6 + j262.5)KV$$
$$U_C = (-151.6 - j262.5)KV$$

Calculating the Electric Field Generated By These Charges. When the equivalent charge of each wire's unit length calculated, the electric field at any point of space can be calculated based on superposition theorem, the (x, y) point can be expressed by E_x and E_y as following:

$$E_x = \frac{q}{2\pi_0}\sum_{i=1}^{m} Q_i \left(\frac{x - x_i}{L_i^{\,2}} - \frac{x - x_i}{\left(L_I^{\,'}\right)^2} \right) \tag{2}$$

$$E_y = \frac{q}{2\pi_0}\sum_{i=1}^{m} Q_i \left(\frac{y - y_i}{L_i^{\,2}} - \frac{y - y_i}{\left(L_I^{\,'}\right)^2} \right) \tag{3}$$

In formula x_i, y_i are the coordinates for the wires i $(i = 1,2,3\cdots m)$, m for the number of wires. L_i and $L_i^{'}$ were separately the distance from calculating point to the image and the wire is. For the three-phase AC line, we can calculate electric field intensity at any point of space horizontal and vertical components based on the formula (4) and (5) charge obtained:

$$\vec{E}_x = \sum_{i=1}^{m} E_{ixR} + j\sum_{i=1}^{m} E_{ixI} = E_{xR} + jE_{xI} \quad (4)$$

$$\vec{E}_y = \sum_{i=1}^{m} E_{iyR} + j\sum_{i=1}^{m} E_{iyI} = E_{yR} + jE_{yI} \quad (5)$$

In formula E_{xR} for the real part charge of each wire in the point produces the horizontal component of field. E_{xI} for the imaginary part charge of each wire in the point generated the horizontal component of field. E_{yR} for the real part charge of each wire in the point produce the vertical component of field. E_{yI} for the imaginary part charge of each wire generated in the point the vertical component of field. The synthetic field intensity of the point:

$$\vec{E} = \left(E_{xR} + jE_{xI}\right)\vec{x} + \left(E_{yR} + jE_{yI}\right)\vec{y} = \vec{E}_y + \vec{E}_x \quad (6)$$

Among them, $E_x = \sqrt{E_{xR}^{\ 2} + E_{xI}^{\ 2}}$ and $E_y = \sqrt{E_{yR}^{\ 2} + E_{yI}^{\ 2}}$ on the ground surface (y = 0) the horizontal component of electric field intensity is that ($E_x = 0$). Examples of: calculation Figure 2 shows the structure of the single-loop 500kV three-phase overhead transmission lines. Erection of wire is horizontal and with n = 4 of the division wires. the equivalent value of the charge matrix：

$$[Q_R] = 2\pi\varepsilon_0 \begin{bmatrix} 71.359 \\ -38.008 \\ -30.590 \end{bmatrix} \times 10^3 c/m$$

$$[Q_I] = 2\pi\varepsilon_0 \begin{bmatrix} -5.886 \\ -65.919 \\ -64.742 \end{bmatrix} \times 10^3 c/m$$

Calculate the frequency electric field intensity P point (x = 15m, y = lm).

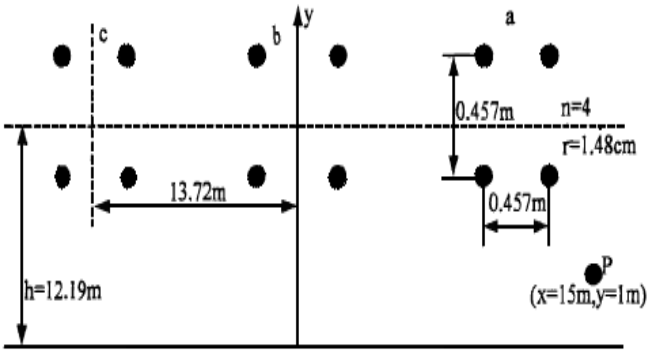

Figure2, Showing the structure of the single-loop 500kV three-phase overhead transmission lines

Calculating the horizontal component and vertical component of frequency electric field intensity at the P point, the coordinates of each wire as is shown in Figure 3:

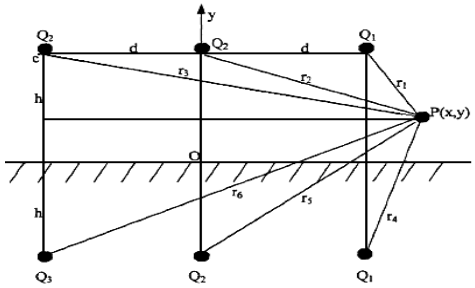

Figure 3, The coordinates of each wire

According to the P point coordinates (x = 15m, y = lm) based on formula (2) and (4), we can obtain the real point of the QR charge generating horizontal component of field at the P point:

$$E_{xR}=\frac{1}{2\pi\varepsilon_0}\left\{\left[\frac{Q_{1R}(x-d)}{r_1^2}-\frac{Q_{1R}(x-d)}{r_4^2}\right]+\left[\frac{Q_{2R}x}{r_2^2}-\frac{Q_{2R}x}{r_5^2}\right]+\left[\frac{Q_{3R}(x+d)}{r_3^2}-\frac{Q_{3R}(x+d)}{r_6^2}\right]\right\}=-0.044\times10^3 v/m$$

The imaginary part of the QI charge generated the horizontal component of field at the P point:

$$E_{xI}=\frac{1}{2\pi\varepsilon_0}\left\{\left[\frac{Q_{1I}(x-d)}{r_1^2}-\frac{Q_{1I}(x-d)}{r_4^2}\right]+\left[\frac{Q_{2I}x}{r_2^2}-\frac{Q_{2I}x}{r_5^2}\right]+\left[\frac{Q_{3I}(x+d)}{r_3^2}-\frac{Q_{3I}(x+d)}{r_6^2}\right]\right\}=-0.423\times10^3 v/m$$

So the horizontal component of the field is at the P point:

$$\vec{E}_x=(-0.044+j0.423)KV/m$$

$$E_x=\sqrt{(0.044)^2+(0.423)^2}=0.425KV/m$$

According to formula (3) and (5) QR real charge generated the vertical component of field strength at the P point:

$$E_{yI}=\frac{1}{2\pi\varepsilon_0}\left\{\left[\frac{Q_{1I}(y-h)}{r_1^2}-\frac{Q_{1I}(y+h)}{r_4^2}\right]+\left[\frac{Q_{2I}(y-h)}{r_2^2}-\frac{Q_{2I}(y-h)}{r_5^2}\right]+\left[\frac{Q_{3I}(y-h)}{r_3^2}-\frac{Q_{3I}(y+h)}{r_6^2}\right]\right\}$$

$$=-4.938\times10^3 v/m$$

So the vertical component of the field is at the P point

$$\vec{E}_y=(-8.420-j4.938)KV/m$$

$$E_y=\sqrt{(8.420)^2+(4.938)^2}=9.761KV/m$$

The result of calculation. According to the above formulas, we can calculate the electric field intensity at any point. It can be calculated the electric field intensity of the point under the 500kV transmission line and above 1.5m the ground, as is shown table 2.

Table 2, The calculation of electric field intensity under 500kV transmission line (single-loop)

No.	Line Height (12m)		Line Height (15m)		Remark
	X (m)	Electric Field Intensity (kV/m)	X (m)	Electric Field Intensity (kV/m)	
1	0	15.49	0	13.17	The Height of Calculating Points Are 1.5m Above The Ground
2	5	11.88	5	10.06	
3	10	9.87	10	8.83	
4	15	9.76	15	8.04	
5	20	7.78	20	6.72	
6	25	5.29	25	5.03	
7	28	4.41	28	4.15	
8	29	3.83	29	3.89	

a:Below the Ground of Middle Wire for the Origin, X for the Distance of the Line Side, Y for the Height from the Ground

As can be seen from the above calculations date:
(1)Below the line erection height have an obviously effect on electric field intensity, the higher line erect for the ground, the more electric field intensity decreases. but the erection of height have an less obviously effect on the electric field strength beyond a distance of both sides.
(2) The height of 500kV transmission line is 15m-12m, under the wire the electric field intensity is 13.17kV/m-15.49kV/m, and 29m from both sides can be met the environmental standards of the radiation.

Conclusion

That high voltage overhead transmission line generating frequency electric and magnetic fields, radio interference and audible noise have an influence or harm on personal safety and health and the surrounding facilities to some degree. But as the following provided protective measures, can reduce the degree of the harm and impact. 1) In order to prevent the electromagnetic radiation of transmission lines from being harm to the environment and person, can improve the height of wire-to-ground in the circuit designing, the double-loop wire error layout, and high and low voltage wire hierarchical erection, etc. 2) Take full advantage of the characteristics of three-phase AC current, namely the voltage and phase current vector sum three-phase are zero; 3) using scientific means to shield electromagnetic fields. 4) Establish corridors of the health protection. For above 220kV EHV transmission lines must be established corridors of the health protection, and the width of the corridor is 40-50m, under the corridor obstructions (trees, etc.) should be basically cleaned up. 5) In order to protect transmission lines, mental health and physical of residents near substation, and proposed that within 250-300m the range provided should not be built homes and crowded activity place.6) Under the high voltage line, if the surface area of the metallic objects is large, it must be well grounded, or it would make people to get electric shock.

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Firms and government behaviors for sustainable buildings energy-saving

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Keywords: Bulidings energy-saving; Sustainable development; Government behaviors; Transparadox

Abstract: Both firms and government characterized dual and simultaneous behaviors about sustainable buildings energy-saving. This study will formulate 2*2 matrixes to construct four different interactive types about firms and government behaviors such as reaction, leadership, acceptance, and transparadox. In addition, we also analyze that how different types impact sustainable buildings energy-saving. This study not only makes important theoretical contributions on analyzing and exploring firms' and governmental behavior portfolios for sustainable buildings energy-saving, but also makes significant managerial implication on transferring other three portfolios into transparadox type in order to growing sustainable buildings energy-saving.

Introduction

With rapid economic development in China, construction industry is largely emerging and become important industrial body in Chinese economic transition. However, coupled by fast-growing buildings, a significant issue is that energy consumption and environmental pollution are increasing, which negatively impact healthy growth of construction industry and social sustainable development [1]. Therefore, how to improve buildings energy-saving and facilitate social sustainable development have been heavily focused by scholars and politicians [2].

In China, government still plays important role in policies making and economic control [3]. Particularly, for sensitive social issue such as energy-saving, Chinese government has paid more attention to regulate eneronmental pollution in construction industry [1,4]. Governmental behaviors in China often express two significant features in regulate industrial development. First, governmental policies always are pulled by practical firms' activities, that is, policies often lag back of industrial phenomenon. Therefore, governmental policies are hard to satisfactory firms demand and social requirements. But some time, some new government decision in policies-making may push industrial development and proactively server social demands. The two features reflect weak and immature institutional system in governmental policies making [3], and formulate different governmental behaviors in regulating industrial development. Further, with intensive industrial competition, firms in construction industry also often make different behavior ---- compliance and proactivenss ---- to deploy building energy-saving strategy in order to win competitive advantage [5]. But huge transactional costs often make more firms not use energy-saving measurements, and only few firms are willing to construct energy-saving buildings in order to enhance reputation and long-term competence [6].

In line with above logic, both firms and government characterized dual behaviors about sustainable buildings energy-saving, but we know little about how different types between firms behaviors and government behaviors impact sustainable buildings energy-saving, which lead unexplored and unresolved question on improving sustainable buildings energy-saving. Therefore, this study will formulate 2*2 matrixes to analyze different portfolio types and their different effects on sustainable buildings energy-saving.

Different Portfolios between Firms and Government Behaviors

We argue that government behaviors mainly focused on pulled and push policies making. Pulled policies making often be impacted by firms' behaviors in environmental pollution and energy consumption of buildings construction activities [6], and it is comparative lag, lack power, and weak effectiveness; push policies making mainly come from governmental foresee in future industrial development and firms' behaviors, and it is powerful to push firms' or industrial involvement in developing buildings energy-saving, often is proactive, efficient, and better performance. The two different behaviors may lead different efficiency in sustainable buildings energy-saving. Compared to government behaviors, firms' behaviors also play important roles in sustainable buildings energy-saving. Construction firms often characterized two kinds of behaviors for building energy-saving issue, that is compliance with governmental policies and proactively innovate energy-saving buildings. Compliance behavior represented that firms are forced to have to implement governmental decisions in engaging in buildings energy-saving, and it is passive, unreluctant, and weak effectiveness [5]. Proactive behavior represented that firms reluctantly develop energy-saving buildings, facilitate energy-saving industry growth, and improve environmental pollution issue caused by their construction activities. It is positive, willing, and better effectiveness.

Although firms' behaviors and governmental behaviors are different types and features, in transitional economies such as China, firms and government play dual roles in impacting industrial developments. In other words, firms' behaviors and governmental behaviors simultaneously exist and decide whether seriously enhance degree to buildings energy-saving or not. Therefore, such simultaneous behaviors from firms and government formulate different portfolios (refer with: Fig. 1) to resolve the issue of sustainable buildings energy-saving.

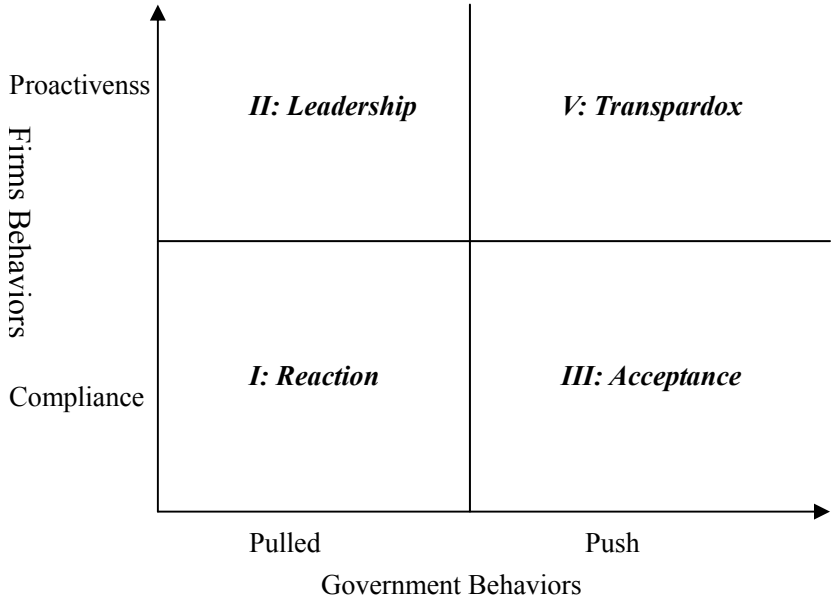

Fig. 1 Behaviors portfolios for sustainable buildings energy-saving

Reaction Type. This type is composed by pulled government behavior and compliance firms behavior. Reaction type suggested that governmental policies making often lag firms' demand, and government policies are pulled by other firms' demands. Meanwhile, the firm obeyed pulled government policies on buildings energy-saving. The type reflected passive adaptation from both firms and government for building energy-saving. On one hand, firms passively obeyed lagged energy-saving policies; on the other hand, government lack activeness to make relative buildings energy-saving policies so as to improve competence on buildings energy-saving. This type makes both firms and government not enough to pay more attention to buildings energy-saving and environmental protection, which is not beneficial to sustainable development based on buildings energy-saving.

Leadership Type. Some constructions firms often make proactive behavior to engage in buildings energy-saving outperform their rivals. These firms always play leadership role in industrial development and direct technological trends. At this time, government policies often were pulled, and the pulling may be caused by these leadership firms. Leadership type reflected firms' proactiveness but governmental passiveness on policies making. However, although some firms proactively deployed techniques, methods, and measurement on buildings energy-saving, lack government policies support often decrease confidence of these firms and increase costs of buildings energy-saving invisibly. On the other hand, these firms engaging in buildings energy-saving mainly focused on win reputation and brand image rather than facilitated buildings energy-saving development. Therefore, leadership type portfolio still has limitation and unity. From long-term perspective, the type also cannot improve sustainable buildings energy-saving.

Acceptance Type. Acceptance type reflected governmental proactiveness in making policies to push policies-implementation of buildings energy-saving and firms' passiveness in compliance with relative policies. These firms usually accepted governmental decisions (e.g., rules, laws, and policies) and implement governmental policies and regulations. However, government actively pushed buildings energy-saving development, but firms' passive compliance may decrease efficiency and effectiveness of governmental policies of buildings energy-saving. In a word, acceptance type cannot also facilitate sustainable buildings energy-saving.

Transparadox Type. Firm's behaviors and government behavior on driving sustainable buildings energy-saving often are at a paradox. Their specific strategies are not synchronization always. To advance sustainable buildings energy-saving, transparadox type become important portfolio between firms' proactiveness and governmental push. Transparadox type argued that not only governmental actively push policies making but also firms tend to actively match and implement policies for buildings energy-saving. The double win combination will be best results on encouraging buildings energy-saving activities. Further, the possible path to make transparadox between firms behaviors and governmental behaviors is enhancing governmental foresee-competence while provide reciprocal policies to encourage firms' proactiveness in involving in buildings energy-saving. Transparadox type is optimal game portfolio beyond other three portfolios to accelerate development and growth of buildings energy-saving filed in China.

Discussions and Conclusions

As stated above, we analyze four different portfolios between firms behaviors and governmental behaviors, and formulate 2*2 matrixes to construct four different interactive types about firms and government behaviors such as reaction, leadership, acceptance, and transparadox. In addition, we also analyze that how different types impact sustainable buildings energy-saving. Of four types, we argue that transparadox type will be important behavioral combinations between firms and government to facilitate sustainable buildings energy-saving. Encouraging firms' proactiveness and strength governmental predictability will become key point for transparadox.

This study not only makes important theoretical contributions on analyzing and exploring firms' and governmental behavior portfolios for sustainable buildings energy-saving, but also makes significant managerial implication on transferring other three portfolios into transparadox type in order to growing sustainable buildings energy-saving. In future research, we will further pay more attention to how to specifically make transparadox-based strategies and paths between firms energy-saving behaviors and governmental energy-saving behaviors so as to synchronously facilitate sustainable buildings energy-saving in Chinese construction industry.

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A New Brick Prepared from Municipal Sewage Sludge and Shale

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Keywords: shale; sewage sludge; normal brick; compressive strength; porosity; thermal conductivity; phase composition; leaching toxicity

Abstract: Series of experimental tests on the forming technique, sintering technique, performance and effectiveness of a new fired brick by mixing municipal sewage sludge and shale are carried out. Test results show that adding sludge properly in the process of manufacture shale fired common brick is feasible. Along with increase of sludge content, the compacting of uniformity of unburned brick decreased and its porosity increased. When shale-sludge mixtures were calcined, the heavy metal solidified, the ignition lost and organic substance volatilized that reduced the unconfined compressive strength (UCS) of the brick and improve its thermal insulation ability. The phase composition and leaching toxicity of sewage sludge-shale baked brick can be up to national standard. Good quality brick can be produced by blending mixture with the optimum moisture content (OMC) 18.0%-20.0%, drying at 105˚C and sintering at 960˚C. With all being considered in manufacturing brick, the content of sewage sludge shall be controlled within 9.0% that can make UCS of the new brick reach MU10 criterion and it has a superior heat preservation effect to normal brick from clay or shale alone.

Introduction

In China, the annual municipal sewage sludge (dewatered) production increase along with the outlet qualitative standard of the sewage and its sewage output. Until 2006, approximately 5 to 6 million tons sludge was put to surrounding, and it increase with the rate of 10%, which reached 20 million tons in 2010. The traditional treatment way to sewage sludge cost so much that its investment of equipment is up to 20% to 50% (more that 70% in developed countries) of comprehensive treatment costs [1,2]. Utilization of sludge as an addition to construction and building material, like building bricks, lightweight artificial aggregates, and cemented materials is a win-win strategy because it not only converts the wastes into useful materials, but it also alleviates the disposal problems. The prospective benefits of using sludge or sludge ash as the brick additive include immobilizing heavy metals in the fired matrix, oxidizing organic matter and destroying any pathogens during the firing process, reduce the consumption of energy and reducing the frost damage based on the results of several full or bench scale studies[3,11].

Considering that lack of systematic research on the sludge brick making technology and the characteristic of sludge brick in our country, with the sludge and shale being used, we comprehensively and systematically study the making technology, the suitable mixing ratio, and engineering properties of the brick in this paper. And the phase composition sludge brick and metal leaching abilities were also investigated.

Material and methods

Materials

The materials used in this study include sludge, shale. The sludge samples were obtained from an industrial wastewater treatment plant in Jiangxinzhou islet in Nanjing, China. The sludge samples were dewatered to 70% in moisture content by filter press, then oven-dried at 60˚C until weight maintains constant, and last smashed. The shale samples were retrieved from a brick factory in Nanjing.

Table 1 lists the sludge, sludge ash and shale characteristics and their metal and non-metal content measured by scanning electron microscope (SEM), energy dispersive spectrometer (EDS). Fig.1 presents the gradation curve of the sludge and shale samples determined by S3500 type laser particles size analyzer.

Table 1 Characteristics of sludge and clay

Characteristics	Shale powder	Sludge	Sludge ash
Density (g/cm3)	1.89	1.77	------
Loss on ignition (%) (combusted at 960±50˚C for 1 h)	7.1	78.1	------
Plastic limits (%)	17.0	70.0	------
Liquid limits (%)	41.7	114.0	------
Maxium density (g/cm3)	1.76	------	------
Optimum moisture content	17.6	------	------
Metals and Non-metals (kg/kg)			
Al	11.48	8.13	9.50
Si	26.32	27.25	23.75
Fe	7.95	5.92	4.12
Ca	1.35	2.43	2.72
Mg	2.50	1.50	1.92
K	3.65	2.42	2.41
O	44.21	41.13	51.96
Na	1.16	0.68	0.70
Ti	0.93	0.55	0.43
Ni	0.45	0.43	0.77

Note: sludge samples were oven dried at 60˚C, sludge ash was sampled from burning sludge at 550˚C

Atterberg's Tests of Shale-sludge Mixtures

As shown in fig.2, the results of Atterberg's tests of sludge-shale mixtures indicated that the value of plastic limit, the value of water limit and index of plasticity increased nonlinearly with the amount of sludge in the brick, different from clay-sludge mixture (Weng C H et al., 2002). A plastic limit value of 17.0 for shale alone shows the shale can be classified as a low plasticity material and the mixture with 15% of sludge has plastic limit value of 21.5. The plastic limit values indicate that the sludge can be applied into brick without losing its plastic behavior.

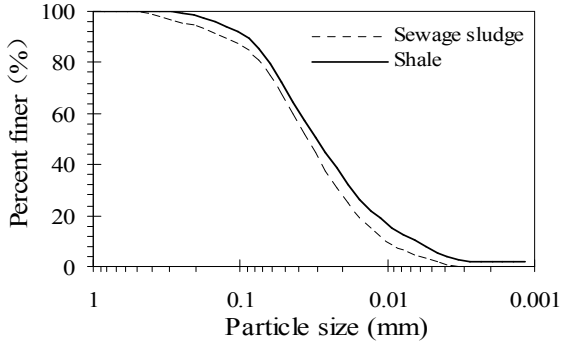

Fig. 1 Gradation curves of shale and sludge

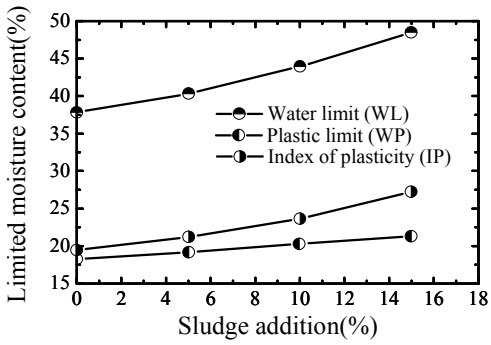

Fig. 2 The atterberg limits of mixtures versus sludge addition

Preparation of Bricks

Four series of composite mixtures (S1 to S4) were prepared in the laboratory. The mixing ratios are presented in Table 2. All compositions were prescribed based on the dry weight of mixtures, and the contents of sludge and shale varied respectively from 0% to 15%, from 85% to 100%.

Table 2 Mixture ratios of shale and sewage sludge

Item	Specimens			
	S1	S2	S3	S4
Sewage sludge [%]	0	5	10	15
Shale [%]	100	95	90	85
Plasticity Index	41.7	18.9	19.8	21.5

Fig.3 shows the process of manufacture the sludge brick. atterberg limits were conducted first to obtain the plastic nature of the shale- sludge mixtures and to determine the optimum moisture content (OMC) in the brick manufacturing process. Under this OMC, the mixtures in various proportions of sludge and shale were prepared by blending with a cement mortar mixer and then aging for 24h in batches. A vacuum machine was used to expel the air from the mixture to avoid cracking in the firing process. The mixtures were then introduced into a series of brick molds (120 mm in length, 53 mm in width, and 27 mm in thickness) and also pressed into shape. After a 24-h 105˚C oven-dry period, the molded mixtures (body) were fired in a combustion chamber with the temperature as shown in Fig.4, and then cooled.

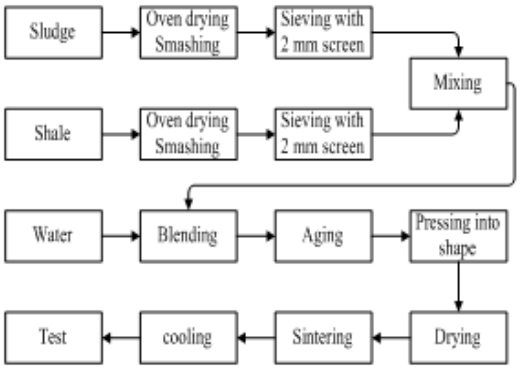

Fig. 3 Process chart of manufacture of sludge brick

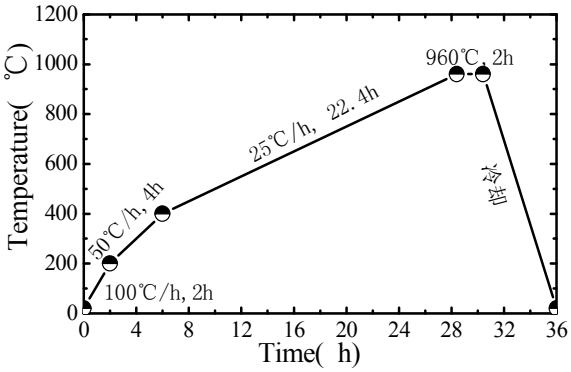

Fig. 4 Temperature curve of roasting sludge-shale brick

Evaluation of Brick

As the quality required by GB5101-2003 (National Standard for Fired Bricks) for building bricks, unconfined compressive strength (UCS) were tested on manufactured brick samples by a conventional strain controlled uniaxial compression apparatus, their thermal conductivity were measured by a thermal analysis instrument, porosity were detected by Auto-Pore Ⅳ 9510 type mercury porosimetry, and the phase compositions were observed by X-Ray Diffractometry. Also following criteria evaluation, with SK-2003AZ type double-beam hydride generation-fluorescence spectrum, the tests of toxic characteristic leaching procedure (TCLP) as described in GB5085.3-1996 standard were performed to investigate the leachability of metals from bricks made from sludge.

Results and discussion

Compaction Tests of Shale-sludge Mixtures

A Chinese standard compaction test was used to determine the OMC and MMD that are important factors affecting the properties of brick. The OMC of a mixture was based on the moisture requirement in which maximum bonding among the mixture particles is retained, and the OMC is correspond to the MMD. The test results (Fig. 6) showed that the OMC is 17.6% for shale alone. Increasing the sludge proportions from 0% to 15% in the mixture resulted in an increase of OMC, from 17.6% to 19.7%. Attach to the OMC, the MMD also decreased from 1.756 g/cm3 to1.583 g/cm3.

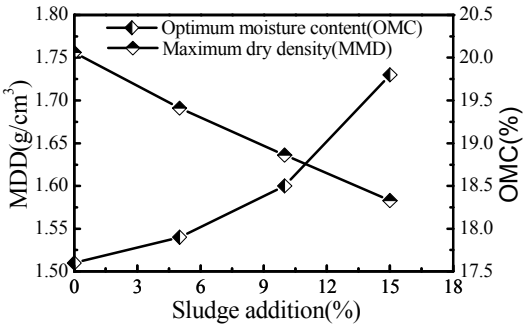

Fig.6 The MDD ,OMC of mixtures versus sludge addition

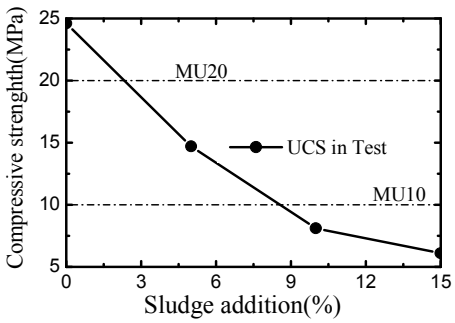

Fig.7 The compressive strength(UCS) versus sludge addition

Compressive Strength of Bricks

The unconfined compressing test is the most important test for assuring the engineering quality of a building material. UCS determines the potential for application of the bricks. UCS is usually affected by the porosity, pore size, and type of crystallization. It is usually defined as the failure stress measured normal to the bed face of the brick. The compressive strength test results are shown in Fig.7.

The results (Fig. 7) indicated that the strength was greatly dependent on the amount of sludge in the brick, consistent with the clay-sludge brick (Weng C H, 2002). As shown, along with the sludge added to the bricks increasing, the strength reduced. With sludge added to the bricks within 9.0%, the strength can reach MU10-class category in GB5101-2003 (National Standard for Fired Bricks), and can be as high as the normal clay bricks. When 2.8% sludge is added in the brick, the achieved brick strength lies in the scope of the MU20-class category. Taking all into consideration, the sludge content shall be limited within 9.0% to meet the requirements of brick standard in practical applications.

Pore Structure and Porosity of Bricks

Fig .8 shows the porosity of bricks (S1~S4) detected through the mercury injection method test (MIMT). As seeing from fig.6, the amount of sludge being added into the shale-sludge mixtures, influenced the porosity of bricks greatly. Along with the sludge proportions increasing from 0% to 15% in the mixture, the porosity increased from 19.5% to 32.1%. This change is so apparent that because the organic maters in sludge fired and the pore left in bricks when the mixtures sintered.

Fig.9 is the SEM photo of brick with 10% sludge added (gray represented soil and black pore). Based on SEM photo (fig.8) and the data collected from MIMT, it can be found that inhomogeneous micropores in sludge brick are up to 35% in volume, and all the pore diameters fit a normal distribution with the average value about 3μm.

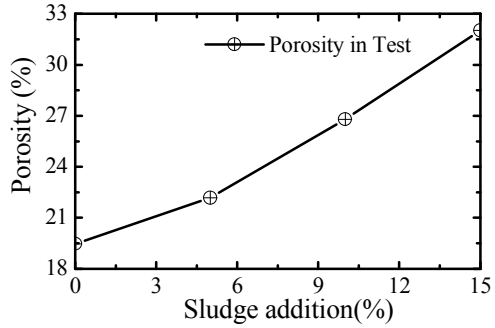

Fig. 8 The porosity versus sludge addition

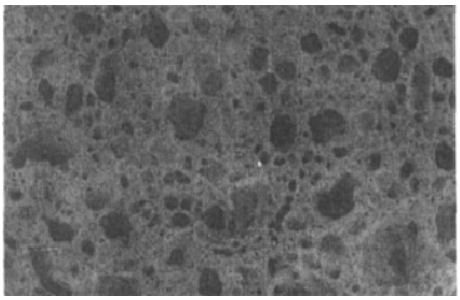

Fig.9 The SEM photo of shale-sludge brick with sewage sludge addition 10%

Heat Conductivity of Bricks

Fig. 10 shows that increasing the sludge proportion resulted in decreases in heat conductivity of bricks. As fig.9 shown, with 5% sludge addition, the heat conductivity reached 0.326 W/m·K, by contrast with the heat conductivity of normal shale bricks 0.356 W/m·K, 9.2% dropped. When

amount of sludge added to bricks within 9.0%, the heat conductivity kept in the range of 0.315~0.356 W/m·K. That is, a proper addition of sludge content can make a reduction in heat conductivity and play an important role to improve in heat preservation of bricks.

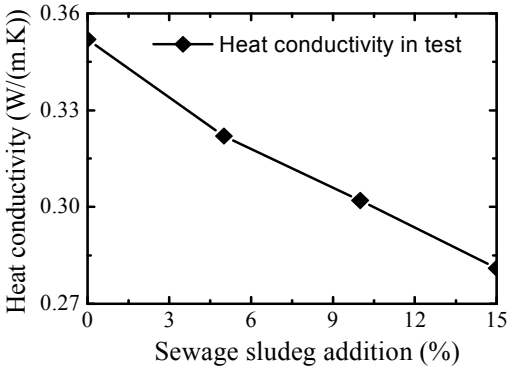

Fig. 10 The heat conductivity versus sludge addition

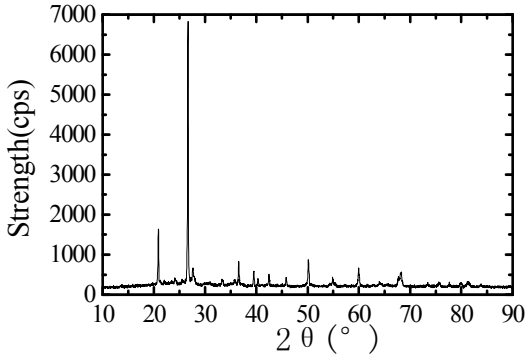

Fig .11 XRD analysis of 10% sludge brick

Phase Composition and TCLP Test

Fig. 11 is the X-Ray Diffraction（XRD）analytical diagram of the brick with sludge addition 10%.With analysis from the diagram, the brick mainly composed of silicon oxides and silicate crystalline.

When diffraction angle θ varied from 0 to 90°, there were many SiO2 peaks, such as 2θ = 26.68° with the strongest peaks and 2θ = 20.88° with the stronger peaks. The phase composition of sludge bricks is quartz (SiO2), kyanite (Al2 SiO5), mullite (Al6 Si3O13), and all that.

Results of TCLP tests are shown in Table 3. Chromium (Cr), cadmium (Cd), lead (Pb), zinc (Zc), arsenic (As), mercury (Hg) and copper (Cu) are leached from sludge bricks, although the concentrations are much less than those of the GB5085.3-1996 TCLP limits. Other leached metals from bricks are of insignificant concern (not listed in Table 4). It is reasonable though, that the rather low metal leached resulted from rending metal in oxide form during the rather high firing temperature environment. Obviously the incineration process makes metal less leachable and the sludge brick can't hurting the environment.

Table 3 Result of the soaking and leaching test of the brick with sludge addition of 10%

Test item	Cr^{6+}	Cd^{2+}	Pb^{2+}	Zn^{2+}	As^{3+}	Hg^{2+}	Cu^{2+}
Results[10^{-2}mg/L]	0.3	0.6	1.0	8.0	0.1	0.1	0.1
Standard*	150	30	30	5000	150	5	5000

Note: standard* represents GB5085.3-1996.

Conclusions

Researches on the forming technique, sintering technique, performance, TCLP of brick by mixing dried sludge and shale are carried on. Based on the experimental program executed in this research and limited on both the tested materials and the testing procedures employed, the following conclusions had been reached:

- Test results have demonstrated that the suitable conditions and adding municipal sewage sludge properly can produce an engineering quality of brick. Along with increase of sewage sludge, the compacting of uniformity of unburned brick decreased and its porosity increased.
- A proper addition of sludge can make a reduction in heat conductivity and play an important role to improve in heat preservation of bricks. With amount of sludge added to bricks within 9.0%, the heat conductivity kept a small changes in the range of 0.315~0.356 W/m·K.

- In the calcination process of unburned brick, the heavy metal was solidified, the ignition lost and volatilization of organic substance reduced the UCS and promoted its thermal insulation ability. With all being considered in manufacturing brick, the content of sewage sludge was proposed to be controlled within 7.0%, that can make UCS of the baked brick reach MU10 criterion and the baked brick have a superior heat preservation effect to common baked brick from pure clay or shale.
- The phase composition and leaching toxicity of sewage shale-sludge baked brick can be up to national standard.

In all, the recommended proportion of sludge in brick is 9.0%, with a 18.0%~20.0% optimum moisture content (OMC), prepared in the molded mixtures，drying at 105˚C and fired at 960˚C to produce a good quality brick.

Acknowledgements

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Analysis on the passive design optimization for unit-divided apartment building in Lhasa based on survey and simulation

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Keywords: local survey, indoor temperature, thermal environment evaluation, direct solar gain, optimization

Abstract. During a time when environmental issues are one of the biggest problems in the world, the development and growth of developing cities can no longer be discounted. As a typical developing city, the building energy consumption of Lhasa had a large scale increase with the living standard enhancement of people. Through the local measurements, the information as indoor air temperature, the evaluation of the thermal environment and so on was collected. The result shows the existed residential buildings used the direct gain system and the attached solar space system spontaneously. However, the indoor thermal environment still needs to be improved. Considered that Lhasa was classified into central heating area, it will face the problem of huge increasing of the heating energy. The basic models of direct solar gain system were established for studying the affecting rules of passive design elements. The last result gives suggestion for the local residential building design.

Introduction

Lhasa is the capital city of the Tibet Autonomous Region in China. It is located at the north latitude 29 °39', east longitude 91 °07' and the average elevation is 3658 m. The yearly average temperature of Lhasa is 7.8℃; the average temperature in its hottest month July is 15.5℃ and the average temperature in its coldest month January is -1.6℃. [1] In general, the Tibetan climate has the following characters: abundant sunshine, intense radiation, large diurnal temperature range, low barometric pressure and oxygen content.

In recent years, along with Chinese economic development, Tibet's economy also made considerable progress. As the capital, Lhasa is a typical developing city and its urban construction already gradually marched into the large-scale construction stage. At July 1st 2008, the first local building energy consumption standard- The Tibet Autonomous Region local standard *Design Standard for Energy Efficiency of Residential Buildings* [2] has been published, in which, Lhasa has been classified within the heating area. This indicates the energy situation for house heating in winter will be notable increasing. On the other hand, the climate in Lhasa has the characteristics of abundant solar radiation and long heating demand period but not so low outdoor air temperature. Therefore, the effective passive design methods, which can be applied to residential buildings, could be proposed for alleviating the contradictions between better lifestyle demands and the environmental loads.

Residential building survey in Lhasa

Basic information of the residential buildings in Lhasa. Because of the elevation, high-rise buildings in Lhasa are few. There are two common styles for the residential buildings in the city: the unit-divided apartment and the townhouse. Most of the unit-divided apartments have four floors, three units, and every unit has one stairs with two families in one floor. The townhouse here means the welfare projects from the local government which is named *An Ju Yuan*. The townhouse has two floors and one yard; the area of structure is under 200 m^2, and one separating wall was shared. The construction materials in Lhasa are mainly four kinds: hollow block, solid concrete block, shale brick, and aerated concrete block, in which the solid concrete block is used most in the last decades, the shale brick and aerated concrete block are more popular now. Fig.1 shows the construction materials.

(a) (b) (c) (d) (e)

Fig.1. The common construction materials in Lhasa. (a) solid concrete block; (b) stone brick; (c) shale brick; (d) aerated concrete block; (e) hollow block

Introduction of the survey. This paper focuses on the unit-divided collective apartment which is most widely spread in Lhasa. In this section, two families were measured, and through the questionnaire, the occupants' subjective thermal evaluations of their rooms and their request for the better life in the future were collected. The measurement items include outdoor and indoor air temperatures, surface temperatures of the interior walls and envelopes, in which, the air temperature is taken every ten minutes, and the surface temperature is taken three times a day. The questionnaire includes build-up time, number of occupants, thermal feeling, and so on. Fig. 2 and Fig. 3 show the pictures of the target families which include the layout drawing, the pictures and the section plan of the external walls. The number in the layout drawings are the serial number of the temperature recorders. Table1 is the information of families and buildings.

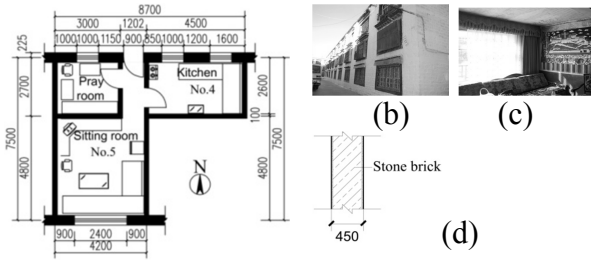


Fig.2. Basic information of Family A. (a)layout drawing; (b) southside picture; (c) sitting room picture; (d)section plan of the envelope

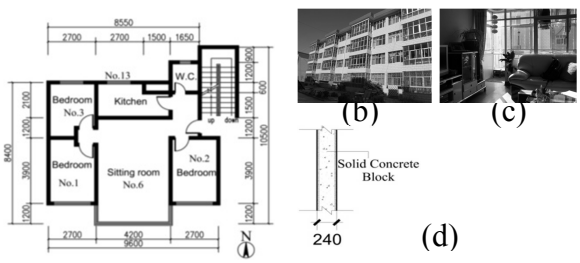


Fig.3. Basic information of Family B. (a)layout drawing; (b) southside picture; (c) sitting room picture; (d)section plan of the envelope

Table 1 Basic information of the buildings

	Building of family A	Building of family B
Build-up time	1990	2001
Structure	brick and concrete structure	
Material of envelope	450[mm] stone brick	240[mm] clay brick
Floor	Third floor (total 3 floors)	Third floor (total 4 floors)
Apartments area	50.78[m^2]	76.56[m^2]
residents	Couple and niece （3 people）	Couple, son and daughter (4 people)

Indoor thermal environment measurement. The measurement period was from 11:00 am, November 22, 2009 to 11:00 am, November 24, 2009. Fig. 4 and Fig. 5 are the measurement results. The two figures include indoor air temperatures and the indoor thermal evaluations by the occupants. The number in the indoor temperature figures are the serial number of the temperature and humidity recorders which are shown in the layout drawings in Fig. 2and Fig.3. The number from -3 to 3 in the abscissa axis in the evaluation figures are the thermal feeling of cold, cool, slightly cool, neutral, slightly warm, warm, hot and the ordinate axis is the vote percentage.

From the comparative analysis of two figures, the differences of the indoor air temperature are obvious. The average temperatures of apartment A during the measurement period are listed as the following: recorder No.5(south), 9.82° C; No.4(north), 7.49° C; as to apartment B: recorder No.1(south), 16.91° C(south); No.2(south), 15.03° C; No.6(south), 14.38° C; No.3(north), 13.32° C; No.13(outdoor), 4.38° C. And also, as the evaluation figure in Fig.4 and Fig.5 show, in two families, the evaluation of sitting room (south) is much better than the kitchen (north).

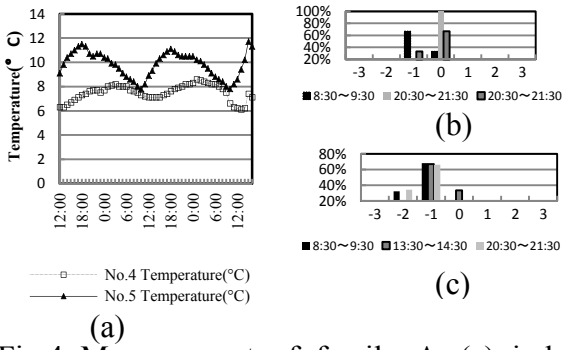


Fig.4 Measurement of family A. (a) indoor temperature; (b) evaluation of the sitting room; (c)evaluation of the kitchen

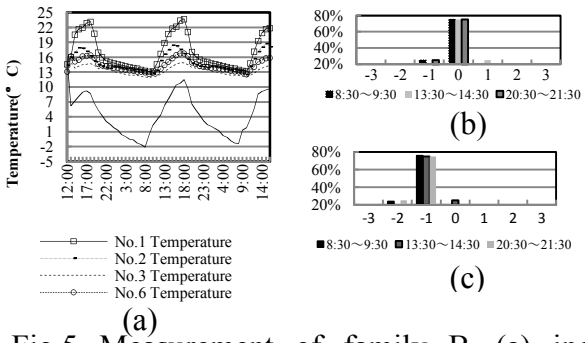


Fig.5 Measurement of family B. (a) indoor temperature; (b) evaluation of the sitting room; (c)evaluation of the kitchen

From the comparative analysis of the indoor temperature and the evaluation, the conclusion is clear that the more scientific passive design resulted in the better indoor thermal environment.

Analysis on the influencing factors of the direct solar gain system in Lhasa

According to the local survey, common passive design methods for the residential buildings in Lhasa are direct solar gain system and the sun space system. Firstly, this section will study the influencing factors of the direct solar gain system; the factors include outdoor temperature, solar radiation, floor plan, windows, insulation and so on. For making the affecting rule study not too complicated, the above elements can be simplified to the building characteristics: 1. area ratio of window to wall; 2. room depth; 3.bay width; 4. Insulation; 5. window type; 6. thermal storage performance.

This section takes December 22nd as the example to study the regularities. The calculating software is THERB[3], the weather data is from Chinese standard climate data base for buildings [4]. THERB is a simulation program for calculating indoor environment, thermal loads, etc., which is authorized by Japanese government.

Introduction of simulation models. Firstly, the basic model will be built, and then the building elements which affect the direct solar gain system will be analyzed based on it. The basic model is created from the local survey, and followed the local standard. The building is located in Lhasa city, it is frame structure, and there are totally four floors, the target family is in the middle of the third floor, the storey height is 3 m, it area is 77.49 m^2. Fig.6 and Fig.7 are the standard floor plan and the layout drawing of the basic model. The area ratio of windows to wall in the south and north direction are 0.47and 0.18; the shape coefficient is 0.36, and the thermal resistance of the envelope is 1.32 m^{2}k/w. Table 2 shows the configuration of the model.

In the calculation, assume that there is no heat transfer between the simulation model and the sounding neighbors as the left/right and the upstairs/downstairs rooms. The calculation frequency is 1 hour, the ventilation of every room is 0.5 time/h, the outside thermal transfer coefficient is 8.7 W/m^{2}K, and the inside thermal transfer coefficient is 23.0 W/m^{2}K.

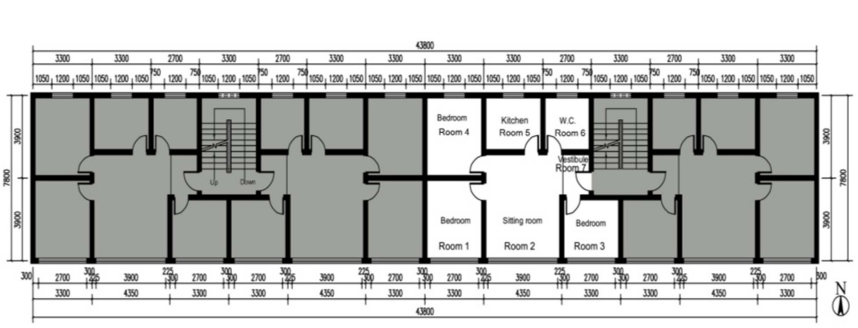


Fig.6 Standard floor plan of the basic model（Unit：mm）

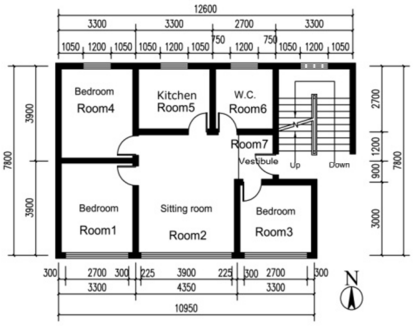


Fig.7 Layout drawing (Unit：mm)

Table 2 The configuration of basic model

	Material	Thickness[m]	Conduction[W/(m·K)]	Density[kg/m^3]
Exterior walls (Indoor to outdoor)	Lime mortar	0.015	0.81	1600
	Sand lime brick	0.37	1.1	1900
	Polystyrene foam	0.04	0.042	30
	Lime mortar	0.15	0.81	1600
windows	glass	0.006	0.76	2500
	air	0.1	0.0259	1.205
	glass	0.006	0.76	2500
Floors	Reinforced concrete	0.1	1.74	2500

Simulation 1: area ratio of window to wall. As Table 3 shows, based on the basic model, four models are built, the area ratio of the south walls of models are 0.4; 0.5; 0.6 and 0.7. The other settings are same. Fig.8 shows the indoor temperature of the 4 models. Fig.9 shows the average temperature comparison and the temperature fluctuation in 24 hours of different area ratio models.

Table 3 Area ratio of window to wall of south wall

Models No.	1	2	3	4
Area ratio	0.4	0.5	0.6	0.7

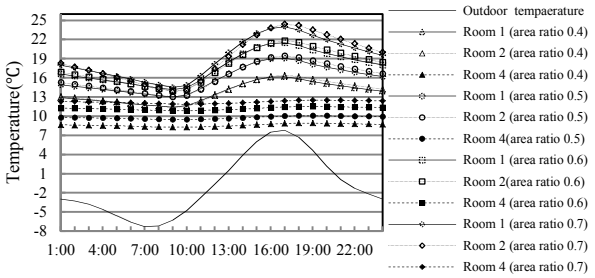


Fig.8 Indoor air temperature of area ratio models

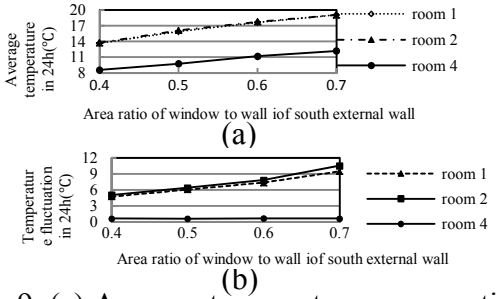


Fig.9. (a) Average temperature comparation; (b). temperature fluctuation comparation

From Fig.8 and Fig.9a, it is clear that along with the area ratio increasing, the average temperature of south rooms and north rooms increase. Take an example of room1(south) and room 4 (north), the average temperature in 24 hours are respectively from 13.65℃ and 8.59℃ in area ratio 0.4 to 19.05℃ and 12.2℃ in area ratio 0.7. The area ratio of south wall changes the indoor temperature obviously. And, as Fig. 9b shows the temperature fluctuation of south rooms is also increasing, which means the stability is getting worse with the area ratio increasing.

Simulation 2: the depth of south room. As Table 4 shows, 11 models are built for the depth pattern. The depth in the table means remain the area of north rooms in the Fig. 6 unchanged and move the south external wall toward south to enlarge the depth of south rooms. Fig.10 shows the indoor temperature calculation result of the 11 models. Fig.11a and b show the average temperature comparison and the temperature fluctuation in 24 hours of different models.

Table 4 Depth of room 1 Unit [m]

Models No.	1	2	3	4	5	6	7	8	9	10	11
Depth	3.0	3.3	3.6	3.9	4.2	4.5	4.8	5.1	5.4	5.7	6.0

From Fig.10 and Fig.11a，it is clear that, along with the area ratio increasing, the indoor temperature of both south room and north room decrease. For example of room1(south) and room 4 (north), the average temperature in 24 hours are respectively from 16.33℃ and 10.26℃ in depth 3.0m to 14.6℃ and 8.88℃ in depth 6.0m. And Fig. 11b shows the temperature fluctuation of room1 is decreasing along with the larger depth, which means the indoor thermal stability getting worse.

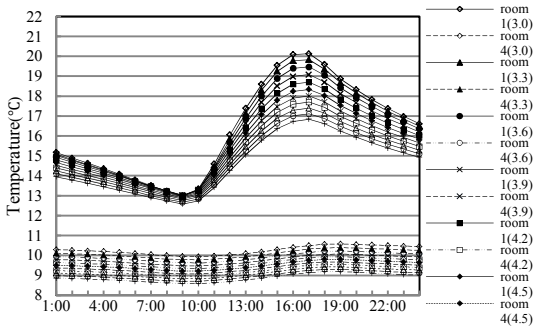


Fig.10 Indoor air temperature of depth models

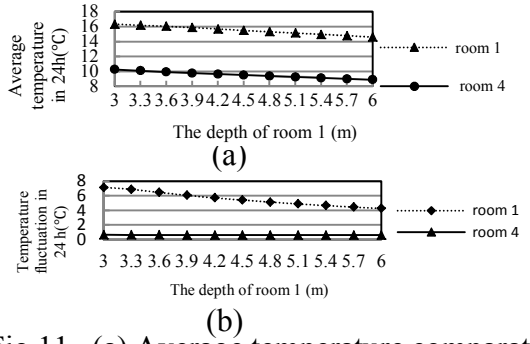


Fig.11. (a) Average temperature comparation; (b). temperature fluctuation comparation

Simulation 3: the bay width. As Table 5 shows, there are totally 10 models for the bay width patterns. The difference of every model is the different bay width of room1 and room4with the condition of the area ratio of window to wall of south wall at 0.5 unchanged.

Fig.12 shows the indoor temperature calculation result of the 10 models. Fig.13 and Fig.14 show the average temperature comparison and the temperature fluctuation in 24 hours of different models.

Table 5 Bay width of room 1 Unit [m]

Models No.	1	2	3	4	5	6	7	8	9	10
Bay width	3.3	3.6	3.9	4.2	4.5	4.8	5.1	5.4	5.7	6.0

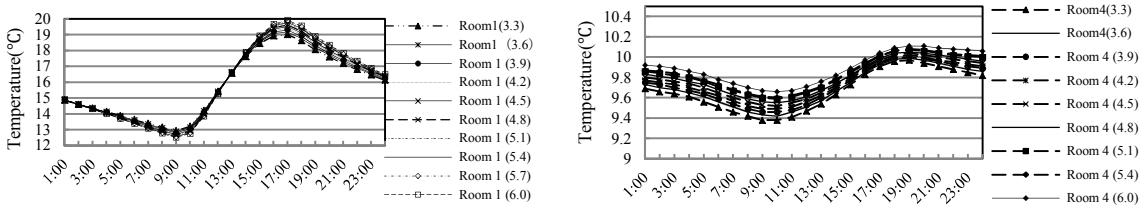


Fig.12. Indoor air temperature of different bay width models.(a) room1; (b)room4

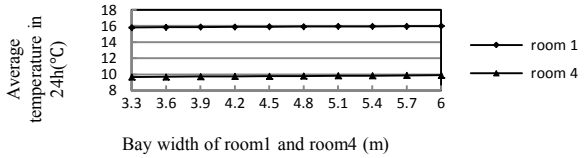


Fig.13 Bay width models average temperature

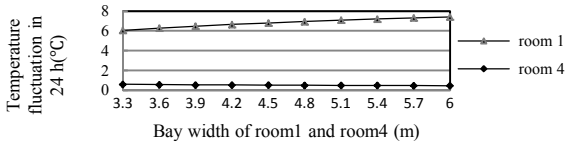


Fig.14 Bay width models temperature fluctuation

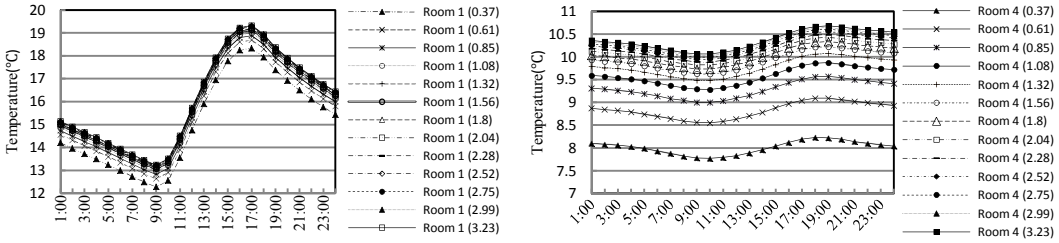
In Fig.12, with the bay width increasing, the indoor temperature of both south rooms and north rooms almost stable. And as Fig.14 shows the temperature fluctuation of room1 is increasing obviously along with the bay width enlargement, which means the indoor thermal stability is getting worse. The result shows that if it is necessary to enlarge the bay width in building design, the corresponding solution for the indoor thermal stability need to be considered.

Simulation 4: the insulation layer. It is well known that in the heating demand area, the insulation is the sensitive element for the heating energy consumption. As Table 6 shows, there are 13 models for insulation layer study. As introduced formerly, the insulation layer is polystyrene foam and in the table, the latter model is 10mm thicker than the former one.

Fig.15 shows the indoor temperature calculation result of the 13 models. Fig.16 and Fig.17 show the average temperature comparison and the temperature fluctuation in 24 hours of different models.

Table 6 Insulation of the envelope Unit [m^2 • k/w]

Models No.	1	2	3	4	5	6	7	8	9	10	11	12	13
Thermal resistance	0.37	0.61	0.85	1.08	1.32	1.56	1.80	2.04	2.28	2.52	2.75	2.99	3.23



(a) (b)

Fig.15. Indoor air temperature of different depth models. (a)room1;(b)room4

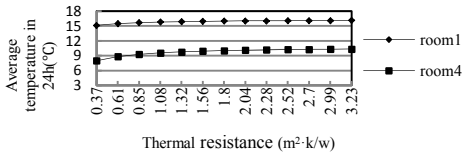


Fig.16The average temperature of models

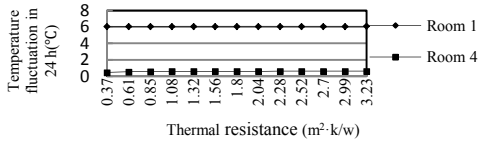


Fig.17 The temperature fluctuation of modles

In Fig. 15, the larger thermal resistance results in the higher indoor temperature. From 0.37 m^2·k/w to 3.23 m^2·k/w，the average temperature of room1 changed from 15.13℃ to 16.10℃ and room4 changed from 8.01℃ to 10.36℃. Compared with room4, the curve of room1 is gentle which means the insulation works better on the north room. In Fig.17, the indoor thermal stability is not changing.

Simulation 5: window type. Window is not only the way of absorbing solar radiation but also the way of losing heat at night. So it is reasonable to take the sensitivity analysis of the window type to the indoor air temperature. Table 7 shows the windows models. In the three models, model 1 uses the 6mm single glass, model 2 uses double glasses with the configuration of 6mm glass plus 10mm air layer and 6mm glass, model 3 uses Low-e glass, compared with model 2, the only difference is one glass has the Low-e layer.

Fig.18 shows the indoor temperature calculation result of the 3 models. Fig.19 a and b show the average temperature comparison and the temperature fluctuation in 24 hours of different models.

Table 7 Windows type models

Models No.	1(Single glass)	2(Double glass)	3(Low-e)
configuration	6mm glass	6mm+10mm+6mm	6mm+10mm+6mm

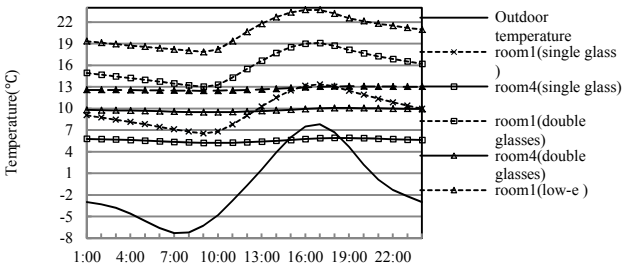


Fig.18. Indoor temperature of window models

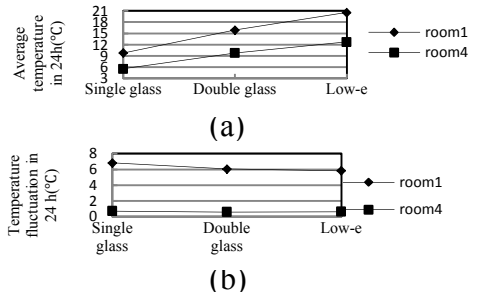


Fig.19. (a) Average temperature comparation; (b). temperature fluctuation comparation

Fig.18 and Fig.19a show that the window type has big influence to the indoor temperature. For example of room 1, the average temperature is from 9.77° C in single galas to 20.57° C in low-e windows. And also, as Fig.19b shows the low-e window has better indoor thermal stability.

Simulation 6: thermal storage performance. Indoor thermal stability is an important index for the thermal environment. Usually, the heavy materials are helpful for thermal stability compared with the light one. It is easy to understand that the south structure is the key part of solar absorbing and storing. However, in case of big area ratio of window to wall, the inner walls and the floor of south room will absorb the solar energy though windows. So in this calculation, inner walls and external walls use the same structure. And the reinforced concrete was selected as the floor material.

Table 8 shows the thermal storage models. According to the density, the models can be classified into lightweight, middle weight and heavyweight. All the models' thermal resistance is 0.413 m^2·k/w.

Fig.20 shows indoor air temperature of room1 and room4 in 72 hours from December 21st to 23rd, the temperature fluctuation of room1in light, middle and heavy models are 11.69° C, 8.79° C, 7.46° C ; and room4 are 3.36° C, 2.11° C, 1.71° C. So to keep the stable indoor temperature, lightweight material should be avoided.

Table 8 Type of thermal storage performance

Models No.	1(lightweight)	2(middle weight)	3(heavyweight)
Configuration	aerated concrete	Clay hollow brick+ insulation layer	RC+ insulation layer
Thermal resistance	0.413[m^2.k/w]		

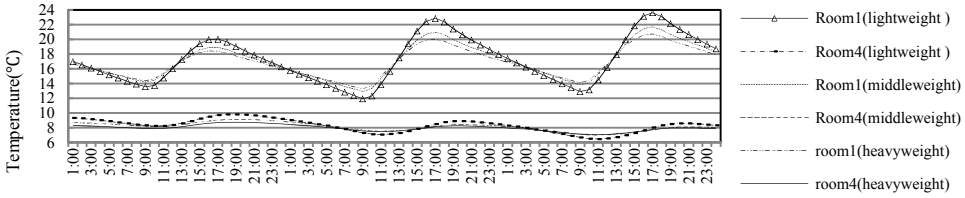


Fig.20 Indoor air temperature of thermal storage models

Conclusions

The survey shows that most of the existed residential buildings used the passive solar design spontaneously. However, the indoor thermal environment still needs to be improved. New material and the efficient passive design can improve the indoor environment obviously.

By analyzing the influencing factors of the direct solar gain system, the optimization suggestion of the unit-divided apartment in Lhasa are listed as the following:

1).Larger area ratio of window to wall in south wall is helpful for the higher indoor air temperature, but the temperature fluctuation need to be noticed;

2).Room depth increasing will cause the indoor average temperature decreasing; so the increased depth in the residential building is not recommended;

3).If the area ratio is maintained unchanged, the enlargement of bay width will not affect the indoor temperature; however the temperature fluctuation will increase;

4). Better thermal resistance of the envelop is helpful for the higher indoor temperature;

5).Windows type affects indoor temperature obviously. Better thermal performance of the windows is helpful for higher indoor temperature and better thermal stability.

6). Better thermal storage of the structure is helpful for the better indoor thermal stability.

After all, by the former analyze, the difference between the new model and the basic model is notable. It is necessary to utilize the more scientific passive design method to reduce the thermal load which is one of the most important step for sustainable development of Lhasa. Due to the limitation to space, the topic of this paper is only direct solar gain system, the potential of the passive design will be discussed in the following study.

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The Study of Energy-Saving Strategies for Building Under the Background of New Countryside Construction——

The Exploration of Utilizing Superficial Thermal Energy in a Low-Carbon Demonstration Community in South Shaanxi Province

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Keywords: new countryside construction; energy saving and emissiion reduction; superficial thermal energy;ground source heat pump

Abstract. It has already beocme a common understanding that renewable energy should be fully untilized under the background of the new countryside construction. Due to its merits and special features, superficial thermal energy has attracted great concern from the society. Its utilization is also supported by the governement. In our study, we choose a community in Xixiang county as our resrearch subject. In this community, ground source heat pump technology is adopted to utilize superficial thermal energy.Hopefully, our study will play an active role in exploring new measures for saving energy and reducing emission in the countryside.

I.Introduction

With China's increasing speed in urbanization and the improvement of people's living standard, the consumption of energy in rural areas has run as high as 320 million tce every year. Compared with the year of 2000, the consumption of commercial energy has increased by 47.6%, non-commercial energy, 26.4%, liquefied petroleum gas (LPG), 122.5%, electricity, 95%. However, the consumption of kerosene has decreased by 67.7%. The rapid increase of energy consumption in rural areas has brought a new problem, namely, the energy conservation of rural constructions. People in the construction business are all faced with the same problem: how to utilize renewable energy in an effective and reasonable way, so that fossil energy can be replaced and its consumption can be reduced.

Of the numerous renewable energies,superficial geothermal energy has attracted great attention for its moderate temperature fluctuation, good thermal performance, and it is not restricted by locations. Surface soil and water is not only a huge solar energy collector, which collects 47% solar energy, 500 times as much as the energy people utilize every year, but also an enormous dynamic energy balance system. Surface soil and water maintain a rather balanced state of receiveing and emitting energy, which makes it possible to utilize the seemingly unlimited solar energy stored in them. Our study, the application of renewable energy in rural constructions in Xixiang County, Shaanxi province, is an exploration of this theory.

II. The general introduction of geographical features and climate in Xixiang County

Xixiang is located in Qinba region and is known as the land of tea in China, with tourism and leisure vacation as its major industry. It belongs to tropical semi-humid monsoon regions in north Asia. It covers an area of 3240 square kilometers, with an altitude ranging from 371 to 2413 meters. Mountainous and hilly areas account for 93.2% of the county's total area, plain areas, 6.8%. The average temperature is 14.4˚C every year, with an annual rainfall of 923.5 mm. The climate in Xixiang is mild with four distinct seasons. The average temperature is about 0˚C in winter.

According to the data of geological prospecting, the earth in Xixiang mainly consists of four substances: plain fill (Q42ml) ,silty clay (Q4lal) ,coarse sand (Q4lal) ,and gravel (Q4lal) .The geological condition is rather stable. Xixiang is also rich in groundwater resources, with a water temperature between 15˚C to 18˚C. A single well with a diameter of 325mm and a depth of 180m can yield as much as 50 to 80 tons water per hour. The weather reports in the past ten years also show that the sunshine hours in Xixiang are between 952 to 1679.8. According to China's solar energy zoning index, Xixiang is between category four regions and category five regions, which means it is suitable for the design and use of solar water heating system. Based on the above analysis, we conclude that the effective utilization of superficial geothermal energy in Xixiang will play an active role in saving energy and reducing emission as well as optimizing regional environment. This means a lot to Xixiang which aims to become an eco-tourism city.

III. The features and principle of ground source heat pump system

The purpose of our study is to explore the renewable energy suitable for South Shaanxi, such as geothermal energy, so as to improve the proportion of renewable energy in this region's energy structure by means of ground source heat pump.

3.1 The features of ground source heat pump system

Usually, we produce heat by burning mineral fuels such as coal, petroleum and natural gas, and then transmit it to building. But the fact is that burning mineral fuels can produce a high temperature between 1500˚C and 1800˚C, and this is a type of high grade heat energy. Whereas low grade heat energy with a temperature between 20˚C and 25˚C is needed for the heating of building. This heating method means a great loss of energy. If we generate electricity by such high grade heat energy and then use ground source heat pump to absorb low grade heat energy from the earth and then raise its temperature for a little bit and transmit it to building, pumary energy consumption on heating will be greatly reduced. At present, the efficiency of thermal power station is 35% to 58%, whereas the coefficient of performance of ground source heat pump, namely, the ratio between heating load and power consumption can reach 3 to 5. Generally speaking, the adoption of ground source heat pump technology enables the utility rate of pumary energy to reach 200% or even more. Therefore, providing heat by way of ground source heat pump can effectively reduce fuel consumption, and it also resolved the problem of the emission of pollutants since no wasted gas is produced.

3.2 The basic principle of ground source heat pump technology(as shown in figure 1)

In summer, on the side of the condenser,the equipment exchanges heat with low-temperature water in a deep well and then sends the water into the condenser from inlet 1, and a further heat exchange will be conducted between the water and the Freon under high temperature and high pressure. After the exchange, the temperature of Freon is lowered and the water return to the underground through outlet 1 of the condenser, and a complete cooling cycle is finished. On the side of the evaporator, recirculated water on the user side goes into the evaporator through inlet 2, and its temperature is lowered after a heat exchange with Freon. The temperature is lowered to 7˚C according to national standards. The cool water is sent to the user side by pump so as to achieve the effect of cooling.

In winter, on the side of the condenser, by switching pipes, recirculated water on the user side goes into the condenser through inlet 1, and then a heat exchange is conducted between the water and Freon under high temperature and high pressure. The temperature of Freon is lowered and the temperature of water is raised to 40˚C to 60˚C in general. And then the water is sent to the user side by water pump and serves as a heat source for building. On the side of the evaporator, the water exchanges heat with deep well water and then goes into the evaporator through inlet 2. The evaporation of Freon will take away the heat of the water and therefore the temperature of well water is lowered. (Usually, the temperature will be lowered to 7˚C). And then the water return to the underground through outlet 2. And thus a complete heating recycle is finished.

As the above analysis has shown, thanks to the utilization of geothermal resources, ground source heat pump system has the merits of good stability, two purposes on one equipment without cooling tower. Besides, no precious land resources are needed for the realization of heat exchange. No discharge of wasted gases. No special space is required in the equipment room. Moreover, according to China's eleventh five-year plan, we should actively develop ground source heat pump systems and the systems should be given the priority for application in some suitable regions. And some preferential policies should also be given. All these provide a broad prospect for the promotion of ground source heat pump systems.

IV. Application of ground source heat pump system to actual cases for energy saving and emission reduction

The residential district is located in Hanbai Road, Xixiang County. The community covers an area of 80.91 mu, with 24.68 mu for the kindergarten. Its total construction area is more than 230 thousand square meters, with a greening rate of 33.3% (as shown in the project design). The construction of this area is completed in four stages. And ground source heat pump systems will be used in phase 1 project of the kindergarten and phase 2 and phase 3 project of the community for heating, cooling and domestic hot water supply. This region is abundant in groundwater resources. According to the well-digging conditions in the surrounding areas, water can be seen 30 meters under the ground, and water quality can satisfy the standard for the usage of ground source heat pump.

4.1 Meteorological parameters and energy-saving design for the project

Outdoor design dry-bulb temperature for summer air conditioning is 32.3˚C, outdoor design wet-bulb temperature, 26.0˚C.Outdoor design temperature for summer ventilation is 28.7˚C. Outdoor wind speed is 1.7m/s on average, atmospheric pressure,947.0.Outdoor design temperature for winter air conditioning is -3˚C. Outdoor design temperature for winter ventilation is 0.7˚C. The outdoor wind speed is 0.8m/s on average, atmospheric pressure 965.0.

Shape coefficient of the building S is smaller than 0.3(S<0.3) and the insulation design of the building are as follows.① 120 polystyrene board is used for roof insulation; ② 20 extruded sheet is attached within the external walls.③ The exterior window is inside hollow steel window (6+9+6); ④ Balcony doors are steel hollow glass sliding doors;⑤ The interior walls and floors adjacent to non-heating rooms use 20 extruded sheet as an insulation layer.

4.2 Interior design parameters for air-conditioned rooms and the calculation of cold load and heat load

In accordance with the main meteorological parameters, structure of building envelope, interior design parameters and air infiltration and other conditions, based on load calculation of design drawing, there are 58629.63㎡ construction areas in this residential district using ground source heat pump for heating, cooling and supply of hot water. The design load for total winter heating is 9132.9kW. The design load for total summer cooling is 8751.5kW. Interior design parameters and indoor cold and heat load calculation are shown in Table 1 and Table 3.References

Table one Interior Design Parameters in Public Buildings

Room Name	Summer		Winter	
	Temperature (˚C)	Relative Humidity (%)	Temperature (˚C)	Relative Humidity
Residence	24-28	60%	18-20	40%
kindergarten	24-28	60%	18-22	40%
club	24-28	60%	18-20	40%

Table 2 The list of heat load in the residential district (kindergarten will be included in phase

Room Name	Construction Area (㎡)	Unit Index (W/㎡)	Heat Load (kW)
Residence	47978.63	45	2159
Kindergarten	10051	55	552.8
Club	600	45	27

The total heat load is 2738.8kW

Table 3 The list of cold load in the residential district (kindergarten will be included in phase 2)

Room Name	Construction Area (㎡)	Unit Index (W/㎡)	Cold Load (kW)
Residence	47978.63	43	2063
Kindergarten	10051	55	552.8
Club	600	60	36

The total cold load is 2651.8kw.

Phase 2 project covers 334 households. Suppose each household has three members, and each member use 60L hot water every day, the total demand for hot water every day will be 334×3×60=60.12tons. To heat the water, around 2796.8kW heat is needed. (Q=1.163·M· (T2-T1) /10=11.63×60.12T× (55˚C-15˚C) /10=2796.8kW). The summit hours for using hot water is from 14:00 to 24:00. If we divide the heat demand into 10 hours, 279.7kw heat will be required per hour(2796.8kW÷10hr=279.7kW). (T2 refers to the temperature of hot water; T1 refers to the temperature of tap water.

4.3The analysis of the design for heat pump air-conditioning

According to the data of geological exploration and hydrological research, as well as the figures obtained from the wells under experiment, a well with a diameter of 325mm and a depth of 180m can yield 70m³ water per hour. The static level is 8 meters. Suppose the drawdown is 8 to 10 meters, and the re-injection quantity of a single well is around 35m³/h, about 50% of the water withdrawal, the temperature of water 20 meters below the ground ranges from 15.2˚Cto 18.9˚C. Suppose the water temperature is 18˚C in summer and 15˚C in winter, the maximum demand for water will be 272m³/h for the full load operation of ground source heat pump. Since kindergarten, club and residence use water at different time, we calculate in accordance with an occupancy rate of 80%. The maximum water consumption per day is 5222m³ (272m³/h×80%×24 h =5222m³) The water consumption per hour is 218m³, which can fully meet the water consumption demands in the community. The design for building are shown in figure 2.

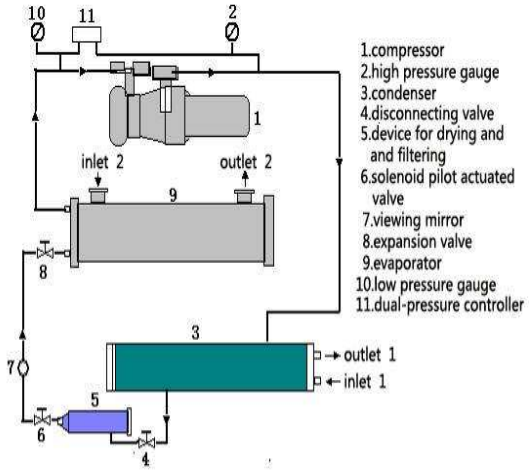

Fig 1

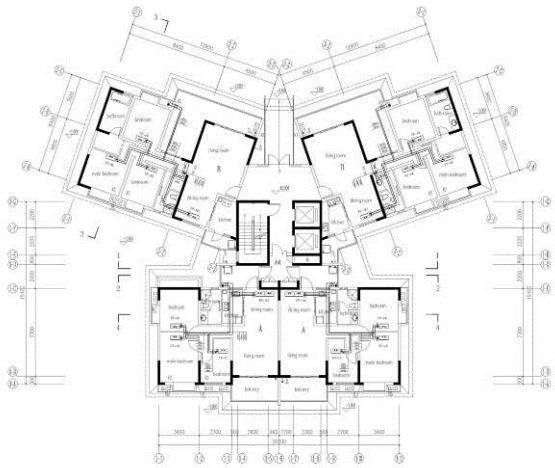

Fig 2

4.4 Analysis of energy saving efficiency

Heat load and cold load are different in different seasons and different time of a day. According to foreign experiences, suppose the average load of conditioner per year is calculated at a load operation rate of 58%, (referring to experimental parameter index of the United States ARI and a number of domestic research institutions), and the average length for cooling and heating is 210 days a year, power consumption for a whole year operation is indicated in Table 4, power consumption for domestic hot water supply is shown in Table 5.

Table Four Power consumption for whole year operation

Types of the items	Water Source Heat Pump Unit
Summer	672.5kW×24 hours ×92 days×58%=861230kW
Winter	800.1kW×24hours×122days×58%=1358762kW
Total	2219992kW

Table Five Power consumption for domestic hot water supply

Types of items	Sanitary hot water units
Heat pump units (summer))	recycling the wasted heat of conditioning units
Winter, spring and autumn	120.1kW×5.6 hours×273 days=183609kW
Well water circulation pump	3kW×273 days×5.6 hours=4586kW
Deep well pump	45kW×27 3days×5.6 hours×60%=41278kW
Hot water circulating pump	4kW×365days ×5.6hours=8176kW
Hot water supply pump	11 kW×365days×12hours=48180kW
total	285829kW

The integrated energy loss ratio of ground source heat pump heating and cooling system, COP is 4.5; the integrated COP of air-conditioners is 2.7. More than 1.4 million kWh electricity can be saved by using ground- source heat pump unit for heating and cooling. If electric water heater consume 46.52kWh power to heat a ton of water from 15˚C to 55˚C, ground-source heat pump can save more than 700 thousand kWh power annually for domestic hot water supply.

Based on the conclusion above, the annual savings of energy in the project can be converted into 545.25 tons standard coal. Besides, the reduction of CO2 emission will reach 365.32 tons, SO2 emission, 8.99 tons, soot emissions, 5.24 tons, NOX emission, 8.51 tons. With people's increasing understanding of the central government's energy saving and emission reduction policies, energy-saving and environment-friendly building is gradually becoming the preferred choice for house buyers. According to the registration of real estate agencies and market research, residence buildings using energy saving technologies such as ground source heat pump and central conditioning have gained a favor of customers.75% households are satisfied with the sold houses after the opening. Through horizontal comparison of sold houses in the second phase, all the values have already met or even exceeded the designed values. Also, rapid return of fund and a good actual operation means huge economic benefits.

V. Conclusion

With the improvement of people's living standard, heating and cooling, as well as domestic hot water has become a necessity for people's life. Power consumption in this area has taken a big share in the country's GNP. Therefore, it has become an important task to look for new substitute for traditional energy resources. In our study, we explores the possibilities of utilizing superficial geothermal energy by ground source heat heat pump system. This method can reduce the consumption of high grade heat energy. Meanwhile, it can produce good economic benefit and greatly reduce the emission of green-house effect gases and discharge of pollutants. This is a a sustainable energy-saving technology, which meets both the demand of the country and the society, and has great practical value and a promising future for development.

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Synthetically Analysis effects about the shape of multi-layer building for results of energy saving building

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Keywords: Synthetically analysis, Multi-layer building, Shape, Energy saving

Abstract. The paper mainly advances the analyze model on the basis of the relation between the shape coefficient of multi-layer building and building energy saving, the synthetically analysis is finished about effects of the different type models for the results of energy saving through using the TH-BECS2010 software, the analysis includes the facing deriction of the building, shape coefficient , and the parameter of the length, and the width, and the heith of the building etc. for effecting the shape coefficient. The the relative results are subjected that effects about the facing deriction and the shape of multi-layer building for results of energy saving building, it can become the theory basis of energy saving building design.

Introduction

Treating energy saving building and energy saving technology should be posited from the high degree of the sustainable development, from the perspective of the development of recycling economy, according to the total life cycle of the building to plan and design the construction. Energy saving building should be the high standard scientific and reasonable planning, from the design being reflected on the idea of energy conservation [1].

The shape and the energy saving of building are toward related closely. Under the certain condition of the building orientation and every part of palisade structure heat transfer coefficient of the building and window wall area ratios, the heat consumption indexes with shape coefficient rise a straight line up. So according to the design standard of the civil building of energy saving (the part of heating residential building), under the content of certain constraints of shape coefficient, the palisade structure of energy saving building should meet the requirements of specified thermal indexes when designing the energy saving [2]. That requests for attention to the design of the shape when designing the energy saving, and should be better controlling of its' shape coefficient, and when meeting the requirements of the architectural modeling should also consider to controlling the shape coefficient within reason.

Controlling research of residential building shape coefficient

Theoretically, if only considered from the perspective of reduce the heat consumption, except strengthen palisade structure heat preservation, should be try to minimize the shape coefficient. [3, 4] According to this theory, under the premise of keeping a certain volume of the residence, only reducing the appearance of residential areas can reduce the shape coefficient. And reducing the appearance of residential areas is only through increasing housing depth and reducing the aspect ratio. As for residential, according to Mathematical deduction can be known that the smallest shape coefficient is square building. If only considered from the perspective of getting the most heat in winter, should try to increase the areas of residential building south [5]. As for architecture, the depth of building is small, and the aspect ratio is large, so a cuboid of the big long axis toward east and west gets the most heat radiation in winter, a square is more, and a cuboid of the long axis toward the south and north is the worst. In addition to, topography and wind still environment and planning

combination also influence the building energy consumption. Therefore, the influence factors of the building shape of energy saving is more complex [6]. When choosing the best shape of architecture, should be comprehensive balance to heat and heat consumption, and do specific analysis needing comprehensive according to the local air temperature outdoor, direction of the wind, solar radiation intensity, and building orientation, palisade structure heat preservation and so on. In order to make the above theory has maneuverability in residential design practice, in view of the climate condition, the direction of the wind, solar radiation intensity of the different regions, should according to 《The design standard of the civil building of energy saving (the part of heating residential building)》 (hereinafter referred to as "The Standards") building shape coefficient control the principles of under 0.3 .Under building orientation and palisade structure heat preservation basic sure, research the reasonable value range of the depth, width, height, area of the parameters of the residential building. So as to glide the architectural design, make the design of the civil building of energy saving to achieve the best effect [7].

In the cities of the northern, many residential buildings are primary multi-layer buildings. Changchun is a cold area of building high energy consumption, therefore, should as far as possible decrease the individual building shape coefficient. According to the standard of the energy saving 65% of energy saving in standards, putting forward shape coefficient should be controlled the principles of in 0.3 and under 0.3(it is shown in equation 1), the length, the width ,the height of the residential building are respectively for L, H, W.

Equation 1: $$\frac{2}{L}+\frac{2}{W}+\frac{1}{H}\le 0.3$$

In addition to, the energy consumption of the palisade of high-rise building is larger, it accounting for the whole about 25% [8, 9]. Because of the H value of high-rise buildings is very high, to realize shape coefficient less than or equal to 0.3 energy-saving criteria is very easy, the smaller the shape coefficient, the less energy consumption of building .But because of the change of the shape of building is one of the major factors of the change of building exposed area, some overseas high-rise buildings, such as the lucky hotel of Los Angeles in United States, Charles DE Gaulle airport terminal in France, the third biggest street 53 number of New York office buildings are all round or oval. As we known, the same area, the perimeter of a circle minimum, so make building exposed area is lesser. Therefore, based on the consideration of the energy loss, the change of the shape of building should not be too much and too complicated.

By Using TH-BECS2008 software synthetically analyzing the shape of building for results of energy saving building

Through the aforementioned analysis, it is concluded the related conclusions of the shape coefficient of the length, the width ,the height and area of energy saving building [10]. But because of energy saving building involves many factors, in order to comprehensive consideration of the whole effects of energy saving , using the Tsinghua Downsview TH-BECS2008 energy saving building design software set up different calculation model of energy saving in this paper, calculating the simulation analysis of the effect of energy saving building.

1. The selection of analysis model

Based on the different models of the typical residential form, establish the different calculation models of length, width, layer, and area, models are divided into three groups.

The first group: 6 layers, the height is 2.8 m, the area of building is about 4000 square meters (deviation is not more than 0.2%), the width is 10 to 15.4 m,, different length (43.4 ~ 66.6 m), design seven different model totally, in order to facilitate the comparison of the calculation results, the model plane shape very rules (namely flat outer wall), the deviation of the ratio of the window and wall is not more. The special model specifications are as Table 1.

Table 1: The first group of model specification statistical chart

Model number	1	2	3	4	5	6	7
Width (or Depth)[m]	10.0	10.9	11.8	12.7	13.6	14.5	15.4
Length[m]	66.60	61.25	56.45	52.60	49.00	46.00	43.30
The total area [m^2]	3996	4003	3997	4008	3998	4002	4001

The second group: 6 layers, the height is 2.8m, the building area is about 4000 square meters (deviation is not more than 0.7% of the average deviation), and take respectively the main body width of the model plane the same as model 1~7. But changing plane shape, after appearing the change of convex-concave, then design seven different models, and specific model specifications as Table 2.

Table 2: The second group of model specification statistical chart

Model number	1a	2a	3a	4a	5a	6a	7a
Width (or Depth)[m]	10.0	10.9	11.8	12.7	13.6	14.5	15.4
Length[m]	59.5	55.7	51.1	47.8	45.4	42.7	43.0
The total area [m^2]	4036	4060	4027	4024	4019	4023	4024

The third group: the height is 2.8 meters,it is respective 6, 5, 4 layer, an area is about 2000-6000 square metres, a total of 16 models, and specific model specifications as Table 3.

Table 3: The third group of model specification statistical chart

Model number	Width (or Depth)[m]	Length [m]	Number oflayer	Area [m^2]	Model numbe	Width (or Depth)[m]	Length [m]	Number of layer	Area [m^2]
8	10.9	24.50	6	1999	16	13.6	58.9	5	4005
9	11.8	37.00	6	3019	17	13.6	73.6	5	5005
10	12.7	49.00	6	3998	18	13.6	88.3	5	6004
11	13.6	61.90	6	5051	19	13.6	36.80	4	2002
12	13.6	73.60	6	6006	20	13.6	55.15	4	3000
13	13.6	86.30	6	7042	21	13.6	73.6	4	4004
14	13.6	29.5	5	2006	22	13.6	92.05	4	5008
15	13.6	44.1	5	2999	23	13.6	110.4	4	6006

From the calculation report of the thermal performance calculation diagram gets relevant data, grouping forms the graph of heat consumption of the unit area changes. Among them:

The first group of calculation model forms the graph of heat consumption of the unit area changes, as shown in Fig.1.

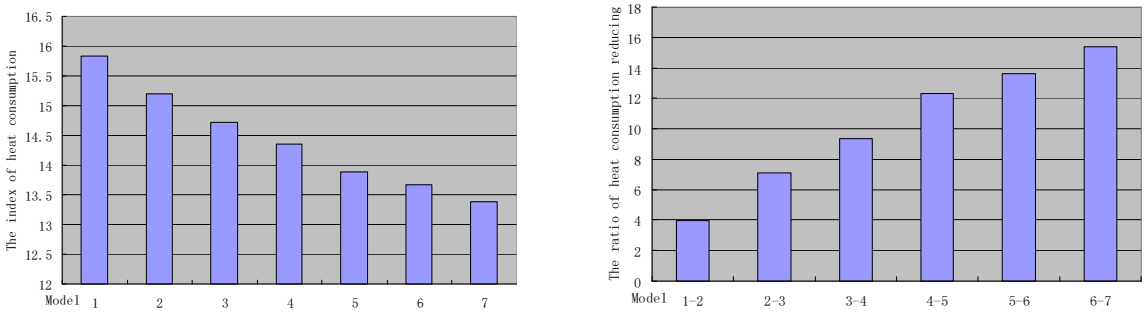

Fig. 1. The first group of model forms the graph of heat consumption of the unit area changes

Of which can be seen in figure 1 curve, under the same layer number and area ,along with the increase of width (depth) , the heat consumption index of the unit area of building reduces gradually, and the energy consumption of the width 15.4 m compared to 10 m reduces more than 15%. But the heat consumption index of the unit area of building reduces gradually,when the width is more than 13.6 m, the reduction of energy consumption reduces greatly.Although the width increases again , the heat consumption index of the unit area of building could not reduce obviously. At the same time, from the plan, the width of building is too big, the layout of building is not rational extremely.

The second group calculation model forms the graph of heat consumption of the unit area changes, as shown in Fig.2.

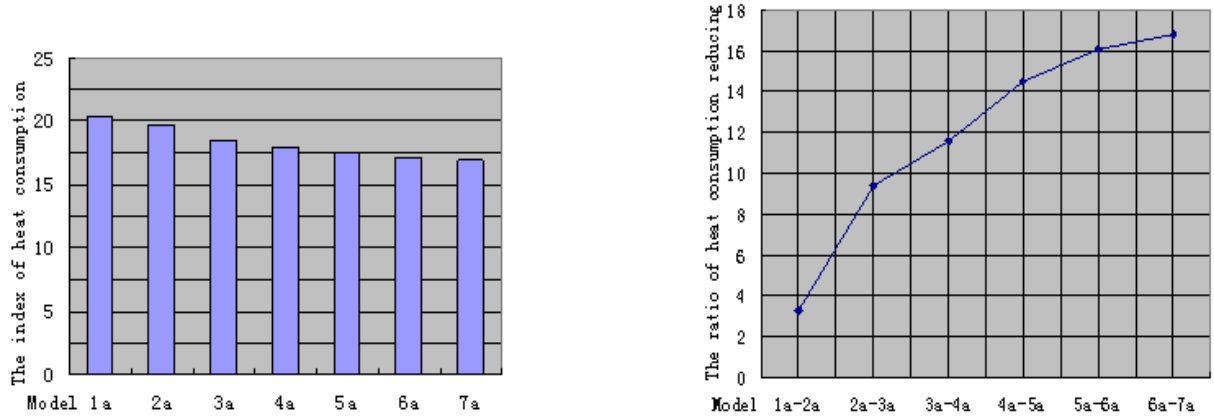

Fig. 2. The Second group of model forms the graph of heat consumption of the unit area changes

Of which can be seen in Fig. 2 curve, under the same layer number and area, along with the increase of width (depth) , the heat consumption index of the unit area reduces gradually, and the energy consumption of the width 15.4 m compared to 10 m's reduces more than 15%. But the heat consumption index of the unit area of building reduces gradually,when the width is more than 13.6 m, the reduction of energy consumption greatly reduces.Although the width increases again , the heat consumption index of the unit area could not reduce obviously. At the same time, from the plan, the width of building is too big, the layout of building is not rational extremely.

The first and second group calculation models form the graph of heat consumption of the unit area changes, as shown in Fig. 3.

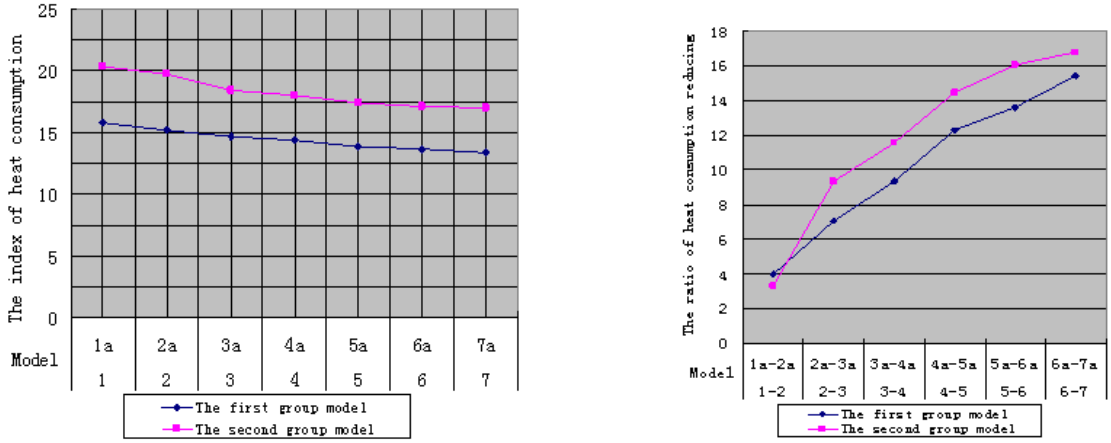

Fig. 3. The first and the second of model forms the graph of heat consumption

Of which can be seen in figure 3 curve, under the same layer number ,area and the width, after the plane shape appears convex-concave, the heat consumption index of the unit area of building increases greatly, closing to 30%, but under the width W < 11 m or W> 15.4 m, the extent of the energy consumption is unchange basically.

The third group calculation model forms the graph of heat consumption of the unit area changes, as shown in Fig. 4.

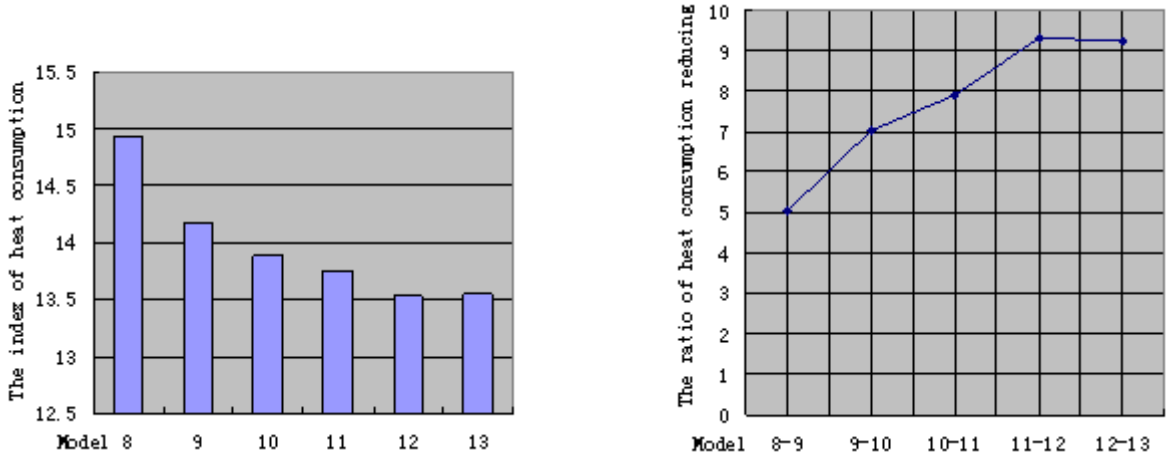

Fig.4. The model 9-13 forms the graph of heat consumption of the unit area changes

By the third group of calculation models 14-18 form the graph of heat consumption of the unit area changes, as shown in Fig. 5.

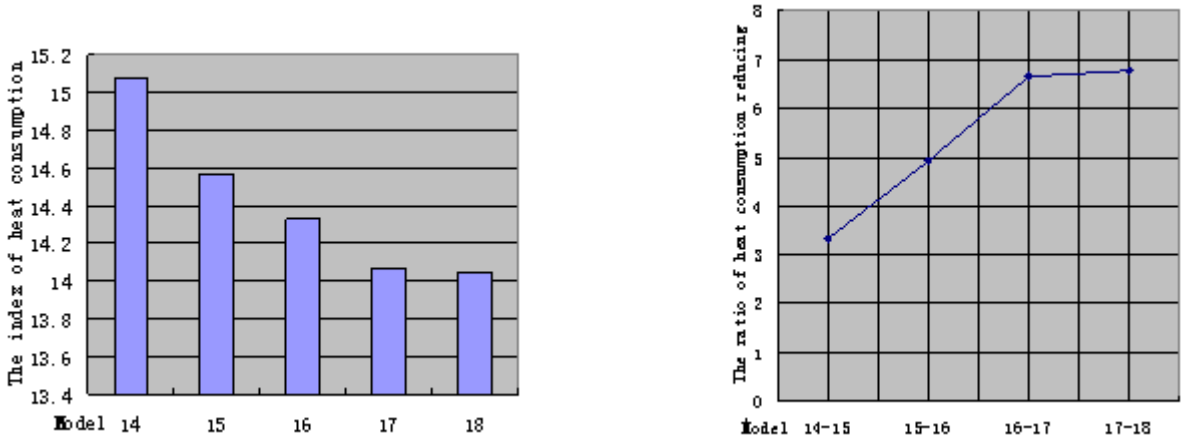

Fig.5. The model 14-18 forms the graph of heat consumption of the unit area changes

By the third group of calculation models 19-23 form the graph of heat consumption of the unit area changes, as shown in Fig. 6.

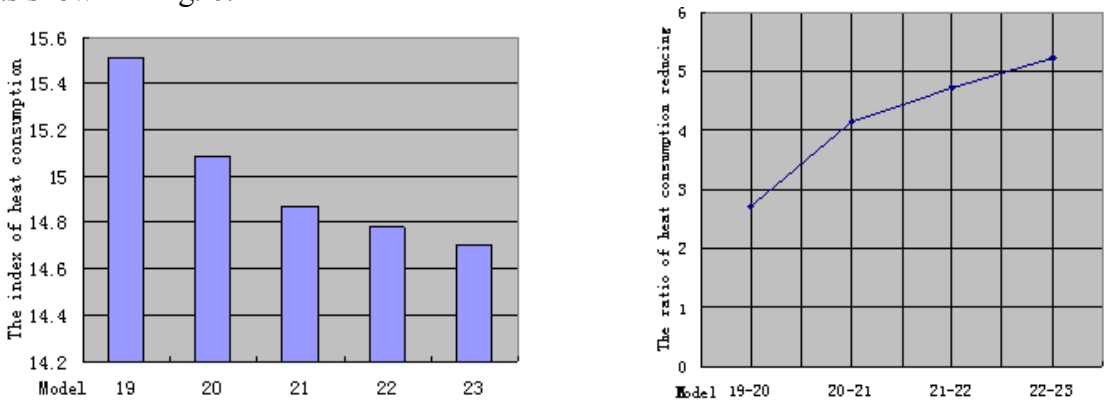

Fig. 6. The model 19-23 forms the graph of heat consumption of the unit area changes

Of which can be seen in Fig. 4,5,6 curve, along with the increase of the length and the area of building, the heat consumption index of the unit area of building increases more, the reduce rate is nearly 10%. But for 6, 5, 4 residences,after the area of building is respectively more than 6000 m^2, 5000m^2, 4000m^2, the extent of the heat consumption index of the unit area of building decreases obviously.

Although, increasing length and area are favorable to energy saving building, but after increasing to 50 m , the increase of the length to the benefits of energy saving is not obvious, so the length of energy saving building in the 50 m or so; In addition to, the length is too long is not convenient to decorate the community of residents ,but also residens in and out, as to considering the fire requirement, the best length is not more than 100m.

Of which can be seen in figure 2-7 curve, under the same area and width ,along with the reduce of height (layer numbe) , the heat consumption index of the unit area of building increases gradually, and the extent is larger. But for the different area, the extent of the heat consumption index of the unit area of building decreases closer.

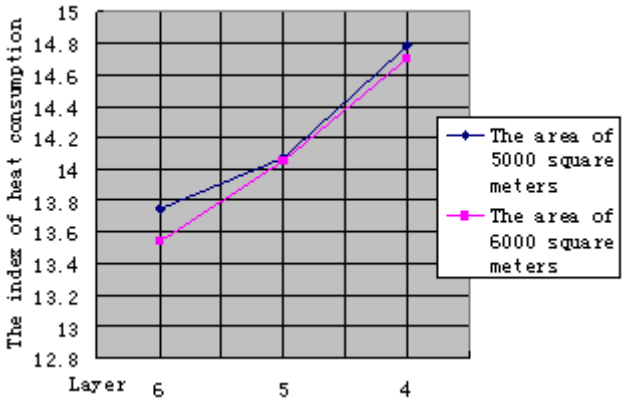

Fig.7 The model with different number of layer forms the graph of heat consumption changing

Conclusions

Through the analysis, the conclusions are as follows:

1. Under the same layer number and area, along with the increase of width (depth) , the unit area of heat consumption index of building reduces gradually. After the width is more than 13.6 m, the reduction of energy consumption greatly reduces. At the same time, the width and the length of building is too big, the layout of building is not rational extremely for multi-story residential housing energy conservation, the reasonable width of the construction for 12~14m, and length between the best in the 50 m to 100 m. After the plane shape appears convex-concave, the heat consumption index of the unit area of building increase greatly, closing to 30%, influent the energy saving effect.

2. Of which can be seen in figure 4,5,6 curve, along with the increase of the length and the area of building, the heat consumption index of the unit area of building increase more, the reduce rate is nearly 10%. But for 6, 5, 4 residences,after the area of building is respectively more than 6000m^2, 5000m^2, 4000m^2, the extent of the heat consumption index of the unit area of building decreases obviously.The single building area of multilayer residence should not be more than 7000m^2, when the area is 6000 ~ 7000m^2, should build 6 layers; When the area is 5000m^2 appropriately built 5~6 layer; When the area is 3000 to 4000m^2,can build 6, 5, 4 layer; When the area is 2000m^2, no matter how many layers, the width is larger, the minimum width is close to 12m.

3. Under the same area and the width, along with the reduce of height (layer number), the heat consumption index of the unit area of building increase gradually, and the extent is larger. But for the different area, the extent of the heat consumption index of the unit area of building decreases closer.

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Environmental Evaluation of FRP in UK Highway Bridge Deck Replacement Applications Based on a Comparative LCA Study

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Keywords: life-cycle assessment, environment/sustainability, fiber-reinforced polymer, bridges, deck replacement.

Abstract: Within the UK bridge engineering sector, fibre-reinforced polymer (FRP) decks have been increasingly used in deck replacement applications. However, study on its environmental performance is limited. This paper examines the environmental credentials of this relatively new decking system by way of a case study comparing its life cycle environmental performance – in carbon terms – with that of conventional concrete decks. In order for the findings to be more general and informative, the bridge is assumed to carry an 'average' volume of traffic across the highway network where it is most likely to be present. Based on the results, areas for improvement are identified in order for this decking system to be more environmentally competitive. Uncertainties and limitations of the results are also discussed.

Introduction

Recently, fiber-reinforced polymer (FRP) decking system has been gaining increasing popularity among major bridge owners in the UK and other parts of the world [1,2], largely driven by its potential cost benefits over the life cycle of the bridge [3]. Despite its higher initial material cost, its high durability means that the maintenance costs over its service life will be minimised. Its light and prefabricated nature enables swift installation so the possession time and disruption to traffic will be minimised. The reduced weight of the superstructure also means that the bridge substructure will be capable of taking more live loads.

At a time when the cost saving potentials of the FRP decking system are increasingly, albeit gradually, embraced by the bridge engineering sector [4,5,6], it is particularly important that its environmental credentials should as well be examined. Despite the growing interests in evaluating the environmental impact of bridges [7,8,9], study on the environmental aspect of FRP bridges is very limited. One such study was carried out by Daniel [10], who compared composite with four other materials in terms of both cost and environment for a 2 single span simply supported pedestrian bridge of 13.5m span each. In that study, the environmental advantage of composite materials in terms of both embodied energy and water/air pollutions has been clearly demonstrated. To the authors' best of knowledge, however, no study has been reported anywhere in the literature on the environmental performance of FRP decking systems in vehicular bridge applications.

This paper attempts to contribute to addressing this knowledge shortfall by comparing the environmental impact – in terms of carbon emissions – of using the FRP decking system and the more conventional prestressed concrete beam and deck system for a typical UK highway bridge deck replacement project. A life-cycle assessment (LCA) is carried out covering major activities at the initial demolition and construction stages as well as during future maintenance of the bridge. In order for the findings to be more general and informative, the bridge is assumed to carry an 'average' volume of traffic across the highway network where it is most likely to be present. Based on the results, areas for improvement are identified in order for this decking system to be more environmentally competitive. Uncertainties and limitations of the results are also discussed.

Basic Information of the bridge

The present study is based on a recent project to replace a 19th century highway bridge in North London. The effective span length is 12 m. The original superstructure comprises 7 no. wrought iron inner girders and 2 no. cast iron outer girders. Brick jack arches span all bays between girders, except the southernmost bay, where flat cast iron deck plates are used. The cross section of the existing bridge is shown in Fig. 1. Following an assessment undertaken in 1995, the bridge superstructure was deemed deficient and subsequently, the carriageway has been restricted to single lane working. Currently, the highway comprises a 4 m wide, single lane carriageway with footways of 4 m width on both sides.

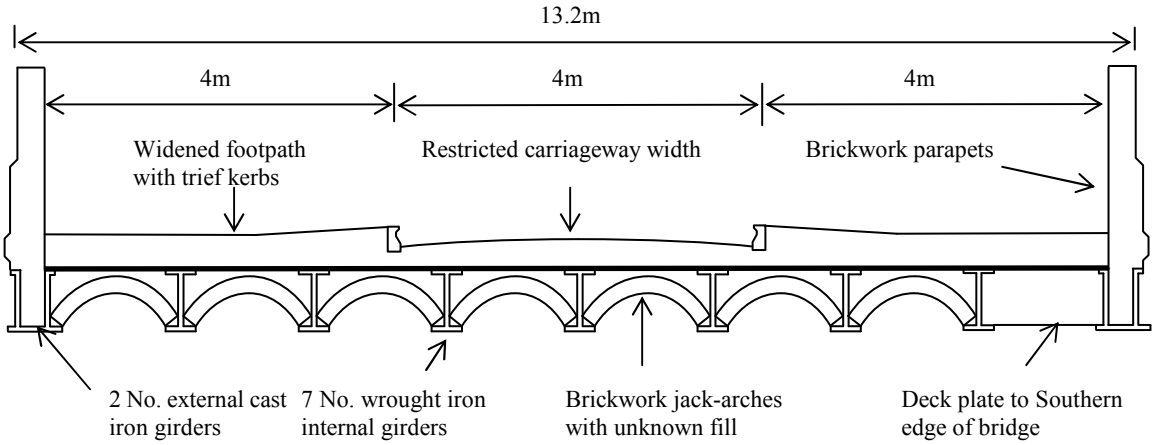

Fig. 1 Existing bridge cross section.

In 2005, the responsible authority decided to replace the bridge deck and restore the load carrying capacity of the bridge to take the full highway traffic on both lanes. In the preliminary design stage, two options were considered: (1) the FRP option, where the superstructure comprises a pultruded FRP deck adhesively bonded onto 6 No. hybrid CFRP/GFRP cellular beams; and (2) prestressed concrete option, where reinforced concrete deck is supported by 11 No. internal precast prestressed concrete beams and 2 No. external reinforced concrete beams. The prestressed concrete option is a common method of construction for a highway bridge of this size. Typical cross sections of the two options are shown in Fig. 2.

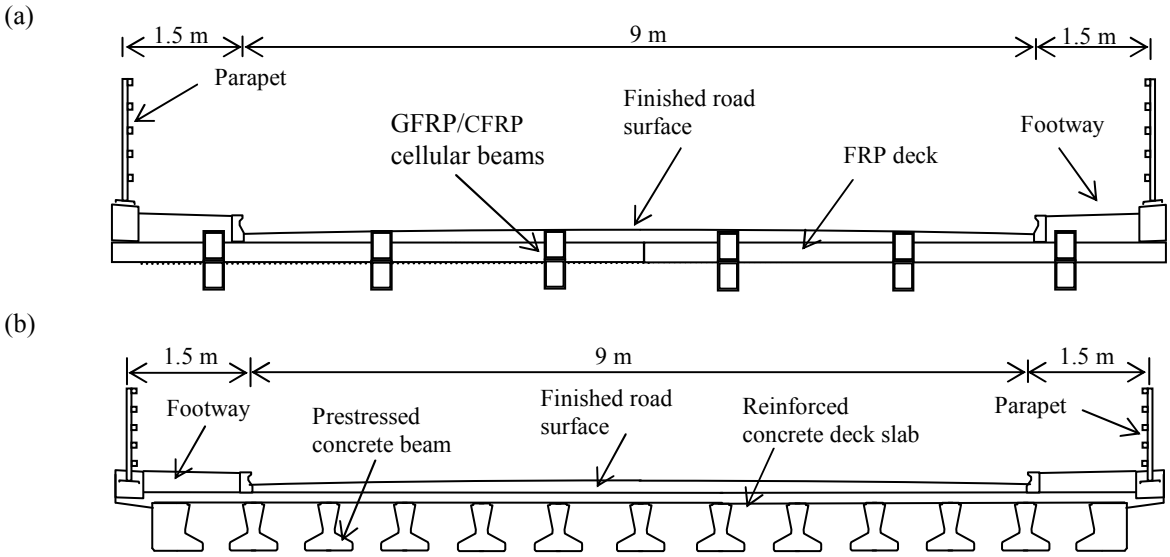

Fig. 2 Sketch of the proposed sections: (a) FRP option; and (b) Prestressed concrete option.

Across the UK highway network, there are a considerable number of bridges of similar size and in need of deck rehabilitation. To some extent, this project may be regarded as representative of a typical highway bridge deck replacement project. Therefore, in considering the carbon emissions from traffic diversions, instead of carrying out a specific case study for the particular site, the bridge is taken as a representative bridge carrying a minor road (as defined in [11]), the part of the highway network where they are most likely to be present. The authors hope that, in this way, the study would provide some more general information to bridge designers/engineers on the environmental impact of such projects, rather than only yet another case study.

Methodology of the study

Life cycle assessment. LCA is a technique for assessing the potential environmental aspects associated with a product (or service) by compiling an inventory of relevant inputs and outputs, evaluating the potential environmental impacts associated with these inputs and outputs, and interpreting the results of the inventory and impact phases in relation to the objectives of the study [12]. Generally, there are four interactive steps necessary for a complete life cycle study: planning, inventory analysis, impact assessment and improvement analysis.

Scope of the study. The objective of the study is to examine the relative environmental credentials of the FRP decking system by comparing the environmental performance of this new system with that of the conventional concrete decks.

Three stages are considered in the study: (1) demolition of the existing bridge superstructure; (2) construction; and (3) maintenance of the new superstructure. Construction equipment use and end of life demolition and materials recovery are not considered. Within each stage, three sources of carbon emissions are considered: (1) embodied carbon of any new materials/products; (2) transportation, including transportation of materials/products to site and waste disposal/recycling; and (3) traffic diversions.

Materials embodied energy. Preliminary design was carried out to determine the initial sections of the main structural elements. For non-structural and auxiliary elements, typical sections were used where it was specified in preliminary design, for example, parapets. Wherever it was not specified, the materials and dimensions were taken based on the authors' many years of practical experience. Kerbs are reused for the new construction.

Unit embodied carbon values for different materials were largely based on the Inventory of Carbon and Energy (ICE) Version 1.6a [13]. Polymer concrete is usually used as the surfacing material for the FRP decking system due to performance considerations. After consulting with specialist providers, its unit energy and carbon values are calculated based on an epoxy resin to aggregate weight ratio of 1:4 from the values for epoxy resin and aggregate given in the database. The unit energy and carbon values for steel reinforced concrete are obtained from the values for steel bars/rods and general concrete using the method suggested in the database.

Material/products and waste transportation. Carbon emissions from transportation of materials/products to site and for disposal of site wastes to landfill or recycling plant were estimated using the carbon calculator prepared by the Environment Agency [14]. Given the good level of local market knowledge that can reasonably be expected of the specialist demolition contractors, it is assumed that a local landfill site or recycling plant is used. A transportation distance of 10 miles was used for disposal of all site waste.

Transportation distance for materials/products is initially taken as 10 miles, assuming local sourcing. All materials/products are transported a constant distance except the FRP sections, which are taken as being sourced from Denmark. Road transportation is assumed, again except the FRP sections, for which water transport is necessary.

Traffic diversion. Carbon emissions from traffic diversions depend on: (1) the daily traffic volume on the bridge, (2) the diversion distance, that is, the extra distance a vehicle needs to travel using an alternative route, and (3) the period of disruption.

The period of disruption is based on the proposed works programme, which is representative for the specific construction method (14 days for FRP and 85 days for prestressed concrete). A bridge of the size considered in the present study is most likely to be carrying a minor road as defined in Road Statistics [11], either in an urban or rural area. The average daily traffic volume on a minor road in England is used to provide more general information to bridge designers/engineers. The diversion distance in real projects is not necessarily related to the volume of traffic using the bridge but heavily depends on the availability and capacity of any alternative routes in the surrounding areas. In the present study, a diversion distance of 5 miles is assumed. The unit value of carbon emissions for the vehicles is taken as 350 g/km, a value used in [8].

Maintenance. The main structural elements are designed for 120 years. The design life for non-structural elements including surfacing and waterproofing, and also for bearings is 30 years. For maintenance, it is assumed that good practice is taken so resurfacing, re-waterproofing and bearing replacement take place at one operation. Based on the authors' practical experience, a disruption period of 2 weeks is used for both options in estimating carbon emissions from traffic diversions.

Results and discussions

Overall results. The accumulation of carbon emissions over the intended service life of 120 years is shown in Fig. 3. It can be seen that the FRP option result in less carbon emissions at the initial construction stage whereas the prestressed concrete option is more environmentally desirable over the entire design life. The total carbon emissions per square meter carriageway area are 4.3 and 3.8 tonnes CO_2/m^2 for the FRP and prestressed concrete options, respectively. A detailed breakdown of the carbon emission is given in Table 1.

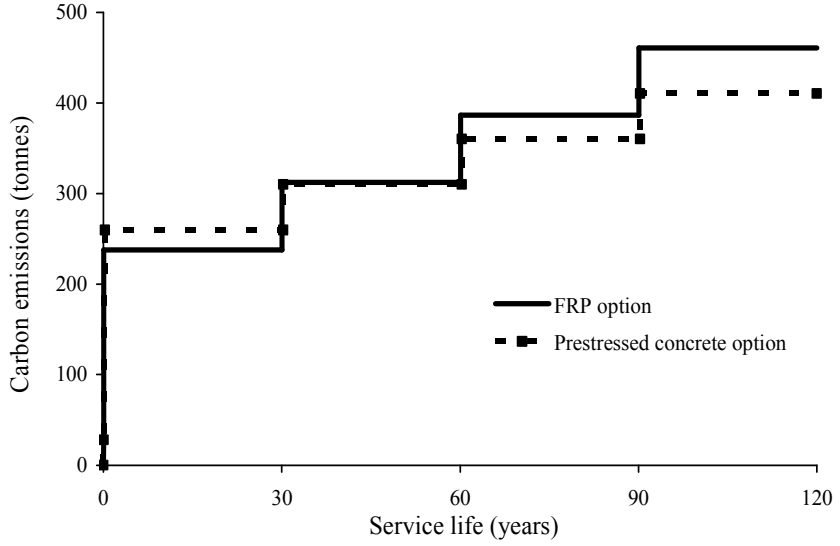

Fig.3 Accumulation of carbon emissions.

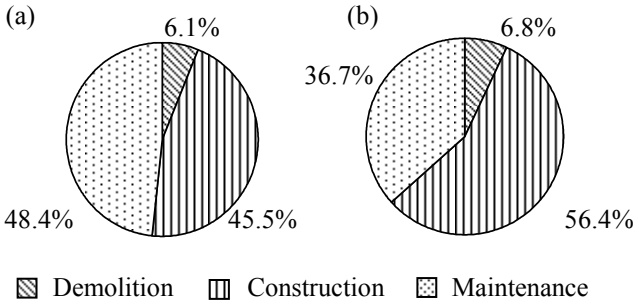

Fig. 4. Carbon emission from different stages: (a) FRP option; (b) prestressed concrete option.

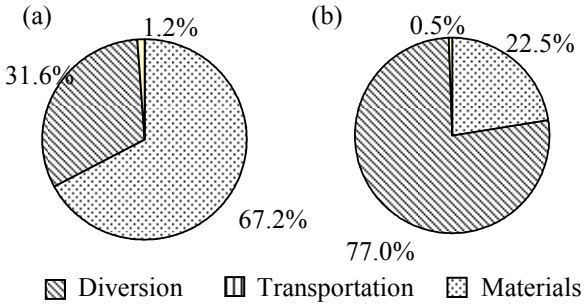

Fig. 5. Carbon emission from different activities: (a) FRP option; (b) prestressed concrete option

Table 1. Detailed breakdown of carbon emissions (Prestressed option in the bracket).

Carbon emissions (tonnes)	Demolition		Construction			Maintenance		
	D	T	M	D	T	M	D	T
Non-structural components	5.3 (5.3)	0.3 (0.3)	42.3 (18.2)	9.1 (29.6)	0.1 (0.2)	126.9 (54.5)	95.6 (95.6)	0.3 (0.6)
Structural components	22.0 (22.0)	0.5 (0.5)	140.3 (19.4)	13.7 (163.8)	4.3 (0.4)	0.2 (0.2)	0.0 (0.0)	0.0 (0.0)
Sub-total 1	27.3 (27.3)	0.8 (0.8)	182.6 (37.6)	22.8 (193.4)	4.4 (0.7)	127.2 (54.7)	95.6 (95.6)	0.3 (0.6)
Sub-total 1	28.1 (28.1）		209.7 (231.6)			223.0 (150.9)		
Total	460.9 (410.6)							

Note: D – Traffic diversion; M – Materials; T – Materials/products transportation and waste disposal.

Demolition v. construction v. maintenance. Demolition activities contribute to a relatively small proportion (in the range of 6-7%) of the total carbon emissions, as can be seen in Fig.4 showing the breakdown of carbon emissions for different stages.

At the initial construction stage, the higher material embodied carbon of FRP is more than compensated for by the shorter construction period leading to less traffic diversion related carbon emissions. During the maintenance stage, however, the disruption period is the same for both options. Polymer concrete, the surfacing material used on FRP decks, has much higher embodied carbon (1.186 $kgCO_2/kg$) compared to conventional surfacing materials (for example, 0.14 $kgCO_2/kg$ for asphalt). These factors have led to the FRP option becoming less advantageous during this stage.

Carbon emissions at the initial construction stage represent 45.5 % and 56.4 % of the total carbon emissions for the FRP and prestressed concrete options, respectively. These are comparable to those arising from the maintenance activities, which stand at 48.4% and 36.7% for the FRP and prestressed concrete options, respectively. This is broadly in line with findings by other researchers [8].

Structural v. non-structural components. If the total carbon emissions are broken down into the structural and non-structural parts, it can be seen that the carbon emissions from the structural components account for 39.3% and 50.2% for the FRP and prestressed concrete options, respectively. The high contribution from the non-structural parts mainly derive from their shorter design lives and therefore more frequent replacement, leading to recurrent use of materials and the associated traffic diversions, and in the case of FRP option, the high embodied carbon of surfacing materials. Despite its much higher embodied carbon, the contribution of structural parts for the FRP option at the initial construction stage (75.5%) is actually slight less than the prestressed concrete option (79.3%), largely due to the high level of carbon emissions from traffic diversions for the prestressed concrete option.

Materials v. traffic diversion v. transportation. Distribution of carbon emissions among different activities are given in Fig.5. It is clear that material production and traffic diversions together contribute to the majority of the total carbon emissions, whereas carbon emissions from materials/products transportation and waste disposal are minimal. Traffic diversion is an important factor that differentiates bridge structures from buildings. The relative small impact of materials/products transportation is largely due to the relatively small quantities of materials for this type of project and the fact that most materials (except the FRP sections and adhesives) are sourced locally (within 10 miles). Indeed, for the current bridge, if all materials were transported from 400 miles, the contribution of materials transportation increases to 10.7% and 16.9% for the FRP and prestressed concrete options, respectively. So the significance of local sourcing is clear.

Discussions. It must be recognised that there exists high level of uncertainty in these results. Large variations exist in the unit values for material embodied carbon, taken from the ICE Inventory produced by Hammond and Jones [13]. In particular, since the FRP is a relatively new material, continuous improvement in the manufacturing technology leading to less unit embodied carbon value may be reasonably expected. There is also uncertainty in the engineering practice. For example, it is not always practically possible to dispose the mixed demolition and construction waste to the same site (either recycling or landfill) at the same time. A poor site waste disposal strategy may result in excessive times of transportation of relatively small quantities of waste materials. Finally, there is uncertainty in the actual service life of both the structural and non-structural components. The results may change considerably if the premature deteriorations and even failures occur.

The results shown here were based on the assumptions that only the amount of materials/products that are actually required would be delivered, and that all site works would run as scheduled with no delays. However, material waste and time overrun have been an image the construction industry has been struggling to shrug off. Therefore, in essence, the values presented in the previous section may represent the lower bound actual carbon emissions, or the target emissions for this project.

Conclusions

From the results of the work presented in this paper, the FRP decking system can be environmentally competitive with – and even advantageous over – conventional materials in UK highway bridge deck replacement applications. The relative merits of the two options are largely affected by traffic diversions. The higher unit embodied carbon of FRP materials is more than compensated for by the shorter construction period leading to less traffic diversion related carbon emissions. However, in order to improve the whole life environmental performance of the FRP decking system, the embodied carbon value of the surfacing materials will need to be reduced. Seek of alternative materials may be necessary.

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Analysis of Building Renewable Energy Use of Suitability

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Keywords: building energy efficiency (*BEE)*; building renewable energy (*BRE)*; sustainable development; building suitable technology

Abstract

Renewable energy use in buildings is a worldwide problem, especially in China; it is under developed and begins very late, so research on *BRE* suitability for technological theory in buildings is a pressed problem. In this paper, a new understanding for building suitable technology with *BEE* is put forward and the character of suitability is emphasized with *BRE* consumption process. In order to improve the energy efficiency suitable technology theory, to produce more suitable environment of human settlements as well, suitability technology theory should be established by regional architecture view. The key to establish firmly building suitable technology theory of energy efficiency is how to exploit the local natural conditions and stick to the requirements for the harmony of human being with environment; this paper sets up the preliminary system frame taking solar energy as an example.

Background

By 2020, China will have built more than 15 billion square meters of urban housing, equal to the European Union's entire current building stock. The building energy consumption of China's terminal energy consumption accounted for nearly one-third, however, on building energy-saving society as a whole the importance and urgency of understanding is still insufficient. Compared with the developed countries, China's building renewable energy use is lack of basic research, a very low level of capital investment; a lack of *BEE* technology identification and certification of effective measures. [1]

Improvements in renewable energy use efficiency in buildings are essential for reasons of energy supply security, economic competitiveness, improvement of citizens' livelihoods and environmental sustainability. But, how to improve *BRE* efficiency still is a problem. Why our labeled energy efficiency building using all kinds of renewable energy is not really saving energy? With above question, this paper pays a key attention to building renewable energy basic research and hope to explore the basic system frame of to *BEE* technology suitability.

What is the Suitability of BEE Technology?

Building is the complete reunification of the natural attribute and the societal attribute, the decision of BEE technology should be suitability natural and social requirements. The energy system in building is a complicated system of opening to the overall, the suitability state mean not only BEE technology systems function to optimize, but also refers to technical system and natural ecosystems, social and cultural systems, and the people, nature and between societies in the construction sector

is interactive. The *BEE* technology theory is also the full integration of natural and social suitability. Achieving basic goals of *BEE*, building on the appropriate for technology through the effectiveness and legitimacy, and specifically the technical progress and social progress, the unity of the economic and environmental benefits, the unity of short-term and long-term interests of the reunification, the value of the reunification of the national interest and corporate and individual interests of the reunification, this is the integrity of building energy efficiency regional theory.

Building energy efficiency technology of regional characteristics in different countries or regions to economic, social and cultural development, science and technology level, and the energy resources distribution is differentiated. Science and technology policy of "suitable technology" of regional buildings put out by *Wu Liangyong*, who advocate *BEE* technology, is suitable for technology development, and fit for the regional environment. [2]

The fundamental characteristic of BEE suitable technology, for the central point is the use of appropriate energy conservation technology, the use of suitable material, the use of energy conservation is based on the building design and consider the environmental protection to lower construction labor and environmental support costs of climate, the best climate in the comfortable environment, to give a minimum cost. Of our development of *BEE* technology, for this would require to choose appropriate technology to meet their national conditions. The mature technology in the developed countries is not necessarily the most advanced technology with low cost to upgrade their technology and the localization process of implementing technical innovation. Energy-saving technological suitability from the regional buildings can be divided into three parts, as figure 1 shows.

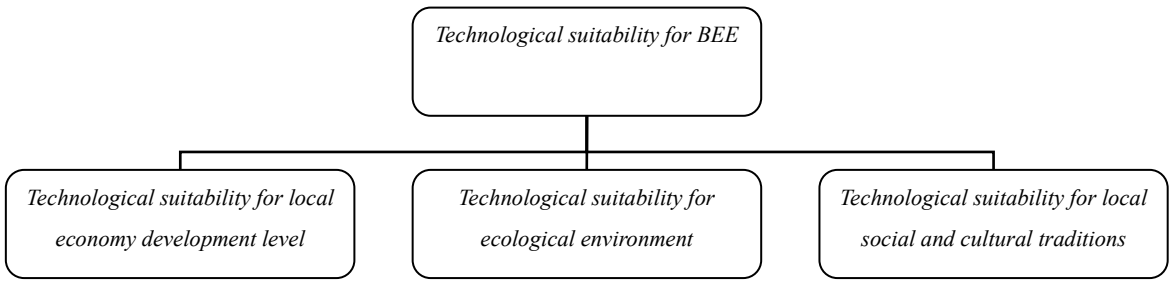

Fig 1 *BEE* technical suitability demands

Its suitability contains in the area of environment and to adapt to the demand for social and economic development. The *BEE* technology is suitable for the following characteristics：

（1）adaption to regional climate and natural conditions；
（2）full use of local materials, energy and building technology；
（3）in the region of social and economic development and the people lifestyle；
（4）with obviously differentiated features and economy than other regions.

BRE Technologies Suitability Analysis

Modern society should be a low energy consumption society, and society life should be also a low energy consumption life, the renewable energy as a new inexhaustible green energy has been becoming the important and worldwide energy, which is a relatively simple, economic, environmental, and reliable energy for the building energy system. For example, the theme of 2010 Shanghai World Expo is “Better City, Better Life”, solar energy is one of the main forms of renewable energy applications in the city. [3]

There is suitability problem with the use of *BRE* in Buildings. Different *BRE* has some features mainly manifested in the following aspects as table 1:

Table 1 Main indexes of BRE as cool or heat resource

Indexes / BRE	*Solar energy*	*Night air as cool resource*	*Geothermal energy*
Capacity of heat	Larger with regional differences	Larger	*Limited at certain area*
Quality of heat	Very high,$\triangle T_h$=6000K	Lower due to weather	*Lower due to location*
Reliability	Energy using condition by the given time	Significant	*Average*
Stability	Average	Good	*Average*
Lasting and renewable features	Significant	Good	*Average*
Technical complexity and economy	Good	Better at building top layer and free of charge	*Better by using heat-pump*
Environmental harmony and social allowance	Significant	*Good*	*Good*

Building Solar Energy Technologies' Suitability Problems

Solar heat use of technological development process is a long time, from making use of low temperature（such as hot water, dry air, and in greenhouses）, gradually to a higher temperature and more complex technology（such as, electricity by heating, refrigeration by using of solar energy ）.Architecture design should be integrated and coordinated to the solar energy products system. From the technical perspective, the solar heat of the product quality and performance data in the current market can't meet the building code, especially the safety and reliability in the solar energy system and its main components. From the engineering perspective, the architectural design institutes less participation in the solar system design, usually by solar energy enterprises by experience. Therefore, the buildings that use of solar energy as heat source have to solve the problem of convergence with the overall design and construction, which can only achieve the solar energy system technical efficiency.

Un-balanced geographical distribution of resources belongs to the natural suitability problems. The passive heating sunlight room reflects climate resources suitability, which is the most common forms of passive lighting and heat use with less investment, economically practical, but will not affect the stability. Due to the density of urban architecture, the use of solar energy capacity is limited, by the urban energy systems need to plan rationally, systems research in city development of the use of solar system of technology, and we must also consider the construction of the economy and environmental factors. [4]

Another problem is fair problem relative to social suitability. Solar energy resources are the common wealth of mankind, the development and utilization of solar energy will also consider that leads to social justice. On January 1 in 2006, the people's republic of china on renewable energy law article 17 clearly gives the provisions of solar energy use of the legal status. The state encourages the collective and individuals to install and use of solar energy system as hot water and heating system, even solar refrigeration system or power system. Even solar energy can be free to use, but access to solar energy for the building should pay the higher attention to rational plan of solar energy through the overall region, a good seasonal store, and the comprehensive design of the technology and key issues.

Systematic View on *BRE* Technology

On the view of *BEE* technological system, the system of *BRE* technologies suitability requirements include：economic development level; traditional culture; social adaptation and coordination of the ecological environment. *BRE* technique is involving many factors, it is a complicated system, in accordance with the establishment of principles and methods to implement a variety of technical factors in improving the system and technology in the ecosystems, social system to coordinate and implement technical and human, natural, social interaction between the feedback. Technology in the people, social and natural effect of the same time, external environment for development leads in this two-way communication with the technology itself. And BRE system should keep on the whole of harmony; this is for regional technical activities concerned. The desirability of combined. Buildings section of renewable energy use the technique of the system is the function of optimization and technology systematic whole function is the function of the subsystem, it was for technical activities in terms of effectiveness. Therefore, from the view of *BEE* technology, technology system to achieve the goal is to the validity and rationality, and specifically the technical and social progress, the unity of the economic and environmental benefits, the unity of short-term and long-term interests of the value of the reunification with the value of human's unity, and first, comprehensive and coordinated, sustainable development of science and technology. [5]

Summary

With combination of building the ecological development, from lower to higher, and from part to whole process, the *BRE* technology options on the investment costs and environmental benefits should be in coordination for economic and environmental balance. At the same time, the geographical conditions, according to different climate and natural conditions for BEE technology system and integrated approach. *BEE* technology is based on ecological civilization to ecological development of the ecological building practice of the basic requirements. The establishment of sustainable technologies to save the world's resources and environmental quality and asked for the way to achieve harmony between humankind and nature coexist. Ecological principles of technology to choose the most effective use of building energy, the rational development and use of natural resources, production and buildings in the course of use resources effectively to ensure that new building environment quality and make it can continue.

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Interfacial electrochemistry of bond cement and tubular steel

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Keywords: Interface, Dielectric Spectroscopy, Bode Plot, Cement.

Abstract. The stability of interface between bond cement and tubular steel is very important to the integrality of oil and gas wells. However, research on the degradation of the interface in aggressive solution is absent to date. This work devotes to discover the relationship of electrochemical parameters and interfacial development during early stage of corrosion by analyzing the electrochemical results. Dielectric spectroscopy obviously describes the stability change of passive film of steel, and Bode plot supports the structure change of cement. The early stage of immersion in aggressive solution is dominated by competition of hydratation and corrosion.

Introduction

H_2S and CO_2 are called as acid gases due to acidity of their solutions. Well cement in oil and gas fields presents alkalinity because of $Ca(OH)_2$ formation. The pH of stimulant pore solution was suggested about 12.5. Thus, the works on durability of cement has been published recent decades. Corrosion mechanism of cement materials has been investigated in solution with brine, CO_2 or H_2S [1-3]. Thier reactions of acid gaese with cement are summarized as following equations:

$$Ca(OH)_2 + H_2CO_3 \rightarrow CaCO_3 + 2H_2O \quad (1)$$

$$CSH + H_2CO_3 \rightarrow CaCO_3 + SiO_2 \cdot nH_2O \quad (2)$$

$$Ca(OH)_2 + H_2S \rightarrow CaS + 2H_2O \quad (3)$$

$$CSH + H_2S \rightarrow CaS + SiO_2 \cdot nH_2O \quad (4)$$

However, the interface of bond cement and tubular steel has not been involved.

If the stability of interface between bond cement and tubular steel degrades, the tubular steel will suffer from corrosion, and gas channeling will produce. It's harm to the integrality of oil and gas wells [4].

Electrochemical impedance spectroscopy (EIS) has been suggested to solve the rebar corrosion in concrete thirty years ago [5]. It is developed to explain the ion diffusion, ion attack and their relation to other properties [6].

In the field of well cement, publishes devoted to thermodynamics, chemical compositions, physical structures and mechanical performances are abundant [7,8], but electrochemical technologies are not brought to the forefront. Electrochemical test is in favor of enhancing the further understanding of corrosion mechanism. Thus, our present works devote to probe into applying various electrochemical methods to investigate the corrosion of cement and casing as unitary system. The paper is a part of these works. It aims at application of dielectric spectroscopy and Bode plot to explain the relationship of electrochemical parameters and interfacial development during early stage of corrosion.

Experimental procedures

Materials and solution

The class G oilwell cement is used. J55 steel is prepared as columniform sample. The chemical compositions of aggressive solution are listed in Table 1.

Sample preparation

The J55 sample is polished with SiC sand papers, and then it was cleaned by acetone in an ultrasonic bath to remove the dirty. A columniform mould is designed. The pretreated J55 sample is hanged at the center of the mould. The cement slurry, prepared with water cement ratio of 0.44, is injected in the mould. The 24-h curing is performed at 85 ^{o}C. The specimen used in the tests is finished.

Table 1 Chemical composition of solution

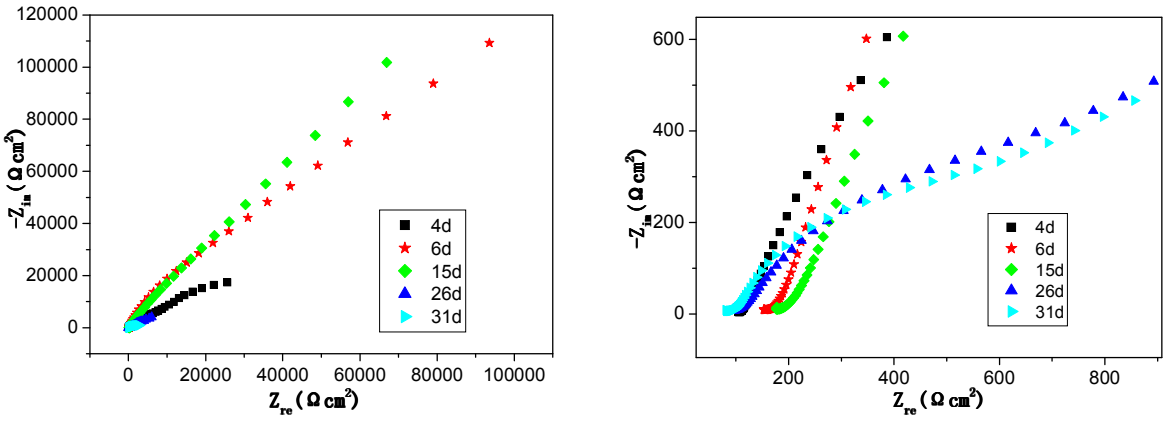
Compositions	K^+	Na^+	Ca^{2+}	Mg^{2+}	Cl^-	SO_4^{2-}	HCO_3^-
Concentration （mg/L）	2.37	66.6	54.0	4.18	101	43.7	133

Electrochemical test

Three-electrode electrochemical cell system with reference electrode, auxiliary electrode and prepared specimen is immersed in the solution as shown in Table 1 at 85 ^{o}C. Gases of H_2S and CO_2 are inlet in the closed container every day to ensure saturation state. Autolab Model PGSTAT302 electrochemical tester was adapted to perform the electrochemical tests. EIS was measured at open circuit potential by using alternating current voltage amplitude of 10 mV in the frequency range of 10 mHz to 100 kHz.

Results and discussions

Fig.1 shows the Nyquist plot of EIS at various days. It widely used to discuss the corrosion mechanism, but when the equivalent circuit is complex, it is difficult to analyze especially in high frequency range.



(a) Whole frequency range (b) High frequency range

Fig. 1 Nyquist plot of EIS

Dielectric spectroscopy is proposed to describe the characteristics of rebar corrosion in mortar due to presence of passive film on the surface of rebar [9]. Passive film is a semiconductor, and it is similar to plate condenser. Therefore, the loss angle (δ) is calculated according electrochemical theory:

$$tg\delta = \frac{C_{im}}{C_{re}} \tag{5}$$

$$C_{re} = \frac{Y_{im}}{2\pi f} \tag{6}$$

$$C_{im} = \frac{Y_{re}}{2\pi f} \tag{7}$$

$$Y_{im} = \frac{-Z_{im}}{|Z|^2} \tag{8}$$

$$Y_{re} = \frac{Z_{re}}{|Z|^2} \tag{9}$$

where, *Y*, Z and *C* are admittance, impedance and capacitance, and *f* is frequency.

The relation of *tgδ* and *f* at various days is shown in Fig.2. The difference is presented in high frequency range. Generally, the characteristic in this frequency represents reaction on the surface of steel. The loss angle decreases from 4th day to 26th day and then it increases. This means capacitor becomes integrity firstly, namely, passive film tends to stability due to hydratation of cement, while the film is destroyed by aggressive medium at 31st day. The electrochemical behaviors in intermediate frequency and low frequency are difficult to distinguish from this picture.

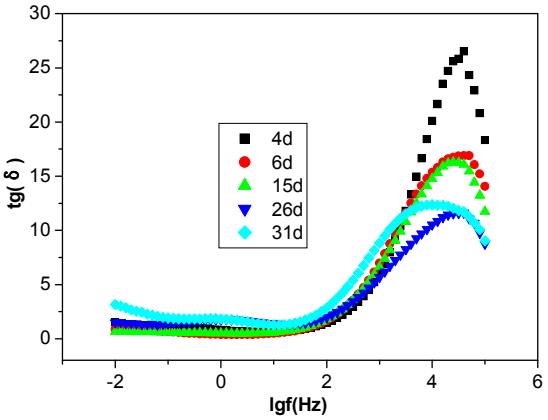


Fig. 2 Dielectric spectroscopy of tgδ-lgf

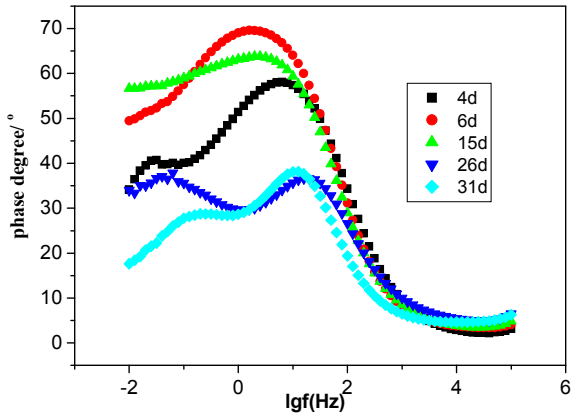


Fig. 3 Bode plot of EIS

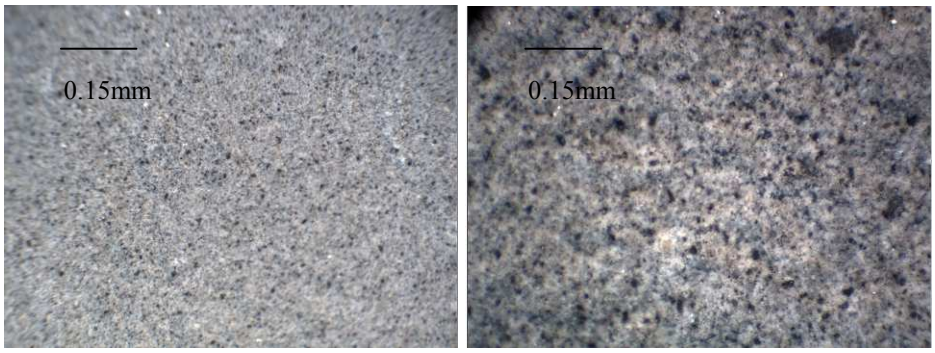
Fig.3 shows Bode plot of EIS at various days. On the contrary, the difference is found in intermediate frequency and low frequency. Two phase degree peaks appear at 4th day, whereas, with the increasing immersion time, the peaks are enhanced. After 26 days immersion, they decrease. The electrochemical characteristics in these frequency ranges indicate the blockage to ion diffusion in cement. The results discover that the structure of cement tend to densification till 15th day. From 26th day, corrosion reactions result in loose physical structure.

Based on the data shown in Fig.2 and Fig.3, the early stage of immersion in aggressive solution is dominated by competition of hydratation and corrosion. On the other hand, the delay time of the turn point in Fig.2 by comparing Fig.3 illuminates the process of ion diffusion. On the basis of discussions, the equivalent circuit should contain three time constants.

Fig.4 shows the morphology of cross section in cement. It is obviously seen increasing pore size after the corrosion of aggressive medium. Also local destroy, as labeled as A, is found to the passive film on the surface of steel in Fig.5.

Summary

EIS is adapted to research the corrosion of compound system of well cement and casing steel in solution saturated with CO_2 and H_2S. Dielectric spectroscopy and Bode plot well explain the aggression of medium to cement and interface between cement and steel. Interfacial electrochemistry provides information on both interface and cement during corrosion.



(a) Before corrosion (b)After corrosion

Fig. 4 Morphology of cross section in cement

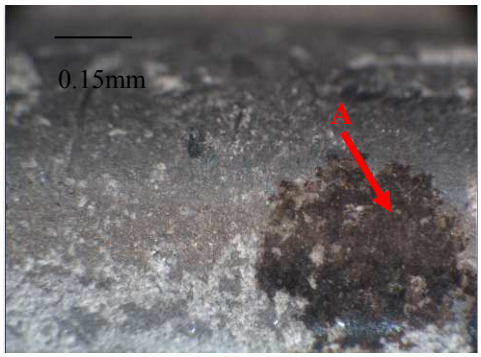


Fig. 5 Morphology of surface on steel

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The Influence of Natural Ventilation to the Thermal and Moisture Environment in a Passive Greenhouse

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Keywords: soil-walled passive greenhouse, tri-dimensional unsteady model, thermal and moisture environment, natural ventilation, air velocity.

Abstract. The temperature and humidity profiles in spatial and temporal field inside the greenhouse are coupled to outside climates. Took a typical soil-walled passive greenhouse located in Jinan, Shandong, China as an example, an unsteady tri-dimensional numerical simulation was applied to solve the temperature and humidity profiles under natural ventilation conditions inside the greenhouse, based on the CFD program. The measurement was carried out to validate the CFD model, the results showed that the special temperature and humidity gradient were obvious inside the greenhouse, a homogeneous temperature and humidity field was obtained at crop level. The simulation results agree well with test values about the temperature and humidity inside the greenhouse with fitting degree of 99.8% and 99.7%, respectively. With high reliability, the model can be used as the basis to predict and control the environment inside the greenhouse. Greenhouse with natural ventilation under different wind conditions was simulated on a typical sunny day to predict the distribution of air flow, temperature and humidity field. By analyzing, some useful conclusions which can provide certain basis about the influence of natural ventilation on the thermal and moisture environment are deduced.

Introduction

Natural ventilation, which is the preferred means for greenhouse ventilation, plays an important role in the mass and heat exchange between inside and outside of the greenhouse. The distribution of temperature, humidity and air velocity are different under different ventilation patterns. With the development of computer technology, computational fluid dynamics (CFD) software becomes a powerful tool to study the spatial distribution of thermal and moisture environment in greenhouse. Many results used in environment regulating have been obtained through the study such as the distribution of velocity field[1], the distribution of humidity[2], the effect of evapotranspiration on the environment in greenhouse[3] etc.. Some study focus on cooling measures for greenhouse in summer[4], forced ventilation and dehumidification[5] etc.. These research objects are mainly large span greenhouse and active greenhouse. However, to the best knowledge, the study for passive greenhouse with natural ventilation as the way to improve indoor thermal and moisture environment is still far from complete.

Combined the experimental test and numerical calculation, this paper studies the effect of natural ventilation on thermal and moisture environment of soil-walled sinking greenhouse.

Materials and Methods

The sample greenhouse selected in this study is located in Jinan, Shandong Province (36.6°N, 117.05°E), with an elevation of 170.3m above the sea level. The greenhouse which is south-oriented is a kind of typical lean-to passive greenhouse with a south inclined roof. The wall was constructed with compacted soil, and the sunlight south roof consists of a PVC film covered with straw and black waterproof sheet as thermal insulation material. Ventilation is carried out through the slot outlets located at the connection of sunlight roof and back slope. The indoor and outside air temperature, the relative humidity (RH) etc. were measured.

Numerical Models

Verification of Proposed Model. The numerical model proposed in this paper is validated by the on-site experimental result obtained on 30 December, 2009. The simulation results and the experimental data of greenhouse operating parameters which include the indoor air temperatures as well as the RH are compared for validation, as shown in Figures 1 and 2. The comparison denotes that, the simulated value and experimental data agree well with each other, with fitting degree of 99.8% and 99.7%, respectively. The model offers basis for further research on indoor thermal and moisture environment.

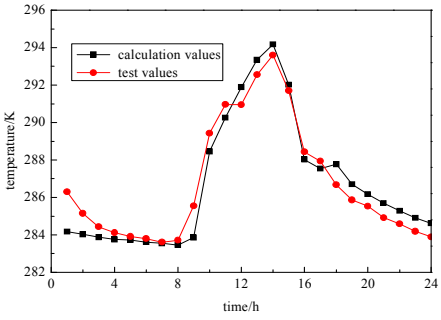

Fig. 1 Comparison of measured and predicted indoor air temperature

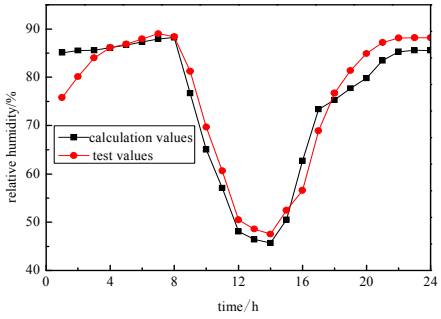

Fig. 2 Comparison of measured and calculated indoor relative humidity

Results and Analysis. As shown in Figures 3 and 5, the average temperature was 284K at 8:00 am and 294K at 2:00 pm, respectively, with a temperature increase of 10K, which can satisfy the thermal need of plants inside. This denotes that the sample greenhouse has the good thermal insulation and heat storage performance. The temperature decreases from the bottom to the top in the direction of height, and it showed a downward trend from north to south at 8:00 am. The temperature distribution at 2:00 pm is opposite to that of 8:00 am. As shown in Figures 4 and 6, the average relative humidity values were about 89% at 8:00 am and 47% at 2:00 pm, respectively, with a big drop. The relative humidity increases from the bottom to the top in the direction of height at 8:00 am. Instead, it decreases at 2:00 pm.

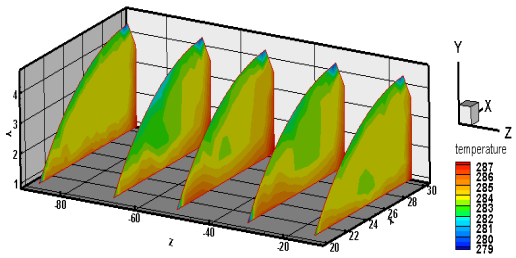

Fig. 3 Temperature field of different sections at 8:00 a.m.

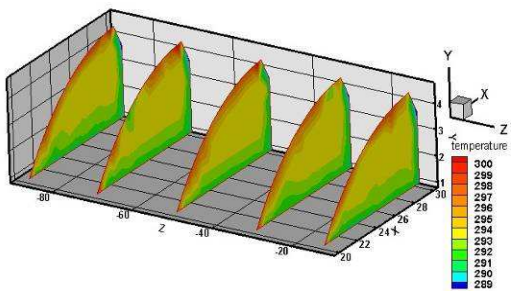

Fig. 4 Temperature field of different sections at 2:00 p.m.

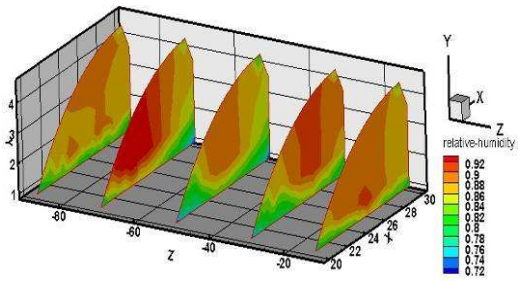

Fig. 5 Relative humidity field of different sections at 8:00 a.m.

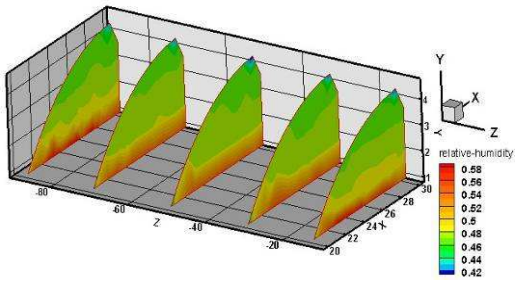

Fig. 6 Relative humidity field of different sections at 2:00 p.m.

Application of the Proposed Model

The Influence of Wind Speed and Direction outside on Air Velocity inside the Greenhouse. As shown in Figure 7, inside air velocity field changes obviously before and after the ventilation period. From 0:00 am to 8:00am, the air velocity inside the greenhouse is almost the same. From 9:00am to 11:00am, the air velocity inside is slightly increased but with little difference for the increasing of airflow movement. From 11:30am to 2:00pm, the ascensional range of the air velocity inside the greenhouse increases with the increasing of wind velocity outside, but the differences between the curves are consistent. From 2:00pm to 3:00pm, in one hour after ventilation, the air velocity inside the greenhouse drops to 0.05m/s at the same time and there is almost no difference until the early hours.

Figure 8 shows that velocity field inside changes obviously before and after ventilation. Under different conditions of wind direction outside, the air velocity inside obeys the same rule. The air velocity inside increases markedly when wind direction outside changes from S to SSW.

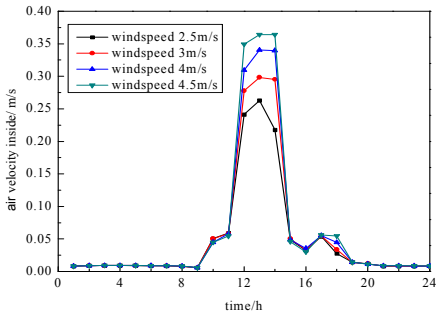

Fig. 7 Comparison of air velocity inside the greenhouse under different wind velocity outside

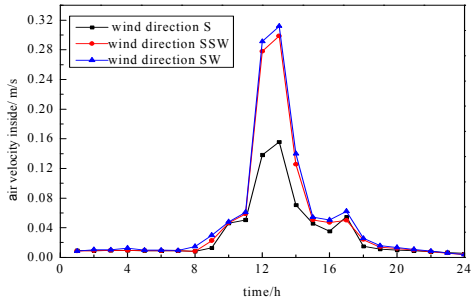

Fig. 8 Comparison of air velocity inside the greenhouse under different wind direction outside

The Influence of Wind Speed outside on Temperature and Humidity Field inside the Greenhouse. As shown in Figure 9, the temperature inside the greenhouse obeys the same rule under different outside wind speed conditions, with the trend of inverted "V". Within one hour after ventilation, the temperature inside decreased slightly, but it increased gradually after an hour. The air temperature inside rises to the peak value at 2:00 pm and drops later. With the increases of the wind speed outside from 2.5m/s to 3.0m/s, indoor temperature declines considerably, however, no significant change is observed while the wind velocity increasing from 4m/s to 4.5m/s.

Figure10 shows that relative humidity inside the greenhouse obeys the same rule under different outside wind speed conditions, with the trend of "V". Within one hour after start of ventilation, the indoor relative humidity decreases by 10%. After that, the magnitude of relative humidity declines insignificantly by 1.9%～3.6%. The relative humidity reached the lowest value at 2:00 pm. With ventilation, the magnitude of this decline increases with the increasing of wind speed outside.

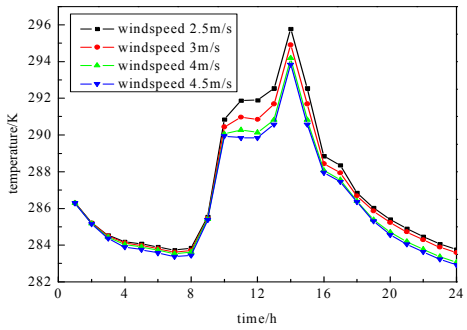

Fig. 9 Comparison of indoor air temperature with different wind velocity outside

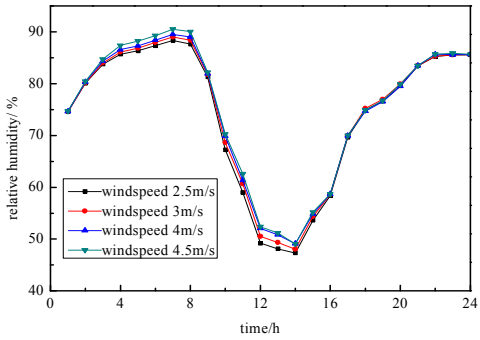

Fig. 10 Comparison of relative humidity with different wind velocity outside

The Influence of Wind Direction outside on Temperature and Humidity Field inside the Greenhouse. As shown in Figure 11, the temperature inside the greenhouse obeys the same rule under different conditions of outside wind direction. The temperature inside the greenhouse shows a decreasing tendency with the change of wind direction from south (S) to southwest (SW). This result may be caused by the enhancement of indoor and outdoor air convection.

As shown in Figure 12, the relative humidity inside the greenhouse obeys the same rule under different conditions of wind direction outside. The relative humidity inside the greenhouse shows an increasing tendency with the change of wind direction from south (S) to southwest (SW), as a result of the enhancement of indoor and outdoor air convection.

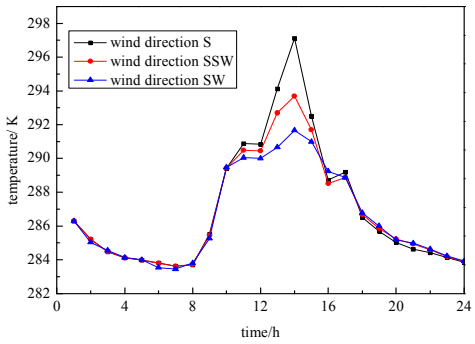

Fig. 11 Comparison of indoorair temperature with different wind direction outside

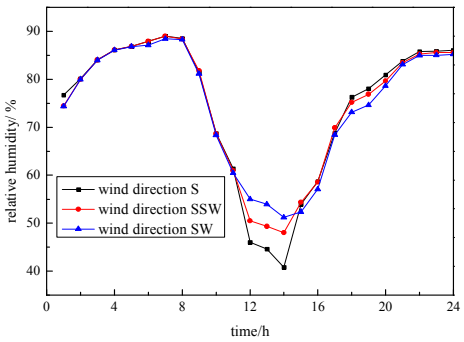

Fig. 12 Comparison of relative humidity with different wind direction outside

Conclusions

With proper simplifications and assumptions, an unsteady tri-dimensional heat and moisture transport model for soil-walled passive greenhouse is established. For temperature and relative humidity, numerical calculation results and experimental data match well with fitting degree of 99.8% and 99.7%, respectively. Under ventilation, when the outside wind speed changes from 2.5m/s to 4.5m/s, The air velocity and relative humidity increase, and the ascendant extent decreases with the increasing of outside wind speed. The temperature decreases, and the decrease extent decreases with the increasing of outside wind speed. In general, temperature is influenced more than relative humidity by the outside wind. Under ventilation with outside wind direction in south (S), air velocity and relative humidity inside reach the minimum value, the temperature inside reaches its highest value.

Acknowledgments

The authors gratefully acknowledge the financial support provided by the Shandong Province Nature Science Fund Project (ZR2009FM007), here thanks to them.

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A Case Study of Water Conservation Evaluate for Green Building

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Keywords: Green Building, Residential, Water Conservation, Comprehensive Benefit, Xi'an

Abstract. With the development of resource economizing social, green building is being paid more attention at present, and also offers wider development space for water conservation technology. Water conservation evaluation is accordingly becoming an important part in green building study. A green residential area in Xi'an, which including a series of water conservation project such as water saving instrument, reclaimed usage of domestic greywater and rainwater, landscape water protection and so on, is selected as a study case. With evaluating its water conservation of incremental cost, rainwater utilization and comprehensive benefit, the paper aims at consulting on the investment decision in green building's water conservation technology to reduce the environmental impact on the earth due to water consumption and wastewater discharge.

Introduction

With the rapid urbanization, population growth, particularly in the urban areas, changing lifestyles to more water intensive ones and climate change are leading to the growing domestic sanitation demand and to the growing deficit between the available water resources and the increasing urban water demands. So, it is increasingly important to achieve sustainability of the city buildings and the urban water systems, through limiting water supply and consumption, through reducing material use, cost, energy consumption and environmental impact, and so on[1-3].Green building has now become a flagship of sustainable development in this century that takes the responsibility for balancing long-term economic, environmental and social health[4,5]. It offers an opportunity to create environmentally efficient and to achieve sustainable development. So, implementation and evaluation of water conservation project for green building in Xi'an is necessary.

Xi'an City Overview

Xi'an is located in the Guanzhong Plain of the Yellow River basin in Northwestern China's Shaanxi Province, and has annual rainfall average 553mm and annual water resource average around 325m3 per capita, which is less than the national average of 1/6 and the world average of 1/24(as shown in Fig. 1).The average water resources for distribution to each individual is poor that Xi'an is a city short of water. With the rapid urbanization, the recent improvements in citizens' standards of living have led to a big increase in the amount of water needed. The per capita daily domestic use of water in Xi'an has increased from 175.7L in 1990 to 210.9L in 2008(Xi'an Statistics). These statistics reveal the heavy demand for domestic water use, the critical water shortages and the need to save water in Xi'an.

Yet, due to the improper water facilities designs in the past, the low water fee, and the usual practical behavior of people when using water, Xi'an has tended to use a large quantity of water, which, accompanied by the difficulty of obtaining new water resources, makes the water shortage problem even worse. Since daily water consumption of the citizen is mainly from their private dwellings, the indicator of utilizing water resources thus focuses on the actual water-saving quantity as far as residential buildings are concerned.

The paper selects a green residential area in Xi'an as study case, which including a series of water-saving project such as water-saving instrument and appliance, reclaimed usage of domestic greywater, rainwater utilization, and landscape water protection and maintenance. This green residential area has area of 38,000 square meters, construction area of 41,000 square meters, and the population of 960 people.

Fig.2 shows water consumption share of different micro-components for every day activities of the households in this area. As can be seen from Fig.2, the water consumption quantity in the household include bath, toilet, kitchen, cloth washing, light washing and so on. A majority proportion of in-house water demand is toilet, bath, kitchen and cloth washing, and the daily total water consumption per person per day is about 210l. However, only a small proportion (appr.19%) of in-house water demand is actually used for purposes requiring drinking water quality (incl. water used for drinking,cooking and cleaning dishes in kitchen). Water consumption patterns can vary significantly from house to house, depending on the household occupancy, as well as on the type of the water consuming appliances installed in the house. So, it is necessary to encourage households to save more water and to use water saving devices in their residences, use recycling water in everyday life to reduce water expenditure and thus save water resources.

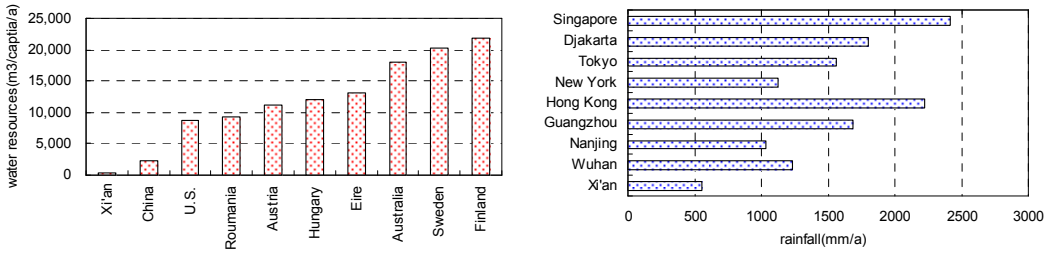

Fig. 1 Comparison of water resources and rainfall in Xi'an with the national and the world

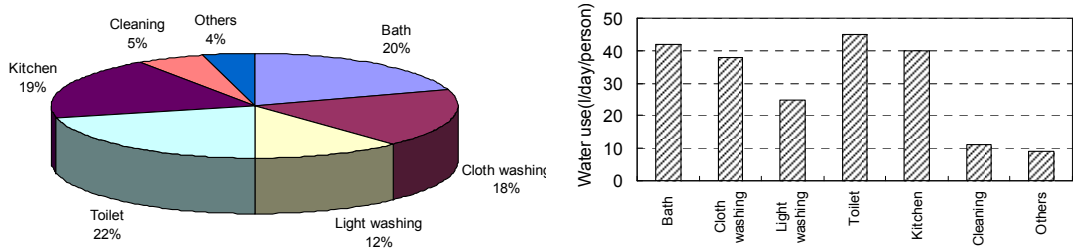

Fig. 2 The distribution of water for every day activities of the household in study case

Water conservation evaluate

The promotion of water conservation facilities has become a trend among the public and designers[6]. Some construction considerations and building system designs for effective use of water resources have been made in this residential area. It uses some effective water saving equipment such as two-sectioned water saving toilets and water saving showering devices. Various other types of water recycling equipment for reusing domestic greywater are also implemented. In particular, roof rainwater utilization system is also designed and used.

Water conservation evaluation is a critical category in green building system, and is considered in relation to saving water resources through building equipment design[7]. This evaluation contains standardized scientific quantification and can be used in the pre-design stage to obtain the desired result. The water consumption quantity include the evaluation to the water saving efficiency within kitchens, bathrooms and all water taps, as well as the recycling of rain and the secondhand intermediate water. Water conservation evaluation of this green building area in this paper include incremental cost, rainwater utilization and comprehensive benefit evaluate.

Incremental cost evaluate

The paper calculates incremental costs and component of incremental cost of this green residential area[8,9]. As shown in Fig.3, water from green residential building's saving project constituted the incremental costs of construction chart shows, the largest proportion of incremental costs, the

construction of water-saving appliance and water supply system, is 37.6%, mainly reflected in the incremental cost of two-sectioned water-saving toilets, water-saving showering devices, water-saving faucet, and other water-saving appliances and equipment purchase costs. As a result of landscape restoration and other technical measures of water, the incremental cost of landscape water quality protection and maintenance system is relatively high to 25.2%. Incremental cost of greywater treatment and reuse system is relatively low and only 18.1% of the total incremental costs. Rainwater utilization system lowers the incremental cost to 2.3 yuan/m^2, 11.0% of the total incremental costs. Non-traditional water reuse system is the lowest incremental cost for 1.7 yuan/m^2, 8.1% of the total incremental costs.

The results show the incremental costs of this green residential area is 20.7yuan/m^2 due to designing and using different water-saving systems as mentioned earlier, and its total construction incremental cost is 848,700yuan.

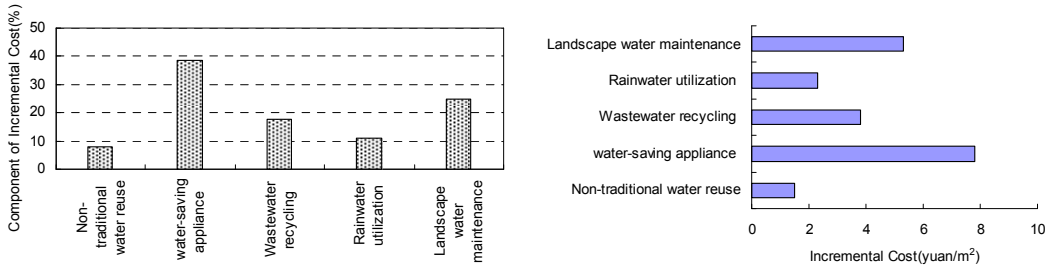

Fig. 3 The component of increment cost

Rainwater utilization evaluate

As the useful and effective available water resources in green building, rainwater play an important role in this residential area. It implements the use of rainwater through constructing green roofs, collecting systems and other methods, and also combines with the landscape water. A monitoring system has been temporary installed in Building 3 and used to record the water usage and to estimate the rainwater recovered for use in this building[9]. In this building, rainwater is recovered from the roof structure, rainwater collector and then used to satisfy part of its domestic water requirements (for toilet flushing).

The monitoring results are used to calculate the collection efficiency of this building compared to potential gains determined from rainfall data of 2008 in Xi'an. At the same time, as another indicator, water-saving rate is also evaluated based on the daily rainfall data of 2008 in Xi'an.

As shown in Fig.4, water-saving rate changed with the different rainwater collector volume ranging0-50l. Water-saving rate increases of efficiency with rainwater storage size. Further analysis of volume storage and reuse indicates that savings of up to 80% of the WC flush water can be made with less than 50l collector volume. Furthermore, collection and reuse of rainwater also results in significant energy savings, which will help to preserve energy stocks and also reduce emission of harmful pollutants.

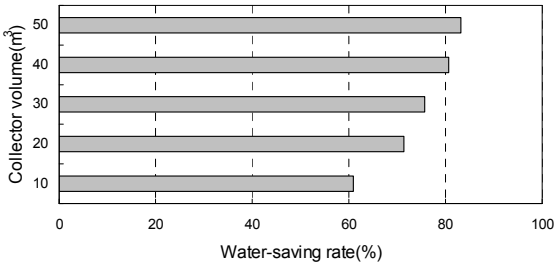

Fig. 4 Water-saving rate of roof rainwater

Comprehensive benefit evaluate

Considering only the economics of water conservation design for the study case, payback periods are perhaps rather long. But when other environmental benefits such as reduced demand for urban water are considered, there are excellent reasons for its implement. Water conservation in this green residential area plays an important role to improve the environmental and economic benefits using water reuse and other measures, with water-saving rate of 37.8% and non-traditional water source utilization rate of 30.4% respectively. It also reduces pollutants annual discharge to the surrounding environment about COD2.97tons, BOD1.48tons, SS1.98tons, TN0.62tons, and TP0.1tons. At the same time, it can relieve daily water supply stress about 94.72m^3 and save annual water costs about 100261yuan corresponding due to domestic greywater recycling and rainwater utilization.

Considering the water saving situation of this study case, the paper calculates its comprehensive benefit including direct water saving benefit, environmental and social benefits, as well as the incremental cost in the full life cycle based on full life cycle concepts and Monte Carlo simulation method[10,11]. The results showed that the comprehensive benefit in full life cycle of this green residential area in Xi'an was 47.24 million yuan, the direct incremental cost was 18.68million yuan, and the ratio of benefit to cost was 2.529:1, shows that the comprehensive benefit of the full life cycle is significant.

Conclusions

For a sustainable urban future, society must move towards the goal of efficient and appropriate water use. For a city with limited water resources and a high-density population like Xi'an, green building is an important task and represents a positive step toward reducing environmental impact and promoting sustainable development. Reuse of domestic greywater and rainwater has a significant role to play in this task.Wter conservation system application in the urban residential housing offers potential in the move towards a more sustainable city. In this study, water conservation efficiency and economy is evaluated for a green residential area in Xi'an. The results show that its comprehensive benefit of full life cycle is significant. For the sustainable policy, its water-saving appliance and water supply system, domestic greywater reuse system, and rainwater utilize system not only saved water resources, but also reduced the environmental impact on Xi'an city.

Acknowledgements

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Indoor Thermal Environment Studies And Comparisons Of Representative Residential Buildings In Urban Village Of Guangzhou During Typical Weather In Summer

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Keywords: urban village; Guangzhou; indoor thermal environment; Predicted Mean Vote (PMV); residential building.

Abstract. In order to improve human thermal comfort of residential buildings in urban village, the study of indoor thermal environment is necessary. Three typical selected houses in Huangpu Village were taken as an example to study. After a seven-day field measurement under the condition of natural ventilation, thermal neutral temperature and PMV indices were calculated based on the collected data. It is shown that the PMV values of the houses vary from -0.5 to 2.1, and the acceptance rate differ significantly in different houses and human activities states. The parameters including outdoor air temperature, indoor air temperature and PMV were studied through the linear regression, and the results demonstrate that their correlation coefficients are high, and their relationships have been developed. The results of this work create a precedent for the indoor thermal environment design and control of urban village buildings in China.

Introduction

Since the Reform and Opening in China, "City Village" has become a special terrain term that spreads during the high-speed urbanization, and it can be widely found in large or medium cities such as Beijing, Shanghai, Guangzhou and so on. Although located in modern cities, the physical attributes of the urban villages mainly embody the poor construction planning and design, and the unreasonable environmental landscape. Consequently, indoor natural ventilation is hard to be guaranteed due to the crowded building space, and the humid subtropical monsoon climate in Guangzhou inevitably challenges the indoor thermal environment. From literature review, most of field surveys and parametric studies on downtown buildings' indoor thermal environments have been actualized at home and abroad by using field surveys [1-3] and theoretical analyses [4], and a large number of thermal comfort indices have been set up for the analysis of indoor climates [5-6]. However, these methods have seldom been used on the buildings in the urban villages or the evaluation of the existing room climate on thermal conditions for low income occupants whose abilities of improving the indoor thermal environment are limited. Therefore, this paper uses the well known method–"Predicted Mean Vote-Predicted Percentage of Dissatisfied" (PMV-PPD) [6] that calculates all combinations of the environmental variables (such as air temperature, air humidity, mean radiant temperature and relative air velocity) which will create optimal thermal comfort.

Method

The indoor thermal environment field survey in this paper is carried out in an urban village named Huangpu Village (latitude: 23.5N; longitude: 113.2E, in the hot summer warm winter zone with the humid subtropical monsoon climate, with an annual average temperature of the hottest months between 25～29˚C) in Guangzhou, China.

Description of typical residential buildings and measurement. Three typical residential buildings are found in Huangpu Village: type A (of about 70%) is the middle terraced house and the internal buildings in the uniting complex; Type B (of about 27%) is the end terraced house and the marginal buildings in the uniting complex; Type C (of about 3%) is the single detached houses.

Three resident rooms of these typical houses were selected as the test objects and the essential architectural information is illustrated in Table 1. The architectural structure of selected rooms is brick and concrete structure and the formation of building envelopes of these resident rooms are the same, as illustrated in Table 2. After the investigation, none of the three resident rooms has installed air conditioner, and the people do not use any means to lower the indoor temperature.

Table 1 Selected residence information

Type	Orientation	Area of structure [m^2]	Clear height [m]
A	South	71.64(1st floor)	3.2
B	South	35.65(1st floor)	3.2
C	East	41.28(1st floor)	3.1

Table 2 Information of building envelopes

Building envelope	Tectonic pattern	
	Thickness [mm]	Structure
Interior wall	20×2	Whitewashed
	20×2	Cement plaster
	240×1	Solid brick masonry
Outer wall	20×1	Whitewashed(indoor)
	240×1	Solid brick masonry
Floorslab	10×1	Cement plaster
	80×1	Precast reinforced concrete boards
	10×1	Whitewashed

The survey lasts from July 10th (4:00PM) to 17th (1:00PM), 2010, and gathered data including indoor air temperature (˚C), relative humidity (RH%), wind velocity (m/s), wall surface temperature (˚C), ceiling temperature (˚C), floor temperature (˚C), outdoor air temperature (˚C) and outdoor relative humidity (RH%) to study their intrinsic relationships and calculate corresponding PMV/PPD values with the occupants sitting or standing and wearing the typical summer clothing.

Climate. During the period of the field measurement, the weather conditions vary with time on different days and they essentially consist of clear days, cloudy days and rainy days. The outdoor air temperature and relative humidity measured are presented in detail in Fig. 1.

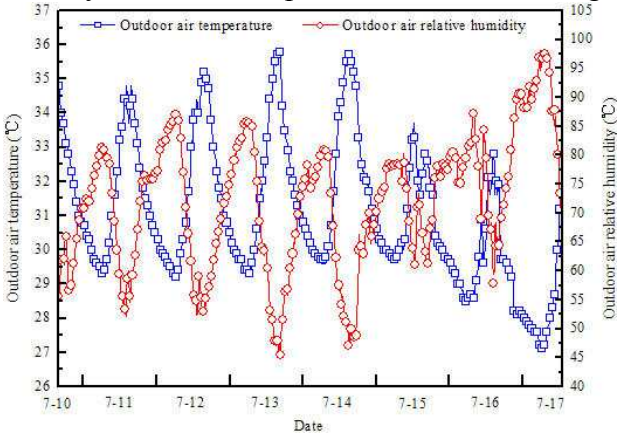

Fig. 1 Outdoor air temperature and relative humidity

Results and disscussion

To simplify, some assumptions are made: (1) the human energy metabolic rate M (W/m^2) is taken as 58.2 W/m^2 (sitting) and 70 W/m^2 (standing) [1]; (2) the mechanical work of human W (W/m^2) is taken as 0; (3) the thermal resistance of subtropical clothing ensemble is 0.5 clo (0.08 m^2•°C/W) [1]; (4) the height and body weight of the occupant are postulated as 1.7 m and 60 kg. And PMV are calculated by "Thermal sensation model" introduced by Ref. [1].

Comparisons of indoor thermal environment. After the field measurement, the corresponding PMV values are obtained through Matlab programming calculation, and the values are presented in Fig. 2, Fig. 3 and Fig. 4, where the corresponding PMV values are plotted against local date for the three typical rooms in hottest month, and the symbols "●" and "○" represent corresponding PMV values for the states of standing and sitting respectively. On the whole, the values of PMV display regular fluctuating which is directly influenced by the outdoor conditions (temperature, humidity, solar radiation and etc.).

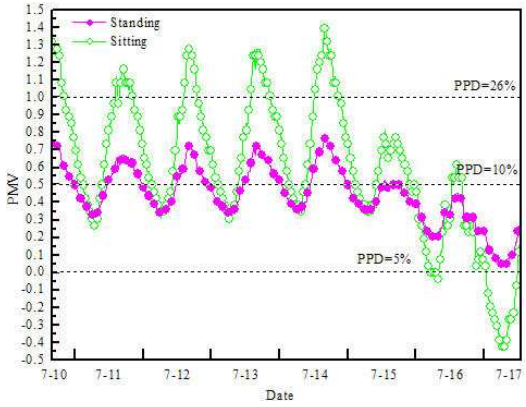

Fig. 2 PMV of type A house

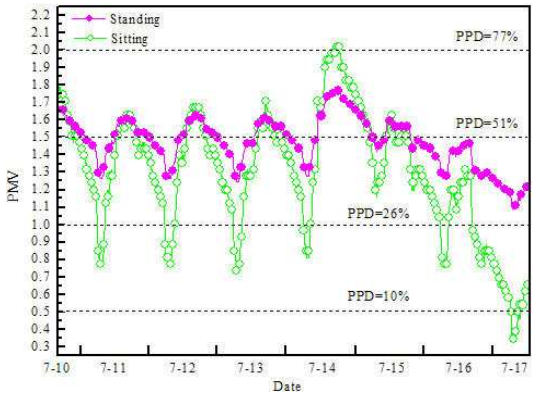

Fig. 3 PMV of type B house

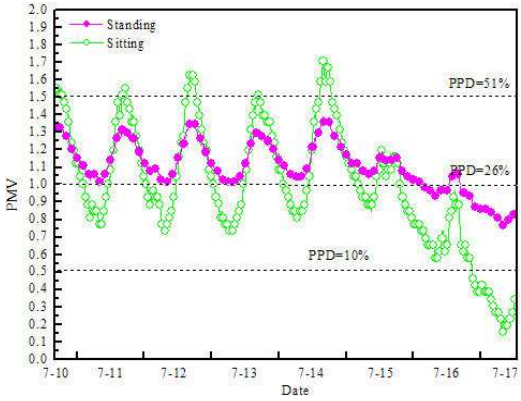

Fig. 4 PMV of type C house

Fig. 2 to 4 also show an increasing trend within the time period from morning to afternoon and a declining trend within the time period from evening to night. The peak value and trough value approximately appear at 4:00PM and 6:00AM, and the peak-to-trough value ranges from 0.9 to 1.2. At the same time of a day, the PMV values for the standing occupant are constantly greater than those for the seated one, and the mean value of the increment is 0.25.

It can be seen from Fig. 2 to 4 that PMV values approximately fluctuate from 0.75 to 2.10 and the great majority of them are between 0.50 and 1.50 (the level of warm) regardless of the type of the house and the states of motion. However, there is a drastic decline when the rain comes. Specifically, the peak value appears in 7-15 and the trough value in 7-16 reach a new low. On average, compared to the clear and partly cloudy days, PMV declines exceed 50% in rainy days and the indoor environment can be rated as comfortable to the people at most of the time. Consequently, the outdoor conditions may be one of the root causes of influencing indoor thermal environment (PMV values).

It is also worth noting that, in the three typical houses, the range of PMV indices is obviously different. It can be seen from Fig. 2 that, at least half of the PMV values in type A house are less than 1.0 and the percentage of it shows an increasing trend when people lower their labor intensity or when the rain comes. Therefore, it indicates that the indoor thermal environment of type A house is basically comfortable in the period of field survey. Such comfort partly results from the high building density, since solar radiation can not enter the room to cause low PMV. It is also noted that the well in the courtyard also plays a role of cold source to cool the room, especially in the afternoon. However, it can be seen from Fig. 3 that, PVM indices of type B house seldom drop to 1.0, and most of values are at the level of warm even hot. Due to the west big window area, solar radiation can enter the test room making PMV increase inside the room, and the highest values appear during the time period from 3:00PM to 4:00PM. It can be seen from Fig. 4 that, the comfort of the indoor thermal environment of type C house is between the first two types, but its cooling rate is also higher than the first two because of the open space around the houses. The comparisons indicate that it is essential for designers and engineers to pay more attention to the effects of architectural composition on the indoor thermal environment in the actual conditions of urban village.

Conclusions

The results demonstrate substantial differences of indoor thermal environment among the tested rooms. The PMV values of type A house vary from -0.5 to 1.5, and it is comfortable to the occupants in the most of time. The PMV values of type B house vary from 0.3 to 2.1, and it overheating and hot sensation exist in the day time in clear or partly cloudy days. The PMV values of type C house vary from 0.2 to 1.8, and the comfort of it is between the first two. The weather condition is considered in the study and it is noted that rain contributes to a marked improvement on thermal environment. The results of this work create a precedent for the indoor thermal environment design and control of urban village buildings in China.

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Influence of zeolite dose on eliminating nitrogen load of europhia sediment capping with active barrier system (ABS)

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Keywords: zeolite dose; eliminating nitrogen load; ABS capping with zeolite; ancient Canal; eutrophication

Abstract: This study investigated to eliminate the nitrogen load of sediment from Yangzhou ancient canal capping with an active barrier system (ABS) using two kinds of zeolite with five different coverage densities. For ABS capping with zeolite F1 when the zeolite dose is low (0.21 kg/m^2 and 0.62 kg/m^2), it is found that ABS failed to achieve good control in preventing N release in the entrophic sediments as total nitrogen (TN) concentrations of overlying water were increased to 3.76 mg/L and 3.13 mg/L, respectively after 16 days. However, when zeolite density was increased to 1.04 kg/m^2, TN concentration of overlying water decreased to 1.94 mg/L and TN removal efficiency is up to 50% after 16 days. For ABS capping with zeolite F2 TN concentration of overlying water is reported to descend in both low dose and high dose series. It is found that zeolite F2 is unfit for remediation of sediments from ancient Canal in Yangzhou because the ability in preventing release of ammonia nitrogen from sediments is weak. A possible explanation is that microorganism attaching on surface of two zeoltes differs to cause large difference of removal capacity between zeolite F1 and zeolite F2. It is found that nitrification and denitrification is the principal pathway for the former one while nitrite accumulation appears in the latter. To sum up, the capacity of eliminating TN load by zeolite F1 is stronger than that by zeolite F2, the optimum capping density of zeolite F1 is 1.04 kg/m^2.

Introduction

Lake sediments are considered a sink as well as a source for nutrients and, therefore, play a decisive role in eutrophication [1]. The supply of N which in most cases is the growth-limiting nutrient initiates phytoplankton blooms as well as the development of cyanobacteria, thus deteriorating the water quality severely [2, 3, 4, 5].

In Chinese Lake Taihu there is an annual average release amount of internal load with TN 81,000 t and TP 21,000 t, 2-6 times than the exotic load of nitrogen and phosphorus [6]. For Erken Lake in Sweden there are a 99 percent of nutrients derived mainly from the release of the lake sediment [7]. It was reported that percentage of internal pollution sources in the West Lake, located in Hangzhou city, is 41% and 21% in Chaohu Lake in Anhui province. It is thus clear that remediation of contaminated sediments has aroused a great deal of scientific and public concern around the world since the contaminated sediment may act as an inner pollution source for the above water column.

Subaqueous capping of contaminated lake sediments involves the placement of sand, gravel, red soil and zeolite as a cover over the sediment in order to seal it off and thus to minimize contaminant release into water column. Inhibition of N release from the sediment by an active

barrier system (ABS) acts as a gentle ecotechnology [8]. It is an effective method to control eutrophication of lakes by using zeolite with large surface area and strong adsorption ability to remove ammonia nitrogen that lake sediment released. Previous studies have shown that zeolite with plenty of pores can enrich and adsorb lots of nitrification bacteria and denitrification bacteria [9]. With this method in situ regeneration was achieved not only by rapid adsorption of ammonia nitrogen through ion exchange, but also the turning of ammonia nitrogen into nitrogen gas through the biofilm adsorption [10]. Zeolite covering showed a broad application prospect. Nevertheless, the effect on the reparation of zeolite was different for types of the zeolite and the covering thickness. This study investigated to eliminate the nitrogen load of sediment from Yangzhou ancient canal capping with an active barrier system (ABS) using two kinds of zeolite with five different coverage densities.

Materials and methods

1.1 Sampling sites

Table 1 showed the property of sediment and water sample used in the experiment. The sediment which used in experiment is taken from the ancient Canal of Yangzhou, with TN concentration of 1.24 mg/g, dry amount of substance (DM) of 36.36% , organic matter content (OM) of 3.14%. The overlying water used in experiment is prepared by simulating release of sediment in Yangzhou with anaerobion. Quality of experimental water is that : pH: 6.5-7.5; NH_4^+-N: 3.47-25.33 mg/L； TN: 3.47-25.33 mg/L; test temperature: 15-30 ℃ .

Table 1 The property of sediment and water sample used in the experiment

Sediment sources	Characteristic of sediment				Characteristic of overlying water					
	Water content (%)	Dry matter (%)	Organic matter (%)	Total nitrogen (mg/kg)	pH	Tem (℃)	DO (mg/L)	Chl-*a* (μg/L)	TN (mg/L)	Depth (m)
ancient Canal in Yangzhou	60.50	36.36	3.14	1.24	6.62	22	3-5	8.53	3.47-25.33	2.50

1.2 Barrier material

Both zeolites F1 and F2 which used in this experiment are purchased from one stuffing factory of Gongyi in Henan province, whose size is 1~2mm. Its physical and chemical properties are shown in Table 2.

Table 2 Chemical composition of two zeolites used in the experiment

The type of zeolite	Chemical composition (wt %)								Physical index		
	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	K_2O	NaO	H_2O	volume-weight (g/cm^3)	SSA (m^2/g)	Micropores (%)
F1	68-67	13-14	1-1.8	1.7-2.2	0.9-1.9	1.5-4.0	0.5-1.5	1.8	1.28	400-800	48
F2	65-66	15-16	1.68	4.22	1.24	3.36	4.22	2.0	1.31	398	21

1.3 Experimental setup

Natural lake water and sediment were collected in summer 2010 from Yangzhou ancient canal at the deepest site (2.3 m) using an in situ sub-aqueous pump and sampler.

The unimpeded release of N from the nutrient-rich sediments into the overlying water with sediments covered by 2 kinds of active zeolite attaching biofilm in plexiglass columns (diameter 28 cm, high 39 cm) was compared. The experiments of active zeolite attaching biofilm see in the literatures [10, 11]. Laboratory experiments were carried out in triplicate at room temperature in anoxic media and under light exclusion.

In summer 2010, sediment cores (30 cm in length and 6 cm in diameter) and corresponding overlying water were sampled from ancient Canal with a man-made sampler. One core was covered by a zeolite attaching biofilm layer and the other was kept without any barrier as a reference. Initial TN concentration of overlying water is 3.47 mg/L and the dosage of the zeolites was 0.21 kg/m^2, 0.62 kg/m^2, 1.04 kg/m^2, 1.46 kg/m^2 and 1.87 kg/m^2, respectively. Water samples (5 mL) of both experimental series were taken once a day with a syringe and a thin plastic tube ending 5 cm above the sediment/water interface. Afterwards, the device was refilled with the original lake water from 1 m in depth to maintain a constant water volume.

1.4 Chemical analysis

Ammonium, organic matter and dry matter were determined according to the Standard Methods (APHA, 1998). Nitrate and nitrite were determined using DR5000 UV spectrophotometry (HACH). DO concentration was measured with a digital, portable Oxy-check (HACH). The pH value was determined with a digital pH meter. Testing sediments were dried by FD-1D-50-type freeze-drying machine (Boyikang Company in Beijing, China).

Results

2.1 TN removal capacity of zeolite F1

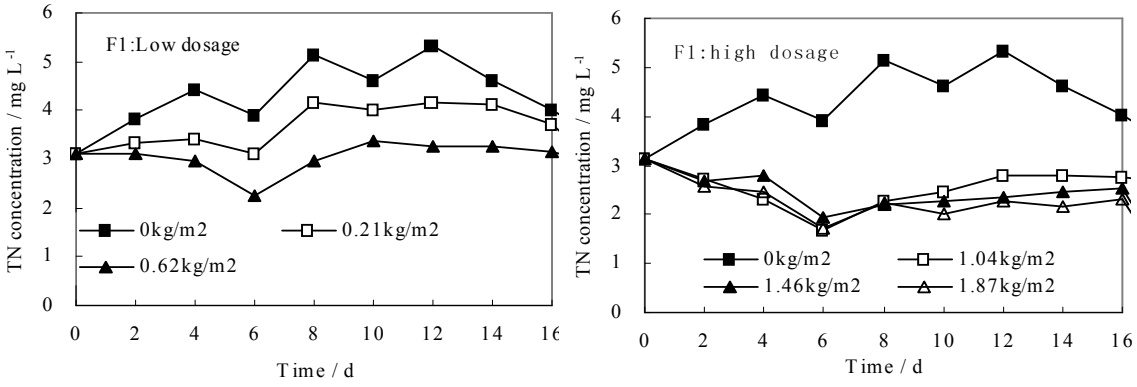

Fig 1 Total nitrogen concentration of overlying water under varying zeolite dosage (F1)

From the results shown in Fig. 1, the concentrations of TN in the overlying water differ greatly under different zeolite doses covered by zeolite F1. In the low zeolite dose (0.21 kg/m^2 and 0.62 kg/m^2), ABS capping with zeolite F1 can not effectively control the realease of nitrogen, the concentration of TN in the overlying water increased to 3.76 mg/L and 3.13 mg/L after 16 days. when raised to 1.04 kg/m^2, TN concentration decreased to 1.94 mg/L and the TN removal efficiency was increased to 50% (TN concentration is 3.91 mg/L in a reference without barrier) after 6 days. It can also observed in the high dosage groups that TN concentrations of the overlying water reduce a little even increased the density to 1.46 kg/m^2 and 1.87 kg/m^2. So, it is clear to conclude that the appropriate density of zeolite F1 is 1.04 kg/m^2 in the remediation of ancient Canal entrophic sediment.

2.2 TN removal capacity of zeolite F2

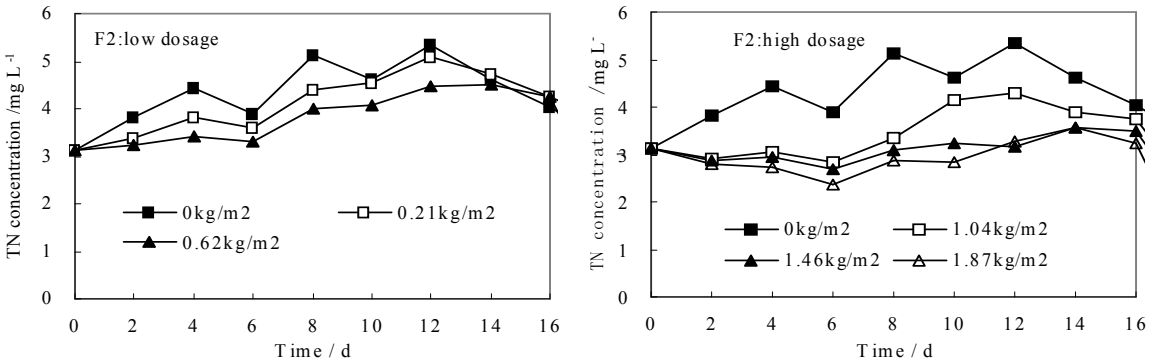

Fig 2 Total nitrogen concentration in overlying water under varying zeolite dosage (F2)

It can be seen from Fig. 2, both the TN concentration in low and high dosages has the trend of ascent. The result indicated the ability in preventing ammonia release of the sediments was weak. So, zeolite F2 is unfit for the remediation of ancient Canal sediments in Yangzhou section. Fig. 3 indicates that comparison of TN removal by zeolite F1 and zeolite F2 in different dosages. It can be seen from the figure the TN removal efficiency by zeolite F1 is higher than that by zeolite F2, the zeolite dose is 1.04 kg/m^2 when the removal efficiency of TN is greater than 50%.

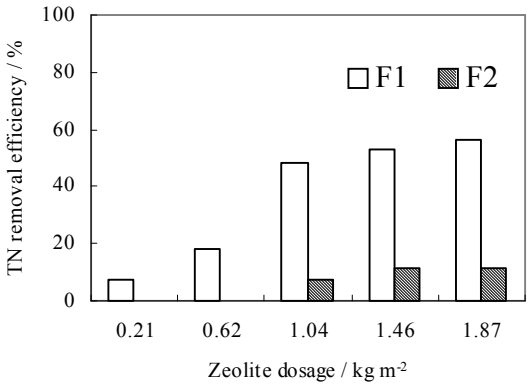

Fig.3 Comparison of TN removal about two kinds of zeolite

Discussion

3.1 Zeolite F1

The sediments used in this study released measurable amounts of ammonium without any barrier, and the concentration of ammonium is up to 5.33 mg/L (Fig.4). The result indicates that the main cause of eutrophic waters is attributed to relaese of ammonia nitrogen in ancient Canal sediments in Yangzhou since the ammonia nitrogen was the primary pollutant in a reference without barrier. This is the result of anaerobic release as DO concentration of overlying water reduced from 6.8 m/L to 1 mg/L after intial 24 hr.

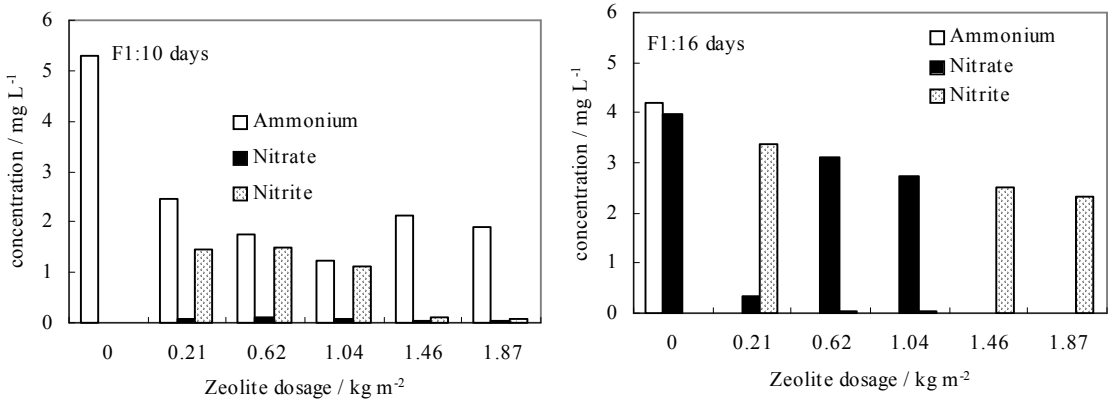

Fig 4 Transformation of 3 nitrogen in overlying water (F1)

In order to reveal the mechanism of inhibition of nitrogen release by ABS capping with zeolite. Determine the concentration of ammonium, nitrate and nitrite in ABS capping with zeolite F1 and analyze the transformation of ammonia-nitrite-nitrates in day 10 and day 16 (shown in Fig. 4). From Fig. 4, after covering zeolite F1, the content of ammonium decreased quickly to zero. So, zeolite F1 can effectively inhibit the release of ammonia nitrogen from the sediments. This is mainly attributed to the presence of structural negative charges on the zeolite F1 framework, which can exchange ion to ammonium with a strong absorption capacity [12]. Moreover, zeolite is not effective and needs to be changed when the ammonium content absorbed is beyond its capacity. It is not possible to change zeolite in deep reservoirs or lakes. Here an idea of zeolite reproduction by bacteria was proposed. If accumulated ammonium inside zeolite is utilized by bacteria, the zeolite barrier can be recovered and effective for a longer time. The result in day 16 shows that all the nitrite turned to nitrate, and 50% nitrate converted to N_2. when changed the covering density from 0.21 kg/m^2 to 1.04 kg/m^2, the concentration of ammonium decreased guadually while that of the nitrite increased. These result indicated that eliminating N is mainly attributed to biofilms attached on zeolite F1 can make further transformation of the adsorped ammonia nitrogen.

3.2 Zeolite F2

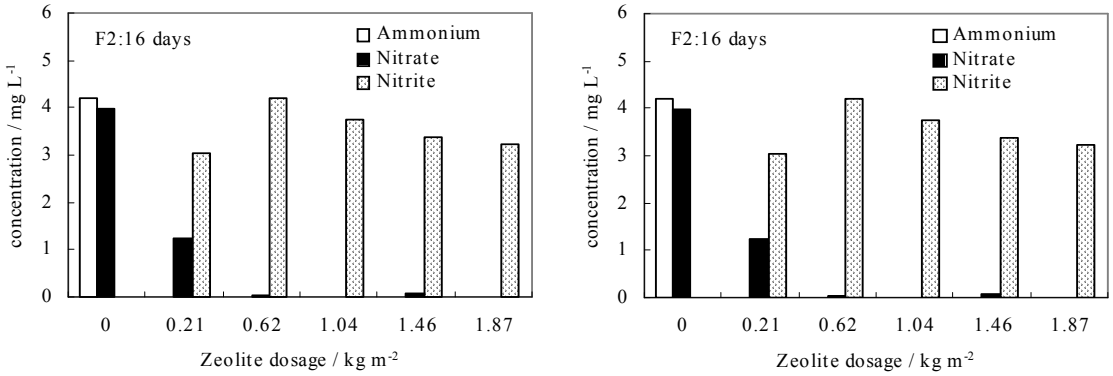

Fig 5 Transformation of 3 nitrogen in overlying water (F2)

Fig. 5 shows the concentrations of ammonium, nitrate and nitrite of the overlying water in ABS capping with zeolite F2. It can be seen that zeolite F2 showed inhibition in some extent for the realease of ammonium when the covering density is greater than 1.46 kg/m^2, biological effect is relatively weak comparing to zeolite F1. The concentration of nitrite increased enormously in the overlying water in day 16 and the nitrite accumulation may account for the low TN removal efficiency by zeolite F2. The transformation of 3-nitrogen varys with different organisms attached on zeolite, nitrification and denitrification is the principal pathway in ABS capping with zeolite F1, while nitrite accumulation appears in ABS capping with zeolite F2.

Conclusions

The effect in preventing N release of the sediments taken from ancient Canal in Yangzhou section by zeolite F1 was much better than that of zeolite F2. The transformation of nitrogen varys with different organisms attached on the surface of zeolite. Nitrification and denitrification is the principal pathway for the former one, while nitrite accumulation appears in the latter and TN removal efficiency is low. Therefore, zeolite F1 is the appropriate capping material to remediate ancient Canal in Yangzhou section and the removal efficiency of TN is greater than 50% when the zeolite dose is 1.04 kg/m^2.

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Sustainable Development Drivers for Green Buildings: Incremental Costs-Benefits Analysis of green buildings

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Keywords: Green Building; Investor; Developer; Benefit; Incremental Cost

Abstract. With the rise of low-carbon economy, more and more investors understand and accept the concept of sustainable development, some investors have gradually shifted business focus to green buildings, but most are still on the sidelines. For investors, the most important consideration in their decision-making is the project's future benefits. The main aim of this paper is to identify incremental return on incremental costs of green buildings from the real estate investor's perspective by analyzing a green residential building project. Based on the detailed analysis of incremental costs and benefits of the green building, the paper obtains the incremental investment rate of return using incremental analysis method. It certifies that there is a large benefit space for the developers to invest in green buildings.

Introduction

Building construction has significant impacts on the national economy, but also has larger energy consumption. Statistics show that in china, buildings accounted for 27.6% of the whole society terminal energy consumption, and account for more than 50% of carbon dioxide emissions and 32% of water consumed annually. They bring greater pressure into the environment. The area of existing building in china was about 400 billion square meters, in which more than 95% were high energy consumers. With the overall development of urban and rural areas, Chinese building construction will increase annually by 20%, with completion area of 20 million square meters, it is imperative to develop green buildings.

Green building has some characteristics such as saving resources, reducing energy consumption, reducing pollution, improving environmental quality of living room. Compared with traditional architectures, the initial construction costs of green buildings are higher generally until the large-scale industrial development model has been formed. On the market economy conditions, the investment power of the investors comes from the reasonable expectations of investment returns. However a lack of evidence relating to the financial benefits and uneven distribution of costs and benefits between investors and occupiers slow the green practices. Therefore, though the government has introduced a variety of green building standards and codes, sustainable principles has been accepted by investors, the development of green building still wasn't the mainstream in the construction industry. According to statistics, until the end of December 2010, China had only 108 projects were identified as green building evaluation symbol [1]. How to turn the government-driven into market-driven in green building practices is an important issue need to be resolved.

The purpose of this paper is to discuss the economic benefits of green buildings in the view of investors, so as to enhance the green practice power of investors and promote the development and improvement of the green building market. First, it analyses the incremental costs and incremental benefits of green building, which are the basis to analyze the incremental return on investment; second, this paper calculates incremental investment rate of return on incremental costs using incremental analysis method, and compares with the rate of return on investment of traditional projects to determine whether to invest on green buildings. Finally, taking a green residential building as an example, it argues whether investors can obtain considerable benefits from investment on green building projects, to help them make green practices decisions.

Definitions of Green Building

Kats (2003) regards green buildings as buildings that: use key resources like energy, water, materials and land more efficiently than buildings that are just built to code[2]. This implies an environmental interpretation of sustainability based on resource consumption and pollution. California's Executive Order D-16-00 establishes a solid set of sustainable building objectives: "to site, design, deconstruct, construct, renovate, operate, and maintain state buildings that are models of energy, water and materials efficiency; while providing healthy, productive and comfortable indoor environments and long-term benefits to Californians." [3]These objectives for green building design include not only tangible savings associated with energy, water and waste efficiencies, but also "softer" benefits, such as human health and productivity. The green practice expands and complements the classical building design concerns of economy, utility, durability, and comfort.

"Green Olympic Building Assessment System" group think "green building is the building that provides health, comfortable working and living space for human, uses energy more efficiently, with the minimum impact on the environment. Green building should follow sustainable development principles, reflect the green balance concept, through scientific design, integrate green configuration, natural ventilation, natural lighting, energy efficient building envelope, solar using, geothermal energy, greywater using, green building materials and intelligent control and other high technologies. Green building construction must fully demonstrate the harmony in culture, environment and technology [4]".

The concept is used in this paper comes from "the evaluation criteria of green building" and as buildings that maximize conservation of resources (energy, land, water and materials), protect environment and save energy, providing people with healthy, practical and efficient using space, and in harmony with the nature [5].

Incremental Costs of Green Building

Incremental cost refers to cost increases resulting from increased output (capacity or volume of business) under the level of existing technology and production conditions [6]. Some scholars divided the incremental costs of green building into soft costs, green building technique costs and certification costs. Soft costs include the costs of green building design (green consulting fees), commissioning costs, application costs and simulation costs. In the United States a statistics on the soft costs of LEED-certified buildings found that soft costs generally account for 3% to 5% of the construction costs, the smaller the project is, the greater the proportion is [2]. Accurate analysis of the incremental cost of green building is the key to predict the expected investment rate of return, also the key to make investment decisions.

As there is no specific criteria to soft cost of green building in china, and the certification costs are fixed, neither of them would be considerated when investors make green decisions. This paper focuses on the incremental cost of green building techniques. Which mainly Includes three aspects: (1)The newly added technical measures for the green building, such as renewable energy systems and greywater treatment systems; (2)Enhanced technical measures, that is the incremental cost for improving efficiency, such as enhanced thermal insulation, efficient COP set, as well as efficient fans and pumps; (3) The incremental cost generated by interaction, it can be positive or negative, for example, enhanced thermal envelope will reduce air conditioning load, thus reduce initial investment on air-conditioning equipments [1]. This part of cost has been embedded in the project design, no need to considerate additionally.

Incremental costs of green building are the increased costs of green building compared to the same type of building meet mandatory basic standards (the benchmark program). When calculating the incremental cost of green building, two questions should be considered:

(1) *Calculate the cost of the benchmark program accurately.* The benchmark program is defined as "the building in accordance with national and/or local standards of construction design" [1]. The accuracy of costs on the benchmark program affects directly the rationality of the incremental costs of

the green building. Estimation of total costs of benchmark program should be combined with construction location, climate zones, project scope, the production process, the conventional local construction practices etc.

(2) *Determine technology solutions of the green building reasonably.* The selection of green technologies and how to design have a great impact on the costs of green buildings, bad technical programs often result in more construction costs. This paper adopted the views of experts and prediction methods in the calculation of the incremental cost of the project, to ensure the cost estimation is reasonable and more reliable.

Incremental cost of green building(△C) can be calculated by eq.1, whereC_1 is the cost of green building program; C_0 is the costs of benchmark program, which is the starting point to calculate△C.

$$\Delta C = C_1 - C_0 . \tag{1}$$

Incremental Benefits of Green Building

It is obvious that green building brings benefits to the community and users, but most of benefits on carbon emissions, resource consumption, water consumption and other areas of the global issues are not attractive to the investors. What they most concern about are the returns on incremental investment. The Sustainable Construction Working Group (2000) experts have pointed out: green building or sustainable construction can receive risk reduction, enhanced corporate reputation and future increased earnings and returns for the investors. Generally speaking, the expected financial returns to the investors are mainly three aspects:

Increased Sales or Rental Level. Green building has a large potential market demand, followed with higher price or rent level compared to the non-green buildings. That is the added value result from green characteristics. Jones Lang LaSalle (2008) conducted a global survey on corporate occupiers' views on sustainable real estate and showed that 70% of the respondents was prepared to pay a rent premium for sustainable real estate. McAllister (2008). Wiley, Benefield, and Johnson find that both ENERGY-STAR and LEED-certified properties have rent premiums of 7.3%–8.9% and 15.2%–17.3%, respectively [7].

In addition to price or rent growth, sales growth rate brings value to the enterprise to some extent. Green building will be pursued by some low-carbon environmental advocators, and will attract more buyers as the development of the market segments. For example, LANDSEA Real Estate Company is the earliest one of companies entering the market segments, in 2009, its houses in Landsea-future home were subscribed more than 80% when launched into market in the morning on November 28.

Benefits of Financial Incentives. In order to promote green building development, national and regional governments proposed and implemented a variety of financial incentives, covering civil and commercial green building design and construction. They give the potential to increase developer profits by such means as energy subsidies, increased density allowance, increased sales revenue, and reduced time required to attain project approvals. In Article 40of "People's Republic energy saving law" states that: The government encourages using new wall materials and other energy-saving materials, energy-saving equipment, installing and using solar and other renewable energy systems in the new construction and energy saving renovation of existing buildings. According to "China Renewable Energy Law", the renewable energy subsidies are over 0.9 billion Yuan in 2007.

Benefits of Carbon Trading. In 1997, the "Kyoto Protocol" pushed carbon assets into the international carbon trading market as a commodity. United Nations Development Programmer's statistics show that China's carbon dioxide emission reductions has accounted for about 1/3 of the global market, the proportion was expected to reach 41% in 2012. Companies can get carbon trading income by selling emission index of CO_2. Shiers (1999) analyses the energy costs of 14 BREEAM-certified buildings by comparing data on energy costs of green buildings to conventional buildings. Results show reductions in energy use, and savings ranging between 6% and 30% [7]. The energy efficiency of green building will significantly reduce carbon dioxide emissions. According the

price per ton of carbon dioxide in the New York Mercantile Exchange (NYMEX) recently, the EU the price per ton of EU Carbon allowances is 14.66euros.The carbon trading income (V_c) is reflected through energy savings, calculated by eq.2. Where △E denotes energy savings, K denotes translated coefficient between energy consumption and carbon emissions, about 0.000785 tons/kw·h, P_c is the carbon price, is 137yuan per ton.

$$V_c=\triangle E\times K\times P_c \quad (2)$$

In summary, the incremental profits of the green building contain three main aspects, see eq.3, where ΔR denotes incremental profits of the green building, FI denotes benefits of financial incentives the company got; V_c denotes the carbon trading income.

$$\Delta R=\Delta I+FI+V_c \quad (3)$$

Incremental Costs-Benefits Analysis of Green Building

Incremental Analysis is a method to evaluate economics of selected programs by analyzing dispersion of costs and benefits. By comparing incremental costs and incremental benefits between green building and the traditional building construction project (benchmark program), the paper argues if it's worth to pay incremental costs for the incremental benefits, which can provide reference for investors to make investment decisions. ΔIRR (incremental investment rate of return) of the green building can get by eq.4, where, ΔNR denotes incremental gross profits of the green building.

$$\Delta IRR=\Delta NR/\Delta C\times 100\% \quad (4)$$

$$\Delta NR=\Delta R-\Delta C \quad (5)$$

Case Study

Landsea International Block is located in the south of Hexi New Town in Nanjing, with a total construction area of 283,500 square meters. The buildings are mainly 18-stories high buildings and 7-stories middle high-level buildings, positioned as a neighborhood apartments. The total number of residents is about 2200, 268,700 square meters living area, public construction area is 14,800 square meters, floor area ratio is 1.8, building coverage is 22%, and green coverage is 40%. The project is a combination of several sets of low-carbon energy technology systems; integrated energy-saving rate reaches 80.8%.

Incremental Costs Analysis. The project cost increase is mainly due to application of four types of energy-saving technologies: (1) the core eco-technologies, such as ground-source heat pump systems; (2)supporting eco-technologies, such as concrete ceiling radiant cooling and heating systems; (3) thermal insulation and energy-saving technologies, such as thermal insulation systems and curtain wall systems; (4)the technologies to improve living environment, including air replacement systems, the drainage systems, noise reduction systems. In which, the eco-technologies, thermal insulation and energy-saving technologies need more financial investment, while the technologies to improve living environment is related to technology and product quality and the costs are determined by the products.

(1) Ground source heat pump systems. Use buried vertical tube, horizontal tube or pipe to the surface water and other means to extract energy from the shallow soil at normal underground for indoor energy using. As the project site is limited, the designers placed majority of underground pipes below the building basement floor, with costs about 150yuan per linear meter.

(2) Concrete ceiling radiated cooling and heating systems. With pipes embedded in the concrete floor, the system refrigerates and heats using hot and cold water at normal temperature as the media. In the summer, the temperature of delivered water is 20˚C, while return water is around 26˚C; in the winter, the temperature of delivered water is 28˚C, while return water is 20˚C. Room temperature stables at 26˚C yearly due to adjusting by the system, it's quiet, no noise and no interior space, but the costs are high.

(3) Insulated wall system. Special thermal insulation is set up outside the wall structure, liking dress the house a coat with thermal Insulated function, so that the cooling and heating energy consumption of the residential houses is significantly lower than traditional houses, but the technology integration of this system increases the cost.

(4) Tight Outer windows system. Use Insulated and heat preserved windows as outer windows, and deal with the gap between window frame and the window by heat- resisted design, so that isolate thermal conductivity. The type of glass is 5 +15A +5 (mm) Insulated glass, coated with LOW-E coat, filled with inert gas to reduce heat transfer effectively. The outer window system is the best product in insulating effect, so cost is higher.

(5) External shading system. Setting metal shading roller curtains outside the outer wall effectively prevent the direct radiation and diffuse solar radiation, shading rate is up to 80%. The system not only saves energy by reducing indoor cooling loads, but also has security and insulation features to some degree. Shading system is the most effective means of energy conservation, and the project uses the aluminum roller curtains, which cost about 500yuan per square meter.

(6) The same-layer drainage system. The bathroom adopts hidden tanks and same-layer drainage technology, through horizontal drainage pipes connecting to standpipes, to eliminate the risk of penetration result from toilet drain pipes passing through the floor. International advanced HDPE pipes are used in the project, which can reduce drainage noise interference. This technology is of technology to improve living environment, cost increased is low.

(7) 24-hours air replacement system. It is the system to keep constant temperature and constant oxygen, which extracts outdoor air from high altitude and ground, through two filters to remove harmful particles and dust, then treats with temperature and humidity, finally delivers clear air into indoors via air outlet setting on the ground of the bedroom and living room. The stagnant air is removed through the exhaust port at the top of toilet and kitchen.

These technologies bring incremental costs is about 2,000yuan/㎡ more than the benchmark program, so the total incremental costs of this project is: ΔC= (2000×26.87×10000=)537,400yuan

Incremental Benefits Analysis. The project launched into housing market in early 2005 with the price of 6000-8000yuan/㎡, the average price is 7,500yuan/㎡, while normal sale price is generally at 4000-5000yuan/㎡around. The incremental sale price per square meter is 2,500yuan compared to the surrounding house buildings. The incremental sales revenue is: ΔI= (2500×26.87×10000=)671,750yuan.

Based on the energy consumption simulation results of the project, annual energy consumption of the project is 87654.17 kw·h, while the average energy consumption of general house building is 191219.30 kw·h, so the annual energy savings of the project is 103574.1 kw·h, it is shown in Table 1.

Table 1: Energy consumption comparison between Landsea International Block and the general house building

Items	Annual heating load [KW·h]	Annual cooling load[KW·h]	Annual total load [KW·h]
house of Landsea International Block	189253.07	1966.20	191219.30
the general house building	86638.55	1006.62	87645.17

The project's design life is 50 years, let K = 0.000785 ton/ kWh, P_c=137yuan/ton, so the value of reduced carbon emissions is: V_c = (103574.1×50×0.000785×137=) 556,900yuan. That is, the project can get carbon trading income of 556,900 yuan.

In addition, the project got 4.56 million yuan as renewable energy subsidies from the Ministry of Finance.

Incremental Costs-Benefits Analysis.

(1) When $\Delta R=\Delta I$

$\Delta NR=\Delta R-\Delta C$=671750-537400 = 134,350yuan

$\Delta IRR=\Delta NR/\Delta C\times 100\%$=25%

(2) When $\Delta R=\Delta I + V_c$

$\Delta NR=\Delta R-\Delta C=671750+556900-537400 = 691,250$ yuan

$\Delta IRR=\Delta NR/\Delta C \times 100\%=128.6\%$

(3) When $\Delta R=\Delta I+FI+ V_c$

$\Delta NR=\Delta R-\Delta C=671750+556900+4560000-537400 = 5,251,250$yuan

Results Analysis. According to the results of analysis, Landsea International Block spent incremental cost of about 537,400yuan on the green energy technologies, i.e. 2000yuan per square meter. Because project selling were almost at the same time as project development and construction, this article didn't take discount into account. Though the cost of the project increased more compared to traditional house buildings around, the direct increase in sales amounted to 671,750yuan, the incremental investment rate of return is 25%, otherwise, the project's "green" qualities made the subscription rate reached 80%.on the launched day, even in the market downturn.

If the company trade their carbon dioxide emission reduction index in the carbon trading market, the carbon trading income also brings additional benefits to company. The paper evaluated the available carbon trading revenue is 556,900yuan with the carbon trading price (137yuan/ton) according to European market recently. And the governmental and local financial incentives also give the company some financial support on energy saving projects. Thus, investing on green buildings is economically viable.

Conclusion

This paper discusses the economic benefits of the green buildings in the view of investors, using incremental analysis method, the results show that it's feasible on economy for investors investing on green building, they can get considerable benefits such as incremental sales income, the potential benefits of carbon trading as well as national and local government funds for the energy-saving project.

Actually, analyzing the costs-benefits of green building is a more complex process; one important drawback for the study was the lack of data. For the statistical analyses and to reduce the variance of data, more detailed data collection is very important for similar studies. And green buildings not only attract higher income for investors, but also provide valuable but less tangible benefits to the company, such as improving the corporate brand, to reduce market risk, etc., how to integrate these variables into the analysis is still an important study issue.

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A Research On The Ecological Footprint Evaluation And Computational Methods Of Urban Water Resourse In Beijing

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Key Words: Beijing urban, water resourse, evaluation of ecological footprint, computational method

Abstract: Since the water resourse insome towns of Beijing were in a big shortage in the past few years, it becomes a key factor which restricts the sustainable development and theurbanlization of Beijing. Based on the fact, this paper introduces the reserrch situation and development of the ecological footprint of urban water resourse in Beijing. And it puts forward the method for calculating the the ecological footprint of urban water resourse , includeing domestic water, process water and eological water, in Beijing. Furthermore, the computational method of ecological carrying capacity and ecological deficit of urban water resourse in Beijing is proposed, which provides reference for the evaluation of ecological capacity of urban water resourse in Beijing.

INTRODUCTION

Accoding to relevent research,the total water resourse in Beijing of 2007 is 3.74 billion cubic metres,thereinto,surface water is 1.77 billion cubic metres,ground water takes 2.56 billion cubic metres,and the water supply for each person is only 300 cubic metres.And this figure will be less than 230 cubic metres if we refer the permenant population of 2007.The date keeps on 300 cubic metres after the implementation of South-North Water Transfer Project in 2010.The water supply for each person in Beijing is only an eighth of the national level,and one thirtieth of the word standard,which is far from the lower level 1000 cubic metres recognized by internatinal institute.Obviously,Beijing is a resourse based serious water shortage region[1].And the situation is aggravated by the increasing water demonds for life and production caused by the rural urbanlization and development of Beijing.For instance,the water consumption of Fangshan District,Beijing in 2004 is 266.7 million cubic metres,while in 2008 the figure is 268.14 million cubic metres,increasing about 30 times than the former. Combined with the weak management of water resources in rural areas, a large number of rural industrial, village and village industrial water is not accurately metered.As a result,it is difficult to charge by the volume of water consumed,which is bound to cause unreasonable exploitation of groundwater resources and water waste[2]. Thus, with the process of rural urbanization of Beijing, water resources will increasingly become an important limiting factor for sustainable development of rural urbanization. Therefore, to make up the limitations in describing the function of water resources in the current ecological footprint model, this article add the composition of water resourse to the model evaluation system, namely the addition of three parts of water resources in the domestic water, process water and ecological water, for completely emboding the real significance of water resource in the socio-economic development.

PRESENT SITUATION AND DEVELOPMENT OF WATER RESOURSE ECOLOGICAL FOOTPRINT RESEARCH

As Wackernagel introduced, ecological footprint model analysis does not fuly describe the function of natural systems which provide resources,absorb waste features, that is, ignoring the estimation of underground resources and water resources[3],and ignoring its absorptive capacity of pollutants. To compensate the limitations of the function of water resourse described in the ecological footprint mode, some progress in theory and calculation method of water resources ecological footprint have been made domestic and overseas in recent years.

The concept of virtual water, defined as the quantity of water resources needed in the production of products and services,also called the virtual water condensed in the products and services,has been proposed by Tony Allen in 1993.He has classified water as the " blue water "(surface water and groundwater) and " green water "(a form of soil water that storaged in the soil)[4]. Hoekstra has put forward a concept of water footprint based on the concept of virtual water in 2003.And the definition is the water needed when all the products that consumed in a fixed tine of a contry,a district or a people which the population is known are in sevice. [5]. From a perspective of water consumption, Hoekstra argues a connection between resources and consumption should be established,and the concept of ecological footprint should be applied to water resources accounting.

In China, Xu Zhongmin ect. used quantity of water per unit area in arid area of Northwest China as a standard in 2001.He devided water resourses into groundwater and surface water ,then calculated1995 water resources ecological footprint of Zhangye[6] ; Li Jinping computed water resource footprint individually when he analyzed the year 2001 ecological footprint of Macaux in 2003[7].

Long Aihua proposed the concept of water footprint, and introduced the concept of virtual water and water footprint measuring method based on this in 2003.Typically, he calculated water footprint of Xinjiang, Qinghai, Gansu and Shaanxi for the year 2000[8]. On the foundation of this, Ma Jing has calculated virtual water content of main agricultural products in our country and other region in 2005.She also calculated the virtual water flows between the international and domestic regions and the corresponding water footprints and water self-sufficiency rate by analyzing the regional relationship between production and consumption of agricultural products.And a correlation analysis has been made. In 2006, Wu Zhifeng ect. used water resources and aquatic products consumption statistics to make a time model of water ecological footprint change of Guangzhou between 1949 to 1998 by appling the ecological footprint theory and methods[9].

CACULAION METHOD OF ECOLOGICAL FOOTPRINT OF URBAN WATER RESOURSES IN BEIJING

With water resources' increasing in the ecological footprint model, correspondingly a new land type "water resources land" has generated. Water resourses ecological footprint is the land which provide the must water for survival and development of our human beings.It is characterized by land area needed to provide enough water for people's consumption. In fact, water resources ecological footprint is mainly composed by demonds for domestic water, process water and ecological water or the consumption of water resourses. According to water users' characteristics, water can be divided into three categories : domestic water, process water and ecological water. And domestic water is made up of water for residents' daily lives. Process water includes primary industry water, secondary industry water and the tertiary industry water. The ecological water consists of instream water uses and offstream water uses. Instream water uses referres to logical use water resourse for the improvement of water environment of rivers and lakes ,and offstream water uses includs water for urban environment and supplement water for wetlands and so on.

ECOLOGICAL FOOTPRINT OF DOMESTIC WATER . Domestic water includes water for rural residents' daily live and water for rural domestic livestock. It has a close relationship with the regional population size and daily water consumption per capita,and it responds to the changes of rural urbanization level, living standard and lifestyles.

And the rural domestic water ecological footprint formula is as follows :

$$EF_W = a_w \times Q_W / P_W \quad \text{or} \quad ef_w = EF_W / P$$

In the formula: EF_w or ef_w-Domestic water ecological footprint, hm^2 or Ecological footprint per capita domestic water, hm^2 per person; a_w-Water resources balancing factor, water resource balance factor of Beijing is 35.92; Q_w-Regional annual water consumption, m^3;P_w-Water consumption per unit area of Beijing, m^3/hm^2; P-Regional population.

ECOLOGICAL FOOTPRINT OF PROCESS WATER . Process water footprint refers to the demand of water resources for all kinds of production activities in the region at a particular time. It includes primary industry water (water used for agriculture, forestry, animal husbandry), secondary industry water (water used for industry, construction industry), and the tertiary industry water (water used for commerce, service). For process water, accounting for agriculture water, industry water and tertiary industry water the three parts is the main task.

Rural process water mainly accounts for agricultural process water, and it's closely related to agricultural irrigation area, the way of irrigation and climatic conditions.

And the rural process water ecological footprint formula is as follows :

$$EF_W = a_w \times Q_W / P_W \quad \text{or} \quad ef_w = EF_W / P$$

In the formula : EF_w or ef_w- Process water ecological footprint, hm^2 or Ecological footprint per capita Process water, hm^2 per person; The interpretation of the letters are the same as above.

ECOLOGICAL FOOTPRINT OF ECOLOGICAL WATER. Ecological water is the volume of consumption of water resources for human to maintain ecosystem health to avoid its degradation in the development process. Water is the best cleaning agent in ecological environment and it has strong natural purification function. Normally, use and regeneration of ecological water can be completed by the natural water cycle itself, which is the reason why 60 percents of water resourse in the water resources carrying capacity must be reserved for ecological environmental protection in theory. But with the development of the urbanization of rural areas and the increased human activities in the process of urbanization, increasingly the ecology has been destructed and the environment is in degradation. What's more, water resources reserved normally for ecological environment has been overdrawn now. It is clear that there is a need for additional water to repaire damaged ecological environment.

Ecological water mainly consists of two parts: water for regional green space and water for diluting pollutants beyond the water environmental capacity in the region.The green water footprint includes water for green vegetation growth and ongoing maintenance of gardens, road green belt, riparian ecological forest scenic areas and woodland. And pollutants water footprint is the additional water used for diluting pollutants beyond self purification capacity to make the water meet the highest water quality standards.

Calculation formula of ecological footprint of rural eco-water is as follows :

$$EF_W = a_w \times Q_W / P_W \quad \text{or} \quad ef_w = EF_W / P$$

In the formula:EF_w or ef_w- Ecological water ecological footprint, hm^2 or Ecological footprint per capita Ecological water, hm^2 per person; The interpretation of the letters are the same as above.

CALCULATION METHOD OF WATER REOURSES' ECOLOGICAL CARRYING CAPACITY

Ecological carrying capacity of water resources is the ablity of sustainable development of resourse, enveronment and society(ecology, production and life) of an area supported by the water in this region in a specific stage of historical development. As mentioned above, this research will use water resourse land area converted by the biggest regional water resources supply (that is the total volume of regional water resourse) to express the water resourse carrying capacity. The total quantity of water resources is stable within a certain period, so in that period the ability of water resourse to undertake the production life of human is also constant. And water resources ecological carrying capacity is calculated as follows : $EC_W = (1-60\%) \times a_w \times \gamma_w \times Q_W' / P_W$ or $ec_w = Q_W' / P$

In the formula : EC_w or ec_w-Ecological carrying capacity of water resources, hm^2 or Ecological carrying capacity of water resources per capita, hm^2 per person; a_w-Water resources balancing factor, the water resource balance factor Beijing is 35.92 ; γ_w-Yield factors of water resources, Fangshan, Pinggu, yanqing Counties' yield factor are as shown in table 1; P_w-Water consumption per unit area of Beijing, m^3/hm^2; Q_w'-Regional water resources, m^3; P-Regional population.

Table1 Yield factors of water resource of Fangshan, Pinggu and Yanqing counties in Beijing (2008)

District	Area（hm^2）	water consumption （10 thousand m^3）	Unit area water consumption（m^3/hm^2）	Yield factors
Beijing	16807.8	342000	2034.7600	1
Fangshan	201900	26814	1328.0832	0.65
Pinggu	95013	9418.6	991.2959	0.49
Yanqing	199375	13893	696.8276	0.34

CALCULATION METHOD OF WATER REOURSES' ECOLOGICAL SUPLUS OR DEFICIT

Water resources' ecological surplus or deficit is a figure to assess the level of sustainable development of the egional water resources in the process of urbanization.When the water resourses' ecological carrying capacity of a region is less than ecological footprint, there will be a ecological deficit in this area. It means that water in this place is unsustainable in the process of urbanization, and there is an urgent need to take measures to decrease the water resourses' ecological footprint.And the measures may be a water saving or an increasing utilization rate of water resourse.On the other side, if the water resourses' local ecological carrying capacity is bigger than ecological footprint, an " ecological surplus " arises, which indicates that the local water resourse is sustainable in the process of urbanization.

Water resources' ecological carrying capacity can be calculated as follows :

$$ED_w = (EF_w - EC_w) \quad \text{or} \quad ed_w = ED_W / P$$

In the formula : ED_w or ed_w -Water resources' ecological surplus /deficit, hm^2 or Water resource per capita, hm^2 per capita; EF_w-Ecological footprint of regional water resources, hm^2;EC_w-Ecological carrying capacity of regional water resources, hm^2； P-Regional population.

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Study on the Growth Characteristics of Fouling in Sewage Source Heat Pump Systems

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Keywords: sewage source heat pump; sewage heat exchanger; bio-fouling

Abstract: According to different sources of using sewage, it can be divided into untreated sewage and reclaimed water. The wastewater treatment station in Shandong Jianzhu University is used as the experimental base in this paper. The components from school life sewage was received. The growth regulation of fouling on the surface of PE pipe in untreated sewage and the maximum thickness of fouling growth was found through biological electron microscopy.

Introduction

The Sewage source heat pump system is a mode of energy recovery and utilization through using sewage resources, which has been put into application and studied in China in recent years. It is a kind of air conditioning equipment for cooling and heating for buildings by making use of municipal sewage and industrial waste water as a kind source of heat absorption and heat release. Compared with traditional air conditioning systems, it has the characteristics of energy saving, water saving, economic and environmental friendly. During the operation of sewage source heat pump systems, fouling problems often affect the system operation efficiency. Growth characteristics of the fouling in heat exchanger is the focus of the study on sewage source heat pump systems.

Although municipal sewage is ideal for heating and cooling as low quality cold and heat sources, but because of the urban wastewater containing various large scale of fouling and small scale of suspended solids and dissolved compounds, it can easily form blocking in pipeline and equipment, affecting heat transfer in heat exchangers. And the cooling and heating capacity of air conditioning systems for sewage source heat pump significantly reduces, then the scaling in serious will affect the normal operation of a heat pump system. This article is about growth pattern of fouling in sewage heat exchanger by experimental methods, and lays the Foundation for development of sewage heat exchanger cleaning device.

Classification of foulings

According to the main physical-chemical process of the fouling formation, fouling can be divided into the following seven categories[1]:

(1) crystallization fouling, it means the crystalline solid ---- dissolved inorganic salts in supersaturated flowing solution precipitated on pad of the heat transfer surface. When comes to cooling water or liquid in evaporation equipment, this dirt is called scale.

(2) the particles fouling, it means solid particles suspended in fluid which accumulate on the heat-exchange surface. This dirt will include gravity sedimentation of larger solid particles on the horizontal heat transfer surface and colloidal particles precipitateother formed by other mechanisms .

(3) chemical reaction fouling: it means the sediments on heat exchange surface by reason of any chemical reaction, except the fouling that the heat transfer surface material itself involved in the reaction to form .

(4) corrosion fouling: it means the heat transfer material itself that participates in chemical reactions into corrosion accumulation. This fouling not only contaminate heat transfer surface itself, but also could prompt other potential fouling to attach to heat transfer surface, new fouling growing.

(5) Biofouling: it refers to micorganisms such as bacteria, algae and their excrement depositing on solid surface ,with growth, reproduction and formation into mucous membrane of biological or organic membranes. This kind of biological mucosa provides condition for attachment and growth of macro-organisms and inorganic conditions, also provide the necessary nutrients for the growth of macro-organisms.

(6) solidified dirt: refers to refrigerants or its components on supercooled heat transfer surface forming because of solidification.

(7) composite fouling: in a heat process, more than one of the above six types of fouling formation mechanisms occur at the same time.

Wastewater quality and fouling composition

Sewage with different quality produce different fouling. Municipal wastewater can be divided into untreated sewage and recycled water in major. Untreated sewage is urban sewage without treated, and its main feature is complex water quality component, high content of kinds of dirt. Recycled water is the wastewater treated after urban sewage treatment plant and reaching related indexes. Suspended solids of recycled water has been greatly reduced, which can achieve in the water reuse.

Fig. 1 Sewage pool for testing

In this paper, waste water treatment station in Shandong Jianzhu University is used as an experimental base, and untreated sewage of the school is for the study. PE-tube was pickled in untreated sewage, and we did pool water quality testing every other week , observed scaling in PE pipe. Experiments were conducted a total of 10 weeks, our tested sewage metric includes turbidity, dissolved solids, pH , BOD5 , ammonia-nitrogen and water temperature.

The test results show that during this test, water quality is relatively stable, the results of fouling test are based on the water quality.

Cui Fuyi[2] etc determined fouling in the spiral-tube heat exchanger which made from copper or stainless steel under different sewage water temperature. Its components mainly is bio-fouling. Wu Ronghua[3] etc tested fouling components in the practical applicational sewage heat exchanger as experimental subject, whose components mainly contain microorganisms and micro-scale sediment, with the water content above 80% and the thickness of mud between 0.3~1.5mm. Through our test, fouling on PE tube surface of untreated sewage mainly includes microbial fouling, with high water content, more than 85%.

Microbial fouling belongs to the soft dirt, so cleaning intensity can not be too large in the cleaning process, otherwise pipe wall would easily worn, leaving the fouling a larger attachment surface.

Growth characteristics of untreated sewage fouling

This experiment was carried out in water treatment station in Shandong Jianzhu University, Three sets of experimental tube was soaked in untreated sewage pool at the same time, the diameter of the three set pipes for test is DN25, whose material is Poly Ethylene (PE), leaving a clean set of PE pipe placed in clean water for comparison. PE pipes are observed regularly every other week and taken pictures by the biological electron microscopy and weighted to obtain the thickness of fouling layer growth. There is one time measurement for every week. By measuring the average of layer thickness of three groups PE pipes, the growth of the fouling thickness is given in Figure 2.

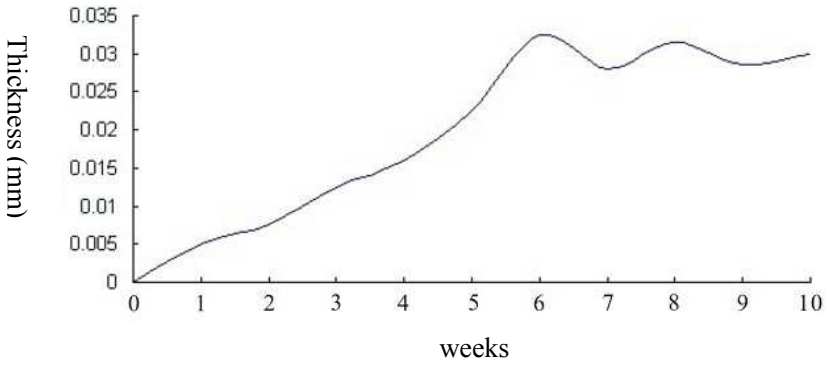

Fig. 2 The growth of fouling thickness by times

Because the thickness of fouling grows slowly, the thickness of fouling is diffcult to measure directly by common measurement tool, we have to take two method with the taking pictures and weighting.

Through continuous observation and testing, we get the growth pattern of fouling as shown in Figure 2. Fouling accumulated slowly in the frist two weeks, started to accumulate faster after the third week, and started to fall off after the sixth week, from then on the thickness tend to be gradually stable and constant.

Due to the large water content of fouling, it was dried during the fouling is tested by electron microscop, the thickness should be converted into in wet condition by water content in fouling.

Fig.2 reflects the thickness of fouling tested through electron microscopy, Fig.4 reflects thickness under wet condition. Results show that its maximum thickness is 30-40μm in dry condition, While the actual average thickness under wet conditions is measured 1.5-2mm. After contrast, the ratio of thickness under wet condition and dried condition is 50-60 times.

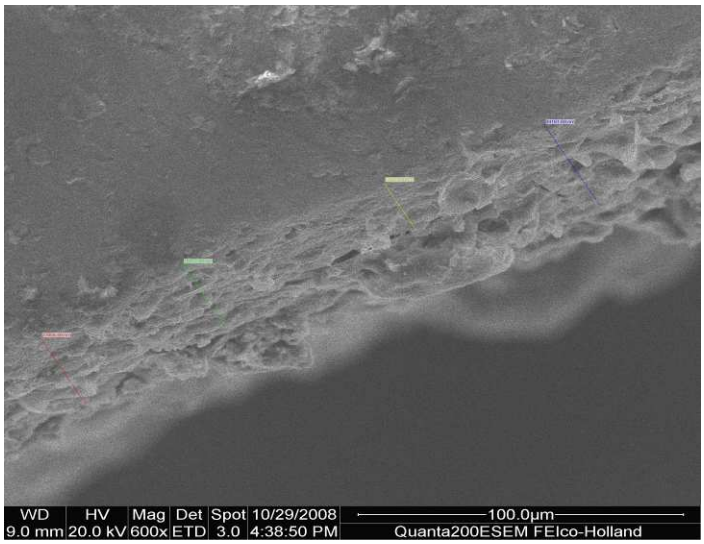

Fig.3 Thickness under dry state through microscopy

Effect of fouling on heat transfer

Fouling is a substance with the poor ability in heat conduction, and one of the main resistance of exchangers. For example, thermal conductivity of pure copper is 387W/ (m.k), brass has a thermal conductivity of 109W/(m.k), while thermal conductivity of fouling is for an average of 0.93 W/(m.k). Difference between them may be ten or a hundred times. The presence of fouling

increases the thermal resistance of heat transfer and reduces the total heat transfer coefficient in heat exchanging equipment, so you must increase the heat transfer area to compensate the reduction of total heat transfer coefficient. Therefore, to ensure the heat transfer of heat exchanger, the solution is to increase heat exchanger area appropriately, another is to remove fouling promptly. Through the study on growth regularity of fouling, it can be determined the cleaning time of exchanger according to the thickness of fouling, reducing the operating cost of the system.

Conclusions

Results shows that it make up of microbial fouling in the urban sewage by experimental verification.

Through fouling growth experiment, we received the growth pattern of fouling in untreated sewage , that the fouling accumulated slowly in the frist two weeks, started to accumulate faster after the third week. Thickness of the fouling reached its maximum in the sixth week. And the fouling started to fall off in the seventh week, from then the thickness gradually tend to stabilize. According to the results of this study, we can take timely measures to determine fouling removal time, improve the heat effect.

Fig.4 Fouling thickness under wet conditions

Acknowledgements

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Advanced Materials Research Vols. 374-377 (2012) pp 90-93

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The analysis of combined prediction model of building energy consumption with grey theory and RBF neural network

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Keywords: Building Energy Consumption, GM(1,1) Model, Radial Basis Neural Network.

Abstract. A kind of new combined modeling method with GM(1,1) and RBNN (Radial Basis Neural Network) is brought forward, according to the idea that the method of neural network can bring grey prediction model a good modified effect. Based on the analysis of the energy consumption data of the existing and the annually-increased building area, the GM(1,1) model was then constructed. And the RBF neural network was used for the model residual error revising. The simulation and experiment results show that the novel model is more effective than the common grey model.

Introduction

Currently, building energy consumption accounts for 46.7% of total energy consumption in the whole society. In China, there are 43 billion square meters of the existing building. And in the annual increase in building area from 1.6 to 2 billion square meters, the total building energy consumption is increasing year by year. The effective forecast for building energy consumption can provide scientific reference for intelligent building energy management, reasonable selection in heating and cooling equipments, and the optimization of energy saving of existing construction equipment system [1].

In recent years, the application of *Grey Theory* has been expanded to many scientific research fields [2, 3] and there have been remarkable achievements in energy consumption prediction [4]. In this paper, a combined RBNN-GM(1,1) model was constructed for building area and building energy consumption prediction.

Preliminaries

Grey Theory. For the original sampled series $X^{(0)}=(x^{(0)}(1),x^{(0)}(2),\cdots,x^{(0)}(n))$, the incremental series by AGO (Accumulated Generating Operation) is: $X^{(1)}=(x^{(1)}(1),x^{(1)}(2),\cdots,x^{(1)}(n))$, where $x^{(1)}(k)=\sum_{i=1}^{k}x^{(0)}(i)$, $k=1,2,\ldots,n$.

If the transform trend of series $X^{(1)}$ shows exponential, the differential equation can be set up: $d^{(1)}x/dt+aX^{(1)}=b$ and its difference equation is $Y^N=XB$. Using least squares method, the result of the equation group is $B=(a/b)=(X^{\mathrm{T}}X)^{-1}XY_N$, replace into the original differential equation, $X^{(1)}(n+1)=[X^{(0)}(1)-b/a]e^{-ak}+b/a$.

Thus, the series $X^{(1)}$ can be calculated out and by IAGO (Inverse Accumulated Generating Operation), the results $X^{(0)}(k)$ can be work out, i.e. $X^{(0)}(k)=X^{(1)}(k)-X^{(1)}(k-1)$. It is the simulation value of the original $X^{(0)}$, and when $k\geq n$, the predicted value can be gained [5].

Radial Basis Function (RBF) Network. The RBF neural network is a typical feed-forward network with good clustering and learning abilities, whose global approximation and convergence make it the primary choice for residual error correction. It consists of three layers. It can be considered

as a mapping in Euclidean space: $T: R^r \to R^s$. Let $x^p \in R^r$ be the input vector, and $c^i \in R^r$ ($i = 1,2,\cdots,k$) be the center. The output is formed by a linear combination of the hidden layer responses, given by

$$y_j(x^p) = \sum_{i=1}^{k} w_{ji}\phi_i(\| x^p - c^i \|), \ j = 1,2,\cdots,s \tag{1}$$

where $\|\cdot\|$ is the Euclidean distance, k is the number of the hidden layer nodes, $\phi_i(\cdot)$ is the hidden layer node response, w_{ji} is the output weight, x^p is the input vector, y_j is the output of the jth output node and s is the number of the output nodes [6]. Gaussian function is selected in the research.

Algorithm

In order to promote the precision of GM(1,1) model, the RBNN algorithm is used to revising the residual errors of the grey model. The prediction algorithm can be summarized as follows:

STEP 1 Testing the original samples, and do nonnegative process.

STEP 2 Suppose the pretreated series is $X^{(0)} = (x^{(0)}(1), x^{(0)}(2), \cdots, x^{(0)}(n))$, the 1-AGO of $X^{(0)}$ is $X^{(1)} = (x^{(1)}(1), x^{(1)}(2), \cdots, x^{(1)}(n))$, where $x^{(1)}(k) = \sum_{i=1}^{k} x^{(0)}(i)$, $k = 1,2,\cdots,n$.

STEP 3 Construct the matrix

$$B = \begin{bmatrix} -\frac{1}{2}X^{(1)}(1) + X^{(1)}(2) & 1 \\ -\frac{1}{2}X^{(1)}(2) + X^{(1)}(3) & 1 \\ \vdots & \vdots \\ -\frac{1}{2}X^{(1)}(n-1) + X^{(1)}(n) & 1 \end{bmatrix} \tag{2}$$

STEP 4 According to $(a, b)^T = (B^T B)^{-1} B^T Y$, the estimated value a and b can be calculated out, where $Y' = [x^{(0)}(2) \ x^{(0)}(3) \ \cdots \ x^{(0)}(n)]$.

STEP 5 Calculating the simulation value $\hat{x}^{(1)}(i)$ according to the time response formula:

$$\hat{x}^{(1)}(k+1) = (x^{(0)}(1) - \frac{b}{a})e^{-ak} + \frac{b}{a} \tag{3}$$

STEP 6 Inverse accumulated generating operation by formula (4).

$$\hat{x}^{(0)}(i) = \hat{x}^{(1)}(i) - \hat{x}^{(1)}(i-1) \quad i = 2,3,\cdots,n \tag{4}$$

STEP 7 Construct the RBF model for the residual error serial. Suppose $e^{(0)}(L)$ is the residual error serial, if the order of prediction is S, take $e^{(0)}(i-1)$, $e^{(0)}(i-2)$, $\cdots$, $e^{(0)}(i-S)$ as the input training samples, where $i = 1,2,\cdots,n$, and take $e^{(0)}(i)$ as the teaching value of the training process.

STEP 8 Calculate the predicted value of $\{e^{(0)}(L)\}$. Suppose $\{\hat{e}^{(0)}(L)\}$ is the predicted residual error serial. A new predicted value $\hat{X}^{(0)}(i,1)$ can be got by using formula $\hat{X}^{(0)}(i,1) = \hat{X}^{(1)}(i) + \hat{e}^{(0)}(1)$, where $e^{(0)}(L) = x^{(0)}(L) - \hat{x}^{(0)}(L)$ is the difference between sampled data and the simulated value on time L.

Application

According to the algorithm described above, the combined RBNN-GM(1,1) model was constructed based on the data collected from *China Statistical Yearbook* from 2001 to 2008. The error tested table was shown in Table 1, and the simulated result is shown in Fig. 1. The average relative error is 0.906% and time respond formula can be worked out, shown in formula (5).

$$x(k+1) = 6735.366816e^{0.046189k} - 6458.166816 \quad (5)$$

Table 1 Error tested table

NO.	Year	Existing construction area [billion square metres]	Simulant value [billion square metres]	Residual error	Relative error [%]
1	2000	277.2	---	---	---
2	2001	314.8	318.39	3.59	1.14
3	2002	339.4	333.44	-5.95	-1.75
4	2003	350.3	349.20	-1.09	-0.31
5	2004	360.2	365.71	5.51	1.53
6	2005	385.6	383.00	-2.59	-0.67
7	2006	401.0	401.10	0.10	0.03

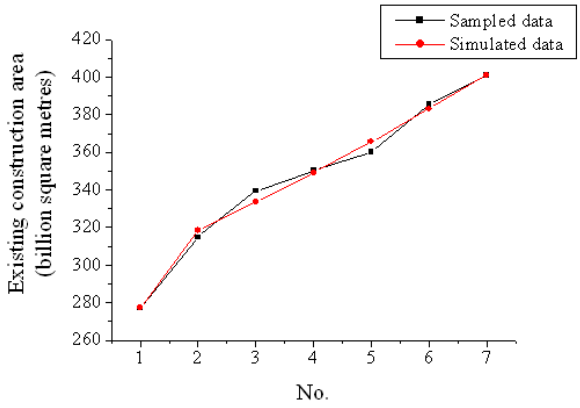

Fig. 1 Simulation result of the existing construction ara

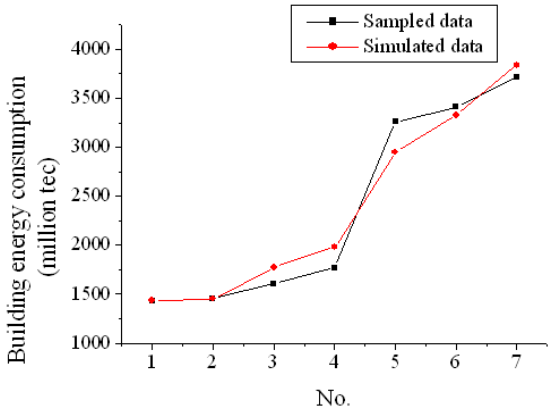

Fig. 2 The simulation result of RBNN-GM(1,1) model

The forecasted value of the existing construction area in year 2007 is 42.0070 billion squre metres which has the relative error 0.2% comparing with the actual value 42 billion squre metres.

Based on the analysis of the energy consumption data of the existing and annually-increased building area from 2000 to 2006, the data sequence doesn't possess the trend of quasi exponential. Therefore, it's residual errors need to be revised. Firstly, GM(1,1) model was built up and the error tested table is shown in Table 2. The average relative error is 10.52%. The time respond formula is:

$$x(k+1) = 6524.805934e^{0.201033k} - 5091.805934 \quad (6)$$

Table 2 Error tested table

Year	Building energy consumption	Simulant value [million tec]	Residual error	Relative error [%]
2000	14.33	---	---	---
2001	14.53	14.529	-0.15	-0.0015
2002	16.10	17.764	1.664	10.33
2003	17.72	21.719	3.999	22.56
2004	32.59	26.555	-6.035	-18.52
2005	34.11	32.468	-1.642	-4.81
2006	37.15	39.697	2.547	6.86

Secondly, the equidistant metabolic GM model was constructed, and the residual error was revised by RBNN which was constructed with 7 nerve cells, target error of 0.002, and distributing constant of 1. The results of modeling are shown in Table 3 and Fig. 2. The average relative error is 0.33%. The building energy consumption forecasted value of year 2007 is 44.664, which has the relative error 9.7%, contrasted with the sampled value 40.31. The contrasted result is shown in Table 4.

Table 3 Simulation results for building energy consumption

NO.	Building energy consumption	Predicted value [million tec]	Relative error [%]
1	14.33	---	---
2	14.53	---	---
3	16.10	---	---
4	17.72	19.783	0.10
5	32.59	29.512	10.4
6	34.11	33.307	2.41
7	37.15	38.400	3.25

The result of the simulation for building energy consumption shows that more precise results can be got by employing the combined RBNN-GM(1,1) forecasting model than the common grey model.

Table 4 The contrastive results

Year	Building energy consumption [million tec]	Predicted value [million tec]		Relative error [%]	
		GM	RBNN-GM(1,1)	GM	RBNN-GM(1,1)
2006	37.15	39.697	38.400	6.40	3.26
2007	40.31	48.536	44.664	16.9	9.70

Conclusions

Aiming at the time series data collected from building energy consumption and existing construction area, the combined RBNN-GM(1,1) model was constructed. The results of the experiments show that the novel model is better performed than the common grey model not only in data analyzing but also in predicting. It may offer scientific reference for intelligent building energy management, reasonable selection in HVAC equipments, and optimization of energy saving of existing equipment system.

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The Investment Management with Global Optimization for Rural Domestic Biogas

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Key-words: Rural household biogas, Global optimization, Investment management, structure system

Abstract. At present, the rural distribution includes Dispersed Type (DT) and Residential type (RT). In this paper, the structure system of investment management with global optimization was suggested to resolve drawbacks caused by conventional-style biogas investment management mode. The Investment Management with Global Optimization consists of four modules: examination content optimization (ECO), follow-up service content optimizing (FSCO), start optimizing (SO), consolidate optimization (CO). Four modules work coordinately to promote household biogas will be Efficient, sustainable and stable development. Finally, an example is described in detail to show the organizational structure of global optimization and its operation modes.

Rural household biogas

Investment of rural household biogas is an eco-agricultural system using methane as the link, on the one hand it will ease the situation of energy shortage in rural counties to improve the farmers production and life, change the rural dirty, chaotic, poor environment condition, and enhance livestock development, improve the quality of agricultural products; the other hand, it will stimulate farmers' initiative of studying science, using science and let the science and technology into practical productive forces to increase awareness of farmers' Consciousness of science and technology, and improve the quality of farmers; while women can also be free for the heavy Kitchen labor, then could have enough time to engage other income-generating activities, so that increase their income effectively; the most important thing is to bring good economic benefit for farmers, because a digester can save 400yuan per year compared with coal and electricity, and using Biogas slurry residue as feed or fertilizer can save 400yuan which are spend to buy fertilizers and pesticides every year, and in aquaculture (vegetables, fruit trees) increasing income of 500yuan each year. So 1300yuan or more can be increased for farmers who build one biogas digester each year. "In the 10 years of 21st century, central government investment in gas up to 240 billion, according to the plan, China's gas production capacity will reach 44 billion cubic meters in 2020. China has become the country which own biogas growing fastest, the largest construction and the largest population with benefit in the word. " the Secretary-General of Biogas Association, Li Jing Ming said.

Conventional biogas investment management mode

The conventional biogas investment management mode of rural household biogas digesters includes the following procedures: farmers apply to village, village to the township, township to the rural energy application of county office, and then the county rural energy office ask relevant technical staff to built biogas digester, finally the county rural energy office organize rural energy acceptance and payment subsidies. And the planning biogas investment funds of each county will be invested by three parts that the state, local self-supporting and farmers, and the respective proportions are about 50%, 10% and 40%.

The drawbacks of conventional processes

The biggest shortcoming of conventional process is to focus only on short-term performance of the construction of the number of biogas digesters and do not take into account the number of years of steady use. Leader carelessness and Investment model frequently used without innovation are two main reasons. Early, no well sound investment planning must be obstacle to long-term development of household biogas. Currently, the number of digesters is the preferred standard to assess the level of household biogas penetration rate, farmers' satisfaction to the new energy biogas and economic benefits generated by biogas utilization use, the two core elements, have been neglected. Through research, rural household biogas social service system came into being to make up the start Hidden danger due to careless. Although experts have been proposed a set of more comprehensive service system as a remedial measure by carefully analyzing, there is a very serious funding problem for the service network in actual operation, and in the establishment of two to three years, almost all service stations face collapse as lack of funds.

The Global Optimization of Investment Management

Global optimization solution was proposed to resolve the bad situation caused by blindly and ignore local conditions and practice appearing in the rural biogas investment management. The investment management of global optimization is similar to a doctor surgery, so investors and policy makers in the initial planning has to realize that our purpose is not to complete the construction of indicators, or to meet a certain leader, but try to promote the cause of rural marsh gas development by all means and contribute to energy saving and environmental protection. Implementation of a project need a lot of links, and planning a single aspect is in fact to "operation" for a local in the whole project. The success of "operation" depends not only whether the cure is local, but also whether the law is recovered.

The concept of global optimization

Sustainable and efficient use of rural household biogas is the target of global optimization in rural household biogas investment management, based on the local and global idea that the link of various aspects of project implementation and sustainable development of the rural, and is composed by four aspects with mutual cooperation that examination content optimization (ECO), follow-up service content optimizing (FSCO), start optimizing (SO), consolidate optimization (CO). Global optimization can effectively avoid serious losses due to lack of funds caused by the lack of practical co-ordination planning node， so that farmers can obtain tangible economic and environmental benefits, in the meantime doing this can promote the biogas industry to development quickly and efficiently.

The structure system of global optimization

The structure of global optimization system is shown in Fig.1.

ECO and FSCO are sufficient condition for the successful implementation of SO and CO. Start early in the project, SO is the core aspects of global optimization, which take ECO and FSCO as the foundation and will select technology and service personnel to construct and maintain the biogas though a rigorous evaluation mechanism.

Selecting technology and service personnel is the sore of SO. On the one hand, choosing people regards ECO as the basis to select a biogas service team which is a good work ethic and full of enthusiasm for biogas industry; the choice of propaganda way mainly based on the characteristics of the layout of farmers, of course there are similarities and obvious differences between DT and RT.

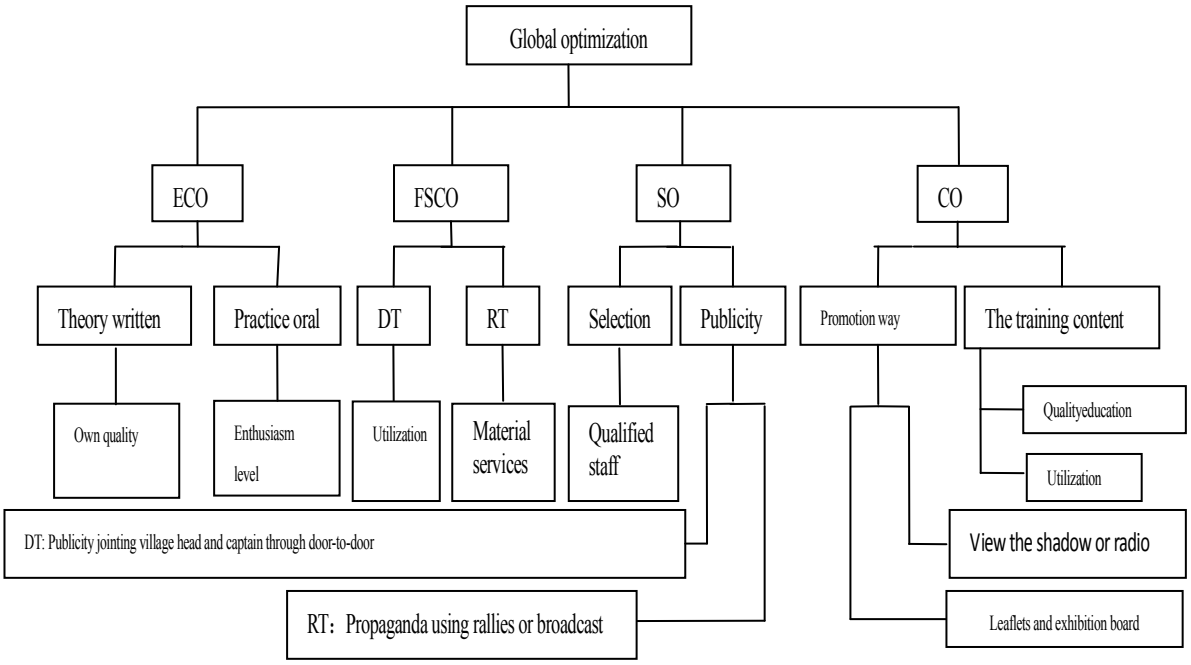

Figure.1 The structure system of global optimization

Both love and understanding degree for biogas industry and the attitude of serving the people are the sores of ECO. The form of assessment includes written examination and interview, in which candidates' assertive attitude and passion for biogas industry are the key index assessment. Written examination involves a variety of practical case studies, and interview focuses on candidates' attitude and sincerity for engaging in biogas work, at the same time whether the candidate will be engaged in other occupations is essential assessment content, because service personnel must satisfy unemployed or unemployment condition so that they can wholeheartedly engaged in biogas career. The above condition is an essential condition for the smooth development of FSCO.

Two services content, digester in and out of raw materials and utilization of biogas slurry, are core objects of FSCO, based on the status of infrastructure such as farmers' living distribution and road to overall plan by dividing farmers into two type of service object that DT and RT. Slurry residue utilization should be supply for DT rather than material supply services due to characteristics of DT that traffic inconvenience and scattered living so that material supply services don't come true. Instead, biogas raw material supply service is necessary for RT, and slurry residue utilization can not achieve for scarce land resources.

Both selection and implementation of propaganda way and training mode are cores of CO. propaganda way changes from start optimizing propagandistic style to diversified forms such as exhibition, radio and regular multimedia. Training mode main focus for improving the quality of personnel, increasing the technology of comprehensive utilization and stimulate the enthusiasm of staff, and measures, regular lecture and material or spiritual encouragement, could be adopted.

Analysis of the Results

Initial optimization is solid foundation to ensure the sustainable use of biogas and key to global optimization, contacting with all details of global optimization. First service personnel are the builders and defenders of household digester, and are key support to get comprehensive utilization technology for farmers. Service personnel with good quality and complete assessment can perform relevant responsibilities efficiently and steadfastly, and courage to discover and innovate in Slurry residue utilization to bring economic benefits for farmers. Secondly,

The standard team who filled with enthusiasm for rural biogas career and struggle for biogas enterprise with undivided attention will be choose though ECO process. One excellent technical team is the solid foundation for rural biogas career, and the level of team personnel quality is the most direct influence factor for the vestment management with global optimization.

FSCO implement a series of follow-up service content of household biogas digesters according to the existing layout characteristics of DT and RT. Obvious profits and convenient brought by pertinent service can dissolve effectively the current psychological resistance of farmers aiming at domestic biogas follow-up service system. At the same time, according to current inhabiting features and combining current technical and economic conditions, service demands that farmers anxiously hope to obtain will be provided. Then encourage farmers to actively apply biogas comprehensive utilization technology for realizing commercialized operation of domestic biogas follow-up service.

CO can stimulate constantly farmers' enthusiasm using biogas to efficient play utilization of biogas slurry and increase economic and ecological benefits. Technical application and innovation are the main support to maintain the sustainable development of biogas career. So CO process is effective measure to prevent biogas career into the situation that "Three up and three fall".

Through four parts of the local optimization, rural biogas investment management will achieve sustainable development starting from beginning. The quality and enthusiasm of service and technical personnel selected from ECO process should be worthy of trust. Excellent service team with high quality solidly implement in turn from SO, FSCO to CO, thus rural biogas career will achieve stable, efficient and sustainable development.

The example Application

Popularizing and applying of biogas career is good prepare for others in XinDu district of Chengdu, Sichuan Province based on research results, which obtained by questionnaire and interview, and biogas service in YongAn town is the example, that its service gained better service effect. In addition there are serious problems for the operation of biogas outlet (service association) in both TaiXing and YongAn, and its operation never smooth as surface, and the crisis of collapse has appeared.

3.1 The Investment and Its Problem of Yi Tuan village Domestic Biogas

In "one up" period of our country biogas career, YiTuan village's part of farmers already started using biogas. With the situation of "Three Up, Two Fall", YiTuan village biogas construction have been entered the large-scale extension stage to comply with national energy-saving and

environmental protection policies since 2007. In domestic biogas investment respect, the government actively encourages farmers to build digester according for state regulations, while for one digester farmer only spend 400 Yuan with 500 Yuan of government subsidies to enjoy biogas convenient and practical. At the same time, the government ask town to set up rural biogas service outlets for avoiding reducing farmers' enthusiasm for all sorts of small accident appeared in use process, and for insuring digester to supply safe and stable gas.

Domestic biogas investment and construction process in XinDu village as follows: rural energy office in XinDu area determines suitable candidates for biogas service, and provide various hardware devices as well as a certain amount of start-up capitals. After the establishment of the biogas service, it belongs to the market-oriented business groups to own profits and losses. Energy office founded biogas office in TaiXing government to assist to propaganda and promote domestic biogas, also accepts users complaint concerned to biogas usage and services, so it responsible for supervision. Service station gets economic income by absorbing members to maintain the basic living standards of service personnel. At present, the realistic situation of service station is that it have recruited only one member, so its income mainly come from cost of raw materials replaced, so that the basic life needs of service personnel cannot be satisfied, and service station already face going bankrupt. This have heralded biogas career towards "Three fall" crisis. Though analyses and discussions, we found that the direct reason is the shift of focus for service workers because a man engaged in a variety of work, further analysis knowable, the most fundamental reason is biogas investment lack of global panning beginning, focused solely on the digester quantity without considering sustainable development and implementing a long-term plan, so that service station standing barely three years mess up in such difficult.

3.2 Global Optimization and Its Outlook

The best way to avoid crisis, that service station closed down, is to implement of long-term planning according with the structural system of investment management with global optimization. The responsibilities and roles of organizations (District, Township, and Organization) in global optimization is shown in Fig.2. First energy office in XinDu district response the link of ECO, and it plays a decisive role for the long-term development of household biogas. Then gas service station in Yi Tuan village should draw up follow-up services for carrying out the implementation of follow-up services. Then getting to start each work of SO, in which publicity must use the door to door way, and this will lay a good mass basis for service station and this is the most effective way to absorb member. Finally, the essential link for biogas sustainable development, CO, should be implemented.

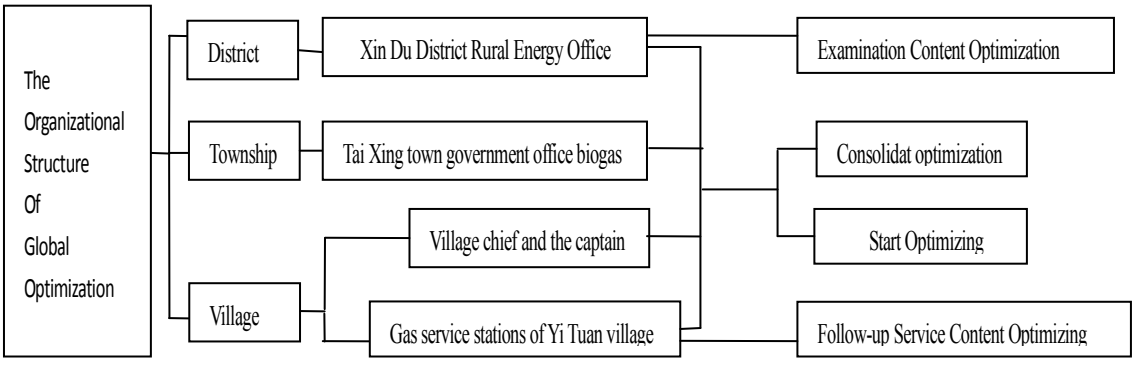

Figure.2 The Organizational Structure System of Global Optimization

Through the implementation of investment management with global optimization, service station in Yi Tuan village will never face closure crisis. ECO can guarantee to select service station staff with a certain quality and passionate, this is the key for ensure core support force. FSCO could inspect work attitude and work capacity of selected staff, and is the decisive link for smooth implementation of attracting members. Next, SO will begin to lay the basis for the masses and to attract members, and is important link for service station operation. Finally, CO could make service station more perfect in the exchange between service staffs and biogas users, make service staff actively innovate and promote quickly the efficient development of rural household biogas.

Conclusions

In current although ministry of agriculture proposed the investment model of industrial gas and established large straw digester for centralized gas supply, vast majority of rural biogas is still in the initial stage. The country's "The Twenty Five plan" expected to increase investment in rural household biogas and actively promote the comprehensive utilization of biogas. The structure system of global optimization proposed in this article based on actual research and further research can be referenced effective measure for the rural areas that have been or are about to invest implementation of household biogas. This can effectively avoid appearing drawbacks in the follow-up service, better promote the efficient and sustainable development of biogas career and enhance farmers' advocacy and favorite for using biogas.

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Sustainable Design on Urban Landscape

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Abstract. Puting forward the idea of sustainable development into the urban landscape design, it can reduce the huge pressure the urban environment suffers from, get ecological, social, economic multiple benefits. Exploring design principles and methods of sustainable landscape from land use, landscape materials, engineering technology, ecological system, maintenance and management of landscape and other aspects, then providing the reference for the healthy development of cities and urban landscape.

Introduction

The urban landscape, as an important part of city outer space, it is urban organism and an important outdoor place for human activities. At present our country city construction are developing fast, the urban environment is under huge pressure, city system between the relationship of the natural evolution and the urban development is becoming more vulnerable[1]. How humans in their roosting place to find more harmonious existence way? Only on the path of sustainable development, which is the way out of the city and the urban landscape.

The meaning of sustainable landscape design

Landscape is a wide concept, including not simply visual and aesthetic significance, but also ecological and cultural significance. Sustainable landscape is the landscape which can conserve resources, be environmentally friendly and coexist harmoniously with nature in the whole life cycl. Sustainable landscape design is based on the concept of sustainable development and principle to research, plan, design and manage the built environment and natural environment[2]. As the most influential professional groups in international landscape design, ASLA said: meeting the needs of human is based on the healthy landscape. Because landscape is a combination of life, constantly on the replacement of growth and decay. So, a healthy landscape needs to constantly regenerate. Fostering the ability of regeneration and update for health landscape, recovering the ability of regeneration and self-renewal for large numbers of destroyed landscapes, is the core content of sustainable landscape design[3].

The specific manifestation of sustainable landscape design

Saving land, improving the land usage. The land which is one of the most effective resources for human survival, especially under the background of China's large population, land resource shortage, urbanization process rapid development, the land use efficiency should be considered an important issue. The urban landscape comes into being and develops in the city land, it has a positive effect on human activities. However in the city and there are some blind construction of landscape, useless, empty without live; Some landscape covers too much area, single function; The spatial relationship among building, green space and hard place straightforward, it is largely waste of land resources.

The regenerative ability of the landscape can be protected and recovered. Sustainable landscape design is essentially a natural system based on the ability of update itself to regenerative design(Lyle． 1994). In order to satisfy people's work, production and life needs, in the urban landscape design, building the artificialization scenery is inevitable. Therefore, interfering the original land state and original natural system is also unavoidable. But through the sustainable design methods and means, can make such damage be minimal and recover the landscape has been destroyed; Following the principles of natural ecology and its beauty, for the least design to meet people's needs.

Lower maintenance cost of landscape. Landscape is composed by a lot of natural elements, and their formation have a natural growth process; At the same time only human's consumptions and using on place are maintained can landscape last for long. Maintaining the landscape is management process of the sustainable development concept of the natural environment and built environment. Through effectively designing the relevant factors of landscape and adding appropriate management concept and method, to make the playground resources realize itself virtuous cycle, so as to achieve the purpose of reducing maintenance cost.

Taking ecological, social, economic multiple benefits into account. A sustainable landscape is ecological health, economy saving, good for people of the cultural experience and human development landscape (including education open, aesthetic, place feeling, equality, self consciousness of people in the natural system)[3]. With China's national conditions, the government also often hope that through the landscape development and construction, driving around the block to develop. For example business tourist area planning in urban landscape, in order to achieve a certain management benefit, the building capacity to be more, the environment to be more better; And in order to achieve the tourism and business to promote each other, it is self-evident important to focus on the ecological, cultural landscape planning and design.

The principles and methods of sustainable landscape design

The high efficiency of land use. It Mainly refers to realize the multifunction landscape space in the limited land area, the space which set up can be effectively used, positively affect on the whole human settlement environment, so as to improve and enhance the quality of survival. We can do from the following aspects:

•The effective control of land use. Firstly we argue it in the scope of landscape project land. This will involve relevant construction management department, from the geographical environment, resources protection, regional population, social undertaking, economic development to demonstrate the rationality and value of landscape projects. So on the one hand save the land, on the other hand have a direct impact on the landscape quality of late site. Secondly, we should deal with the relationship between buildings and environment. The important problem of site design in

urban landscape that solved is the relation between building and environment. Building built what position within the field, the decision has an important influence on the every back step. In deciding how to let a new building construction adapt to the environment, we must comprehensively consider the sunshine environment, wind environment, ecological environment (vegetation, wetland, permeable level ground), etc. Finally, building three-dimensional city space use mode. At the same time deal with the relationship between buildings and environment, considering three-dimensional landscape environment, to make the site of the best quality, highest space utilization.

•Human use the site efficiently. We can consider it from the following several aspects: Firstly, there are activities which attractive people. A place with life, culture, exciting activities, naturally it will attract people to go. Thus, it is easy to realize the venue's value, build cost-effectively; The city's vitality can be shown up to a certain extent by the citizens' activities. Secondly, the accessibility of landscape place.Through the project the earlier investigation argument, make the landscape build in a suitable location; Through the reasonable allocation of transportation, public facilities and sign system, make certain area resident space form a organic whole, so as to ensure the landscape space accessibility and readability. Finally, the appropriate scale of the site. In a particular external space, the scale of the site needs further design to optimize. Yoshinobu Ashihara said that: the so-called external space form was to make the great city for human scale, divide or revert the "big space" into "small space", the technology which makes the space rich full of the milk of human kindness[4]. The feeling of landscape space empty without marginal makes the person produce the alienation, couldn't stay down. According to the different psychological need, in the external landscape space, it not only needs to have open space of a great scale, but also needs to have little space of relatively private. The diversity and richness of space scale in specific places can meet the different needs of people, which greatly improves the utilization rate.

Rationality of landscape materials and engineering technology applications

A reasonable use of landscape of the hard material and materials, mainly reflect in the following aspects: First, control hard landscape especially the proportion of hard pavement and green space. Secondly, to hard landscape we can mostly intersperse permeable material with green to provide the activities venue .Finally, achieve real green rate. That is controlling the amount of lawn, with trees, shrubs to realize green stereo. Using shade trees to hide sun and wind, form a pleasant micro-climate inside area.

Effective utilization of water resources and protection. In all about the material and on the sustainable use of energy, water saving is the key issue about landscape design that designer must be currently cared about, which also can play a unique role in the landscape design. At present in China, water used in urban landscape mainly is the traditional artificial surface irrigation. In sustainable landscape planning and design, groundwater, surface water and rainwater collection should be carried on the design of system. It shows in the following respects: the use of water, rainwater collection system planning and design, water purification through wetlands system, the use of water-saving irrigation system, division grade of water resource to different use in the environment. So it meet the urban landscape ornamental water and save and protect water resource at the same time. As fig.1 shows a field of constructed wetland system, which enable to realize the rain collection and water purification through the vertical design, the plants and the set of filling bed .

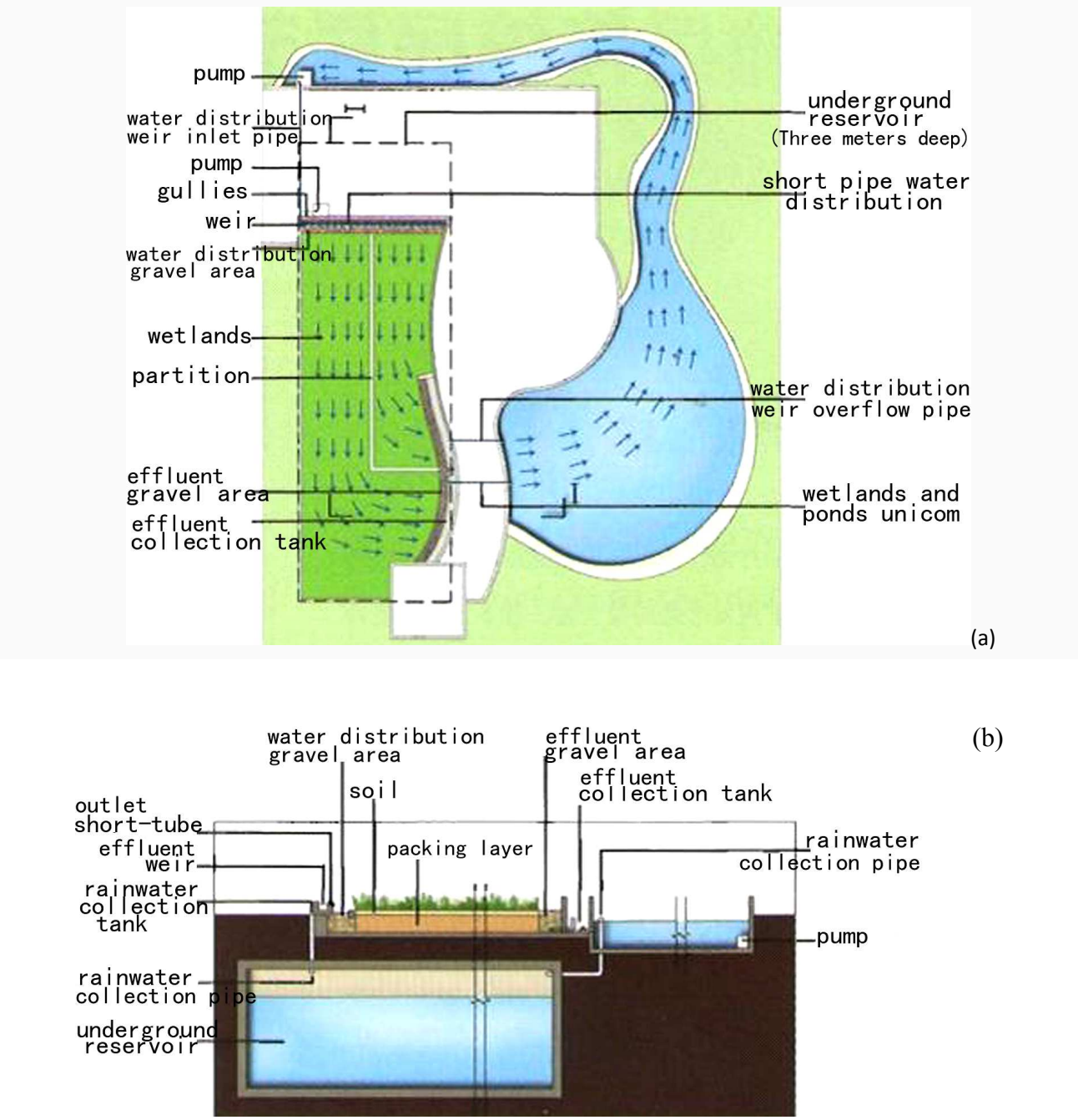

Fig.1 Ecological wetland operation system signal (a) wetland system layout (b) cross-section expansion plan of the wetland system[5].

Protect and build a perfect ecosystem

•Nature ecology. Landscape as an ecosystem or the the aggregate number of ecosystems, its sustainability is influenced by many factors, such as ecological system in the diversity of species or not, the people influence etc. The relevant principles of landscape ecology provide reference for the design for us to protect and construct ecology system. Such as we have to respect the original topography, prevail circumstances, protect the exist species and other available resource; To add corridor, increase landscape connection degree so to strengthen the contact of landscape elements in function and ecological process. Particularly for water corridor and n corridor, their planning not only can help improve the road and ecological environment quality but also can connect each landscape plaques to realize the penetration and connection of material in or out of space.

•Culture and social ecology. Sustainability involves not only the natural ecological, but also a cultural ecological and social concepts. In the process of human influence, sustainable landscape reflects the value of cultural heritage and the preservation of human history and culture heritage; Reflects the saving and cherishing of human social assets. Creates a place having a sense of belonging and identify; Provides education and interpretation system about sustainable landscapes to improve the land and the environment on human ethics.[3] Urban landscape within culture and social ecology can cause environmental and spiritual interaction, can improve people's life, happiness, safety, attribution laning improvpeople's life, happiness, security, ownership and other perceptual parameters, and to promote the relationship between man and nature in harmony.

Emphasis on landscape maintenance and management

• Consider post-maintenance landscape design elements. Using the growth characteristics of the landscape allocate plant, use and manage water. As far as possible to plant trees, special local trees, achieve a certain degree of mixed species, pay attention the match of trees, shrubs and herbaceous plants. Lawn should be planted trampling grass, be reduced plants need for plastic. During the water landscape design, we should pay attention to design water shape and size according to the base situation, elegant water cycle and system to reduce the maintenance cost later.

• Sustainable landscape use. Through the use of the landscape and experience to educate the public, to promote advocate sustainable environmental ethics; Using the necessary public facilities, signs and banners remind the public behavior standards, so as to reduce the man-made destruction of public landscape.

• Integrate into the operating philosophy of the site layout. At present, designer in China has considered to add some consumption activities project combination of green space, such as sports grounds, game entertainment facilities, sales and etc ate the beginning of designing. It not only satisfies the demand of different crowd activity, at the same time as the site of the later maintenance and operation management to provide the necessary support costs.

Conclusions

Relevant practitioners use the concept of sustainable development and principle to research, plan, design and manage artificial and natural environment, which can make urban landscape develop from the level of professional practice to the sustainable direction. Meanwhile, we should make the public set up sustainable environmental consciousness through a wide range of guidance. Through the top-down whole understanding and practice, the city and the urban landscape sustainable way will go more health and long.

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Study on Calculation of Ecological Footprint Model Parameters of Beijing Urban Water Resources

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Abstract: The conception and study status of ecological footprint of water resource were summarized and the research of two ecological footprint model parameters, ie equilibrium factors and yield factors were analyzed and compared. On this basis, the calculation of ecological footprint model parameters of the Beijing urban water resources, ie balance factor and yield factor were proposed. Water balance factors of Beijing urban water resources and water yield per unit area and water yield factor of Beijing Fangshan, Pinggu, Yanqing were calculated, thus provide reference for appraisal of ecological carrying capacity of Beijing urban water resources.

Introduction

In current ecological footprint model, the interpretation of water resources only take into account the production function of water biological which is represented by fishing industry, without considering water consumption and its ecological regulation functions, therefore can not fully reflect the full content of water resources in urban development. Water biological production function is part of the water resources function, water consumption of human production and living and environmental regulatory function of water resources play a more important role in the social and economic development.

Water ecological footprint refers to the land area in a certain area which can provide human water consumption and absorb the necessary water pollution, including the ecological footprint of domestic water, ecological footprint of production water and ecological footprint of ecological water. In the calculation process, the consumption of water resources converted into the corresponding land area according to certain rules, in order to achieve unified foundation with other kinds of composed measures. According to the regional water cycle approach, although water land outlines other types of lands in space, due to its own characteristics of water resources, the overlap of water land and various types of land will not have impact on other land function, so this will not contradict with the promise of mutually exclusive of ecological footprint model. Therefore, after we converted water into water land, such land will be treated as "virtual land" (shown in Figure 1-1).Such land plays a true production function, but do not take up actual land area.

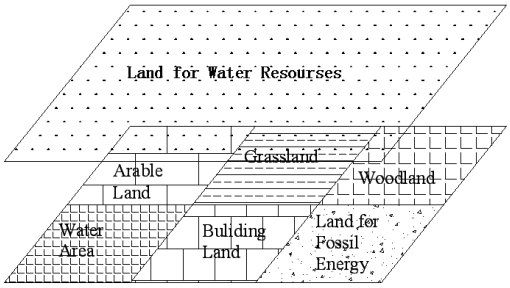

Fig.1-1 The land styles of ecological footprint

Research and Development Status of Ecological Footprint of Water Resources

Xiaoqiu Fan conducted a systematic study on the ecological footprint water resources, in the research water consumption was divided into living, production and agricultural water. At the same time, apart from the six categories of bio-productive land established Class 7 land types, namely