論文の内容の要旨

Abstract of Dissertation

SELF-SUFFICIENT SUSTAINABLE URBAN FABRIC
integrating vernacular design concept for modern planning

自立した持続可能な都市の形成
近代的な計画のための伝統的なデザインコンセプトの統合

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(Purpose)

The current experiment is about how we can have vernacular ventilation for energy saving strategies and make a city sustainable. The main goal by this experiment is to focus on environmental pollutions and have it under control through energy saving methods. For that a city is considered where all solutions suggested in this experiment will be tested and decided. As any sustainable practice is unique in its terms and conditions, the project is required to be tested in a real city to exactly know about its feasibility. The case study that is used in here is Hashtgerd New Town located in Iran. The method proposed could be utilized in residential buildings up to 3 floors. To better know how the suggested system works a model house is simulated to clearly show what happens in interiors after such installation is used. The final goal by this project is to renovate residential areas in a sustainable way. By making proper use of natural ventilation an awesome amount of energy is saved.

By suggested system usage provided the temperature will be lowered to 22C° in interior spaces and will also make outstanding rate of energy save. It all indicates that for having a sustainable strategy in our cities, starting from energy saving methods brings about best results in developing countries. The current system suggested in this experiment extremely depends on water and wind and lack of water in such areas is a national endurance. The project is necessary to be integrated for the absence of sustainability in new architecture design of Iranian cities. While in ancient times Wind-Catchers [Funnel or Bãdgir in Persian] were vastly used all over in Iran and could also make their way into nearby countries, there are unfortunately no good solutions for modern time in Iran. To improve life environment in modern cities the current system is suggested. It will be displayed that it could make the city sustainable and economically self-sufficient.

(Traditional funnels malfunction)

As a vernacular ventilating system the funnel performance fluently cools down the building air to good extent without use of electrical energy. It's important to know that traditional Wind-Catcher performance has some defects that may cause malfunction. As the suggested system by this experiment strongly depends on use of funnels, the most significant disadvantages are listed as the following;

1. In traditional funnels the temperature of the air entered to the building through the drafty is almost equal to ambient temperature outside.
2. The only effective factor to lower the temperature in funnels is low night temperature that flashes to the exterior walls toward the sky.
3. Because of limited building materials in funnel structure, the storage of energy has significant limitations and due to the transfer of high temperatures air, this reserve energy is consumed shortly.
4. In wind speed is about zero Wind-Catchers cannot supply the air amount needed for comfort of people.

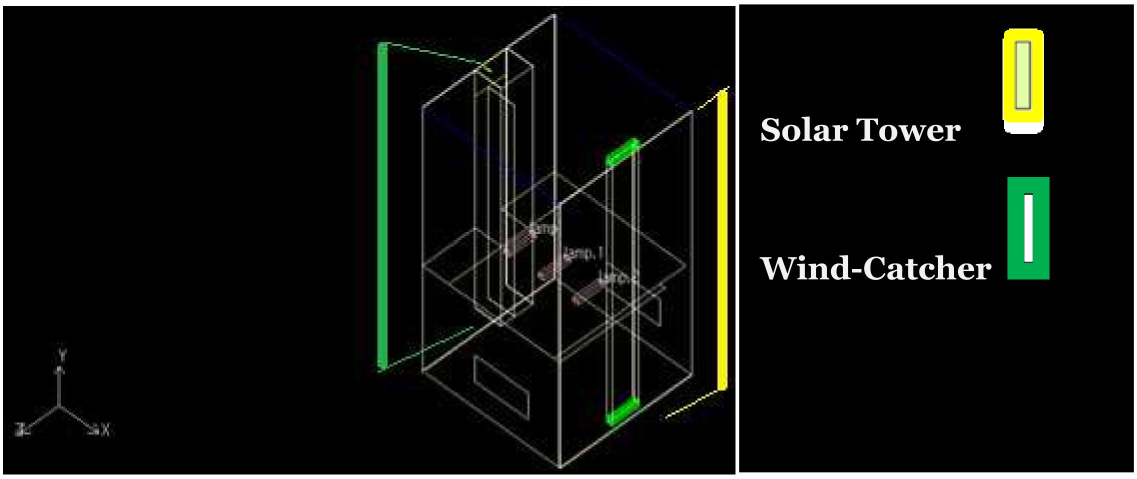
(The suggested system)

With construction of Double-skin walls and use of solar tower the automatic blow of the air will consequently happen in the building. Inside the funnel for a negative buoyancy, (cold and heavy weather) air moves down and in double-skin wall of solar tower because of warm air, positive buoyancy will be made to move the air up. By placing suitable humidifier faculty in the port of air entry into the funnel a pleasant atmosphere is created inside by proper temperature and humidity. Construction materials to be used are adobe bricks, clay, plaster and wood. Regional wood has high epithet of good resistance. The sun exposure makes the air in the solar tower warm and eventually suction is created to outside space. Such system can be even on process in absence of wind in the area. Also in the funnel the showering procedure makes the air a little heavy and as a result it moves down. By this we can force the air move in desirable direction without use of any electrical appliance.

Now the question is; how water can move that high for moisturizing the tower duct for entering wind? The method used in here would be through use of Commuting Vessels Law. Hashtgerd NT has good topographic potentials for optimum use of land altitude. For every block of buildings a water pond is suggested for flooding wind-towers on lower altitude. By increase of water injection the temperature decreases until a glut amount is achieved so in this case more water will not be wasted through evaporation procedure. This effect alone can help a huge save of water in the tower. On the other hand inside solar chimney because of sun exposure to the interior wall and passage of it through the tower hot air moves up and works like a fan.

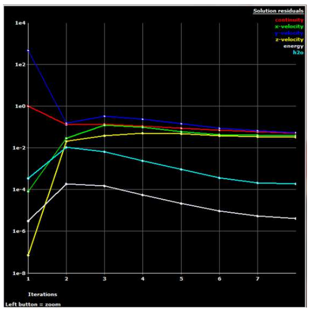
(The model house simulation with funnel)

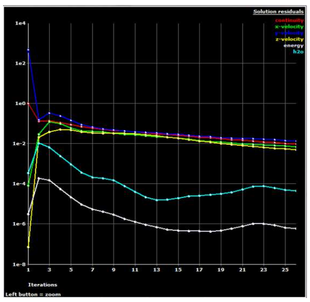
For better simulation it is needed to consider some portable elements in the model house for making more accurate simulation and understanding of the air circulating behavior in the space. In the room some very popular household items are also determined that in thermal simulation are also considered. The following figure shows the model house presented by FLUENT software. Solar Tower and Wind-Catcher with common furniture are used.

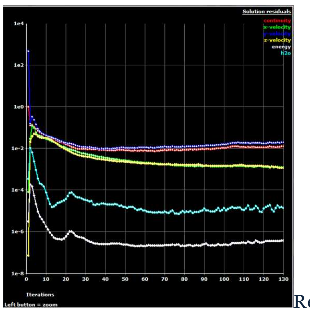


Isometric view of the model house

Right after the system starts to work, temperature and wind in the model house show significant alteration. The best time to clearly verify its condition in the area is 20min after when the system starts to operate. The following figures display the effect of ventilation and temperature diversities on furniture and people in the space.

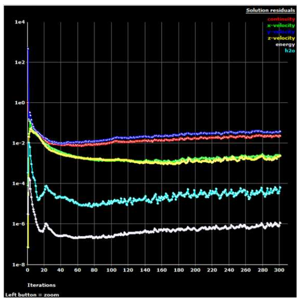




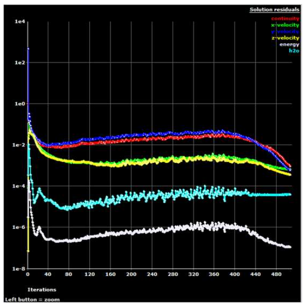


Residuals simulation- 5 min after use   Residuals simulation- 10 min after use

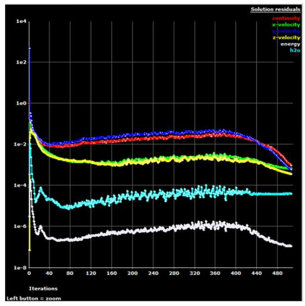
Residuals simulation- 15 min after use



Residuals simulation- 20 min after use



Residuals simulation- 25 min after use



Residuals simulation-25 min after use

The system suggested in here is tested for Hashtgerd city to figure out if the place can become sustainable by this model. By EMS method it was shown that the city can become economically self-sufficient and it's now time to figure it out if the place is also sustainable or not? It is proposed to be used in Hashtgerd NT new buildings. It also declares the temperature can be lowered up to 22℃in the building while the outside temperature is around 40℃. The system suggested here can be successfully used in residential buildings up to 3 floors. The level of comfort and amount of air transferred stands out at an acceptable level to show all vital standard acquired in any sustainable development. By using FLUENT software we elicit the fact that the system lowers the temperature below ambient and can make the city self-sufficient. It will be time to verify if by using the system the city can also become sustainable?

(TOPSIS modeling of the case study)

We have u methodologies as our alternatives [A_1, A_2, . . . , A_u] for making vernacular ventilation. On the other hand we need some methodologies that are shown as S_{ij}. The Ideal point or satisfactory ratio considered lies within the domain that will be latterly calculated. We need it for preparing the matrix that is followed however before that we need to determine the criteria elements alongside with possible alternatives. The main concept in this project has is to figure out best methodology to make sustainable urbanity by vernacular architecture. The alternatives used are as follows;

1. Construction price
2. Lifetime and validity period
3. Organic and nonorganic materials
4. Emissions rate

5. Space occupation
6. Aesthetical views and architectural design method
7. Comfort coefficient obtained
8. Temperature difference observed
9. Ecological considerations
10. Maintenance and rehabilitation costs and overhead expenditure

Now it is needed to normalize the numbers as the following. The alternatives in TOPSIS method are normalized by the following formula[1];

$$j= \qquad i \in [1,2,..,u] \; , \; j \in [1,2,..,v]$$

Beyond it we should also notify the Ideal Point and Anti-ideal Point for further calculations. We can even consider them as Positive Ideal Solution and Negative Ideal Solution that could be defined as the following;

$$A^{+}= \qquad , \; i \in [1,2,..,u] \; , \; J$$

$$A^{-}= \qquad , \; i \in [1,2,..,u] \; , \; J$$

For interior options the method to calculate is as is followed;

1 Čupić, M., and Suknović, M., Multicriteria decision making: formal access, Faculty of Organization Science, Belgrade, 2003.

$D_i^+ =$, $D_i^- =$ $i \in [1,2,..,u]$

The operations up to here will produce the scrambled index that needs to be sorted. Moreover a relative closeness coefficient or an initial D_i is needed to determine the correct order of all attained points. To precisely determine the relative closeness coefficient D^+_i and D^-_i are also needed for each point that was previously shown as D_{ij}. They are all calculated as the following;

$D_i^+ =$, $D_i^- =$ $i \in [1,2,..,u]$

To verify which amount stands out to be the answer or not the following consideration should be taken into granted. If we show the final result as R_i it will be extracted from the table as below;

$R_i =$; $i \in [1,2,..,u]$, $D_i^+ \neq 0 \Rightarrow (R_i \rightarrow 0 \text{ if } D_i^- = 0)$, $D_i^- \neq 0 \Rightarrow (R_i \rightarrow 1 \text{ if } D_i^+ = 0)$

However in most cases the result or R_i is an amount between [0,1]. Now we have all is needed to make the allocation table. By implementing the so-mentioned method on real data we would get the following results that clearly partially show the sustainable situation in Hashtgerd NT. The final results based on the mathematical method explained for Hashtgerd can be accurately obtained. The results are displayed in the following table. From this table we can finally understand whether Hashtgerd NT is a sustainable city after using vernacular ventilation or not? The details of the table are explained in the following page.

Index	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
Crit.	1	2	3	4	5	6	7	8	9	10
Alternative	9	7	5	8	7	4	6	5	7	9
Type	Max	Max	Min	Max	Max	Min	Max	Min	Max	Max
Benefit	0.136	0.106	0.078	0.121	0.106	0.070	0.095	0.078	0.106	0.136
Hashtgerd ratio	[0.31, 0.37]	[0.33, 0.38]	[0.12, 0.17]	[0.8, 0.97]	[0.33, 0.38]	[0.1, 0.14]	[0.38, 0.47]	[0.12, 0.17]	[0.33, 0.38]	[0.31, 0.37]
Variables	A+=[0,9.1]		A−=[0,0.1]		Di+=1.789		Di−=1.33		Ri=0.5245	

Data Analysis Modeling Table

Considering the table above we find out C_4 represents a number a lot different and is considered as unwanted criterion. By omitting it we can obtain D^+ as is deducted from the amount above.

Where i = 1.877 ∈S6, Di− = .65 Ri = .25, i∈C_6 is FANTASTIC quantity & Acceptable

The above numbers based on TOPSIS method of analyzing numbers will clearly indicate that Hashtgerd city can be considered as a sustainable urbanity from vernacular architecture methods. R_i that is illustrated above indicates the closest criteria to A^+ as our Ideal alternative. So we should consider the weights which are assigned have to address methodologies for sustainable planning, for development of new urban fabric or for documentations of infrastructure manuals. Possibilities of integrated planning and infrastructure development to increase energy-efficiency depend on many factors that can be added to the alternatives considered in here. However natural ventilation alone methodologies could bring about favorable urban comfort. Iran’s ethnic architecture has good solutions that if they are efficiently used can make all areas a kind of sustainable unity.