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Effects of Temperature Fluctuation and Air Aridity on Architecture

(Case Study: Dastkand Village Located at Kerman Province)

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ABSTRACT: Constructed upon a height (by footing) or breaking in to the ground, in a building, making a close relation between earth and soil is of great importance. In addition, earth as a prior factor in creation of a shade and residence, plays a crucial role in architecture history. Throughout the different area, earth is paid attention differently: as a source of cool (in China), a source of heat (Cappadocia, Turkey), and conversely as an offensive source in Amazon forests. In hot-arid climates, proximity to earth is useful to apply the heat in the buildings. Present study aims to investigate the mentioned factor in Dastkand village located at Kerman province. Mountainous moderate climate, cold and icy winters and moderate summers is of the considerable properties of the studied area. The maximum and minimum temperature was recorded, 42 and -18° C during summer and winter, respectively. Hence, in addition to cultural as well as economic factors, temperature fluctuation played a key role in breaking the buildings in to the ground. So, this study assists to investigate the studied area within natural bed, in plan and section. On this basis, technical methods of earth profiting throughout the studied area have been investigated, in order to profit earth in modern architecture. Results showed a harmony between dominant winds and buildings in winter and summer. Moreover, profiting from high sun shining with special architecture is of Meymand village characteristic. Using breaking in to the ground technique, 26.57 % decrease occurred in cooling need, annually. On the other hand, Day-Degree heating need has reduced to approximately 13.65 % annually solely by earth profiting technique. Overall, results demonstrate a harmony between applied technique and the studied region climate. Besides, there reported a proper isotropy between temperature fluctuation and air aridity throughout the region.

Keywords: *Climatic architecture; Local architecture; Meymand village; Kerman province; Materials; Earth-profiting*.

INTRODUCTION

Dwelling protects the human beings in front of natural accidents, cold and hot weather, so that directly related to climate. Accessing to fossil fuel, no attention paid to climate conditions, no more. So that energy, and fuel consumption applied to heating and cooling increased (Malek Hosseini and Maleki, 2010). Sustainable design basics suggest architects and engineers to achieve mentioned aim profiting local architecture techniques, and integrating opinions with modern material and methods (Nemati, 2011). According to experts, one can understand that sustainable architecture, as a part of sustainable design is a logic approach to the difficulties of the industry age. In addition, like as the other section of architecture science, sustainable architecture is also composed of some particular principles, (equipped to special strategies) including:
Save the sources;
Design for return to life cycle;
Design for human beings;
Studying provinces located at plains; such as Yazd, Kerman and Kashan demonstrate a remarkable harmony between modern findings in architecture and structural characteristics of historic and traditional sections of the studied regions. Besides, this success was recorded through a long process of try and errors occurred during construction of municipal texture and buildings (Mellat Parast, 2009). Antecedent civilizations architecture not only exhibits the culture, but also discovers effective notes regarding created places. In other words, these studies show a remarkable relation between architecture and the place. In addition, earth as principle place and mother of needed materials in local architecture play crucial role in creation of these techniques. (Barzegar, 2010). Meymand village, with 3000 years historic antecedent, is the sole village where traditional life and correlation between human and nature in second millennium flows. Studied region was recorded because of natural-cultural and historic position and won the Mercury awards. Throughout the studied area, no building was constructing in an open and void, i.e., every construction were broken in to the ground, and no material were applied (Fig. 1). Having 150 sunny days, Kerman province highly profit of sun light (Table 1). On the other hand, despite of profiting of sun shining in winter and enjoy from thermal welfare, there exit no sign of offensive shining of summer. On this basis, present study aims to investigate feasibility study of profiting the applied methods in modern architecture using analysis the weather data and architecture of the region.

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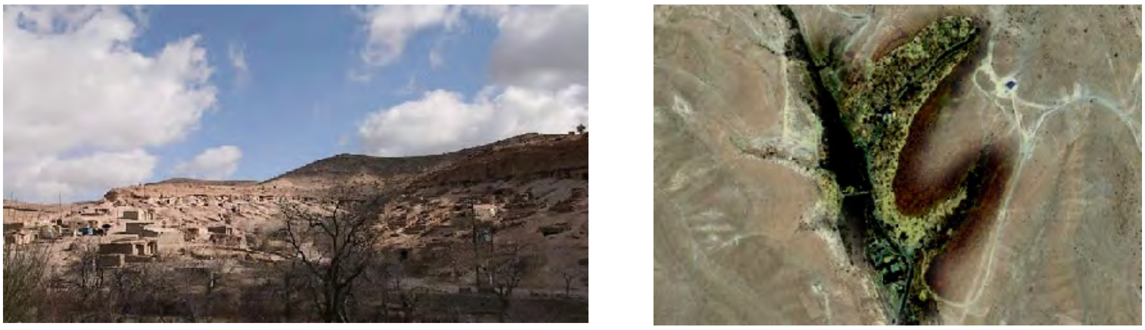

Fig. 1: Architecture in the earth

Table 1: Sunny hours, different months in Dastkand village 2009-2010 (Source: Iran Meteorological Organization, 2012)

	April	May	June	July	August	September	October	November	December	January	February	March	Monthly Average
monthly Sunny hours	373.1	347.4	344.8	365	305.5	308.3	212	217.4	213.8	213.8	263	274.9	293.5

MATERIALS AND METHODS

Earth-Profiting in Hot-Arid Climate

Earth appeared various characteristic in different area: as a source of cool (in China), a source of heat (Capadusika, Turkey), and conversely as an offensive source in Amazon forests. Hence, either upon earth or under earth, human beings apply this natural element in different manner; such as that occurs in architecture. Present study discusses these techniques in hot-arid area (Barzegar, 2010) (Fig. 2).

Advantages of breaking in to the ground strategy throughout the hot-arid regions are remarkable. Soil mass prevent high temperature in the studied climate. At the deep points of earth, temperature was recorded close to annually mean temperature. Soil is cool enough to absorb the heat during summer days. Under ground is a cool place in hot months where inhabitants of a building waste lots of time there (Crouch, 2001). These building reduce the heat by earth temperature (Talib, 1989). Compared to the building constructed on the ground, a building located at 2 m underground, from -2 °C to very hot weather, is a more pleasant resident whether in winter or summer.

Climatic Position of Meymand Village

According to experts and inhabitants, Meymand in definition includes different meanings:

Some ones believe that Meymand composed of two words: Mey (wine) and Mand (drunkenness)

Others believe that extracted from Meymanat and Mobaraki (happiness), this word is of lucky.

Meanwhile, some other think that the inhabitants of the studied region immigrated from Meymand region located at Fars province.

Having hot-arid weather (according to climate division of Iran), located at 38 km eastern north of Shahrbabak Province, 30°

Fig. 2: Architecture in the earth

Table 2: Advantages and disadvantages of locating building in the earth in the hot and dry climate

Disadvantages	Advantages
Lack enough light in all spaces	Soil prevent high temperature
Impossibility design of spaces with ideal order	Solid as a thermal mass
Impossibility design of spaces with ideal dimension	Reduce of building's temperature fluctuation
-------	The use of indigenous materials and durability

16Êlatitude and 55° 25Ê longitude. Height above sea and total area were calculated as 2240 m and 420 km^2, respectively. Annually rain was estimated 185mm. temperature fluctuation during days and nights was sometimes recorded 30 °C (Iran Meteorological Organization, 2012). Cold winters and relative hot summers are of the characteristic of the area. In a common limit of plain and mountain, studied area located in a distance from Shahrbabak and Meymand. Recently, pistachio and almond trees covered the region. Seasonal rivers and ditches, as well as springs were observed throughout the area and environ which greatly improve the agriculture prosperity. Along with other natural effects, agriculture play crucial role in the area.

Construction of a shelter in semi hot-arid and hot arid regions confront with lots of problems because of high temperature as well as dry air, so that following strategies is to be noted to supply thermal welfare.

RESULTS AND DISCUSSION

Good Orientation Exposed to Wind and Sun Shining Installation of Proper Openings

As shown in Figs. 3 and 5, due to the studied area orientation exposed to dominant wind, building orientation is appropriate during winter and summer. Offensive heat of summer could be bearable only by being exposed to cool wind. Hence, installing the openings exposed to live and cool wind, which blows from southern west. On this basis, the whole village as well as all the openings orientation, prepares thermal welfare. On the other hand, dominant and cold wind in winter accelerates aridity and cold weather, moving from northern east to the residence. Applied strategies play great role in reduce of undesired climatic effects. Second climatic property is high sunlight, which was reduced remarkably thru proper orientation. Dominant orientation of the region was reported from southern east-South to southern west, which is the most appropriate orientation. In summer, vertical sun shining does not penetrate into openings, however, needed light is supplied. In contrast, in winter vertical light entirely penetrate into the building and warm the area (Fig. 4 and 5).

Relation between Weather and Cavernous Architecture Cooling Needed for Buildings Breaking in to the Ground

As maximum heat during hot summer has been calculated 38 °C, cooling the interior area is of higher priority for Meymand village. According to Sadeqi Roshan (2009), summer welfare temperature is 21.7-28 °C. Supposing mean temperature as 25 °C, Day-Degree cooling required for each month and year constructed upon earth is determined for the buildings. However, earth temperature at 2m depth was equal to annual mean of the studied area. Hence, supposing the maximum temperature as 28.6 °C during summer required cooling for the buildings at the 2m depth was determined. Upon the calculation, method for Day-degree cooling required for the Meymand village, results showed 26.57 percent annual

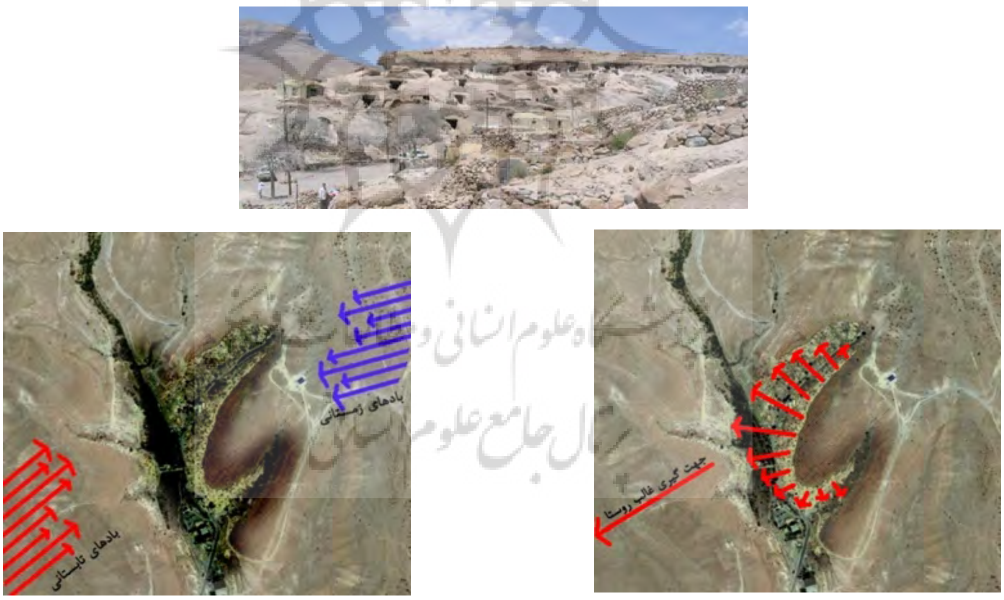

Fig. 3: Building orientation in Meymand, Kerman
Right: Building orientation,
Left: Prevailing wind in summer and winter

Table 3: Monthly prevailing wind in Meymand village (2009-2010)(Source: Iran Meteorological Organization, 2012)

	April	May	June	July	August	September	October	November	December	January	February	March	Monthly Average
monthly Prevailing Wind	260	270	360	20	360	20	240	270	210	210	360	274.9	240

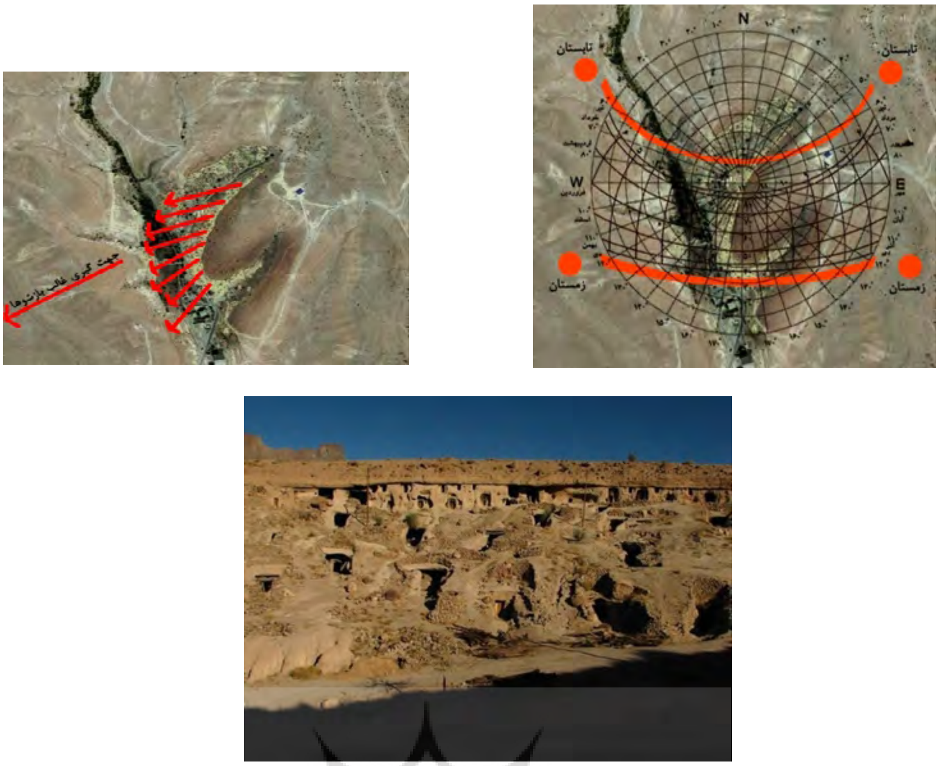

Fig. 4: Right: Sun radiation's position on settlements, Middle: Openings of the village Meymand, Left: The dominant orientation of window

decrease profiting from breaking in to the ground technique. Just during June, about 36.15 % decrease in cool energy consumption appeared using applied strategies (Table 4 and Fig. 6)

Heating System in the Buildings Broken in to Ground

Despite of very hot summers, winters pass so cold, so that minimum temperature was recorded – 3.4 °C and last for 6 months during October to march, in the study area, Therefore, heat preparation especially during nights is essential and need lots of energy. Maximum monthly Day-Degree heat occurs in February. Moreover, annual Day-Degree heat need calculated as 4506, which is so high. However, cave buildings were constructed using particular strategy (profiting earth), in which each building profit from stone body' heat. Therefore, Day-Degree heating need decrease to 13.65 %; and 3891, annually. Maximum decrease of Day-Degree needed for these buildings is 17.95 %, which clearly demonstrate efficiency applied technique in the studied climate.

Daily Temperature Fluctuation of the Buildings Broken in to Ground

In hot-arid weather, temperature fluctuation is too high which often reach to 30 °C. Undesired effects are of the effects of hot days and cold nights. Throughout the studied area, this factor has been recorded 25 °C at 2009 (Table 6). The mentioned climatic property entirely control the buildings constructed on the ground, whereas there reported no problem

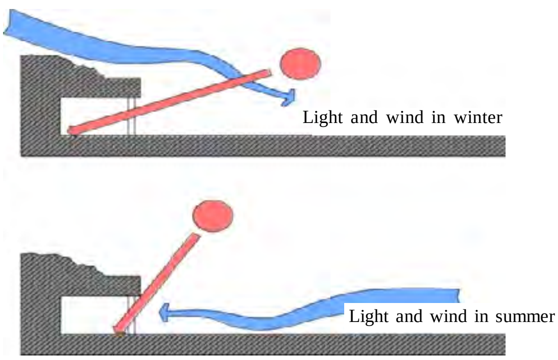

Fig. 5: Opening placement in summer and winter wind and radiation

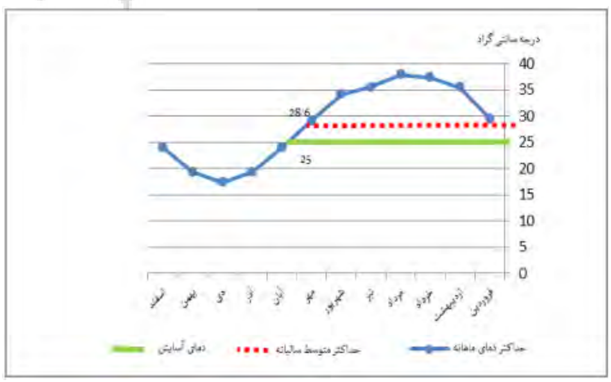

Fig. 6: The savings in heating degree days required in Meymand village with placement techniques in the earth (2009-2010)

Table 4: The amount of cooling required in Meymand (2009-2010)

	Unit	April	May	June	July	August	September	October	November	December	January	February	March	Annual Average
Monthly maximum temperature	Centigrade	29.6	35.5	37.4	38	35.6	34.2	29.2	24	19.4	17.4	19.4	24	28.6
Cooling degree days required level of comfort temperature at the Earth's surface	Cooling degree days	138	315	372	390	318	276	126	-	-	-	-	-	1935
Temperature adjustments	Centigrade	29.1	32.05	33	33.3	32.1	31.4	28.9	-	-	-	-	-	
Cooling degree days required level of comfort temperature at a depth of 2 meters	Cooling degree days	123	211.5	240	249	213	192	117	-	-	-	-	-	1345.5
Reduce the need for cooling in the deep Earth to the surface	Percent	10.87	32.86	35.48	36.15	33.02	30.44	7.14	-	-	-	-	-	26.57

Table 5: Average monthly maximum and minimum temperatures Meymand village 2009-2010

	Unit	April	May	June	July	August	September	October	November	December	January	February	March	Annual Average
The average monthly minimum temperature	Centigrade	7.7	11.5	15.1	18.6	15.7	13.7	5.7	1.6	-0.9	-2.6	-3.4	-0.6	6.8
Heating degree days required level of comfort in the surface temperature	Heating degree days	-	-	-	-	-	-	579	702	777	828	852	768	4506
Temperature adjustments	Centigrade	-	-	-	-	-	-	6.25	4.2	2.95	2.1	1.7	3.1	3.383333
Heating degree days required level of comfort temperature at a depth of 2 meters	Heating degree days	-	-	-	-	-	-	562.5	624	661.5	687	699	657	3891
Reduce the need for heating in the deep Earth to the surface	Percent	-	-	-	-	-	-	2.85	11.11	14.86	17.03	17.96	14.45	13.65

Table 6: The average monthly temperature fluctuations Meymand village 2009-2010 (Centigrade)(Source: Iran Meteorological Organization, 2012)

	April	May	June	July	August	September	October	November	December	January	February	March	Monthly Average
The average monthly temperature fluctuations	12	18	15	25	21	12	23	19	23	20	17	20	18.6

Table 7: Average maximum and minimum humidity Meymand village 2009-2010 (Percent) (Source: Iran Meteorological Organization, 2012)

	April	May	June	July	August	September	October	November	December	January	February	March	Monthly Average
Average maximum humidity	42	31	25	23	23	32	47	80	79	80	75	51	49
Average minimum humidity	42	31	25	23	23	32	47	80	79	80	75	51	49

for that buildings broken in to the ground. The main reason is for such thermal welfare low fluctuation of temperature at depth of earth. Hence, one can say understand that making contact between the building structure and depth of earth is remarkably decrease need for heating and cooling.

Relation between Arid Weather and Cavernous Architecture

Although, there reported humidity to some extent at the depth of earth, and water exited in the building body, increased the relative humidity of interior area, but aridity is too high and is of the crucial characteristic of the studied climate; so that during June and July, it reaches to 8%.

CONCLUSION

Present study could not express all advantages of construction the buildings at the depth of earth throughout the hot- arid area. In this area, soil mass perform as effective barrier in front of high temperature. At earth depth, normal heat is usually close to annual mean temperature. Soil is relatively cool and plays a great role as heat absorber during summer hot days. Underground supplies cool air during summer where inhabitants prefer to spend time there. This study assists to investigate *Dastkand village* located at Kerman using earth profiting technology. Therefore, considering location of residence, as well as various parameters, including, climate, cool, heat, aridity, and temperature fluctuation, following results were gained:

Building orientation during winter and summer was proper due to well location of habitants exposed to dominant winds.

Offensive heat during summer could be bearable just through cool winds. For this reason, in buildings construction, openings were tried to be installed exposed to winds blow from south-west. Beside, during winter, dominant and cold wind, move from mountain to the habitant. However, openings appropriate orientation cause to reduce the undesired climatic influences.

Second climatic characteristic is high sun shining, normalized throughout the studied region using proper orientation. Dominant orientation throughout the whole village is from southern east-South to southern west which is the most suggested.

According to calculation Day-Degree cool needed for the area, results showed a 26.57 % annual decrease profiting earth depth for building construction. Just during June, about 36.15 % decrease was reported in cooling consumption.

Cavernous buildings decreased thermal consumption about 13.65 % profiting stony body' heat. Maximum Day-Degree needed heating, showed 17.95 % decrease.

Another offensive climatic problem is temperature fluctuation solved in cave buildings.

On the other hand, aridity is too high and during June and July reach to 8% and sufficient humidity penetrates to the interior area through the building body.

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