Influence of climate in building design, Tropical climate, Climatic Orientation

The effect of climate factors on human constructions, building and design has long been considered so much so that in the traditional architecture and new civil engineering, this issue has been accounted for according to the available facilities and information. Considering climate factors registered based on long-term climate data is essential in designing and building construction in different locations so as to assimilate with the region's climate and minimize the potential adverse effects and also to optimize the climate potentials. There have been many studies on designing buildings consistent with climate among which we can refer to. But the effect of all climate parameters on building design and civil operations has never been analysed altogether briefly.

This lecture attempts to refer to the most important climate factors affecting in the field and analysed their roles. Also, there has never been any study on the use of weather conditions in near future about the adjustment of civil operations especially on weather and climate disasters like flood, heavy rain and snowfall, heavy wind, etc. in any scientific research. This lecture tries to deals briefly with this issue as well.

CLIMATE FACTORS

There are different climate factors that must be considered in civil operations, building constructions and building designs. The most significant climate factors are as follows: weather temperature, soil temperature, angle and intensity of sunlight, relative humidity, direction and wind speed, rainfall and sunlight. Climate factors cannot be reduced in these items. Rather barometric pressure and such are also considered as climate factors but they don't play a big part in designing and civil operations. Besides, the changes of some climate parameters are not high over the year so it does not make a big difference knowing about their time changes. Now, we'll be dealing with each of these factors.

Weather Temperature

Perhaps weather temperature is the most important climate factor affecting climate designing. The intended dimensions in designing various points of a building and also the material in use is determined by the maximum and the minimum temperature of the region. Therefore, the quantity and quality for constructing a building are different depending on the type of the region: tropical, cold and moderate. Glacial region would require taking special decisions on the choice of materials. In order to prevent energy dissipation in tropical and cold regions in summer and winter time, body insulation of the buildings must be considered whereas this issue might not be of priority in moderate regions.

Soil Temperature

Soil temperature and its changes are of importance over the year. The soil surface experiences the most changeability of temperature during the year which is caused by proximity with air and its changes. The more we go to the depth of the soil, the less changes of temperature we have so that in a specific depth called depth or attenuation depth temperature, annual changes of soil temperature are caused. Given the fact that building foundation lies in the soil, knowing about soil temperature, especially glacial soil and its depth, is of high significance in the selection of the materials and determining the foundation of abuilding.

Moreover, knowing about the depth of glacial soil can be effective in the installation of gas, water... pipes. The depth of glacial soil is a point where the soil does not freeze in the coldest time of the year. It is clear that in cold regions the depth of installing such equipment must be lower than the depth of glacial soil so that they become immune of any frozen state. In order to know about the depth of glacial soil in any region, one shall refer to long-term climate data provided by meteorological stations. Now that the question of constructing urban common tunnels is around, this issue’s importance is doubled.

Sunshine

The rate of receiving sunshine is a function of several factors which include: latitude (angle of sunshine), the amount of cloud, and sunshine hours. The less the latitude, the less the angle of the stretch of sunshine with the vertical line to horizon and the more the receiving sunshine. Sunshine hour is irrelevant with the amount of cloud, when one increases the other decreases. In areas where the rate of receiving sunshine by the earth surface is high, temperature is high too. If the goal is to reduce the amount of sunshine entering the earth surface (this method has recently been noticed by climatologists and it is one of the strategies for reducing global warming and earth engineering), we can use reflexive mirrors.

Relative Humidity

By definition, relative humidity refers to the proportion of the existing amount of humidity in the air to the maximum amount of acceptable humidity in terms of percent. The more the rate of relative humidity, the more the possibility for the formation of water drops on physical objects on the earth surface (including buildings and other constructions such as bridges, streets etc.). This means the acceleration of the effect of humidity on equipment and their rust chemically (corrosion of metals, oxidation of metals, etc.) and physically (freezing water and causing cracks in building design. In the regions where there is more relative humidity of weather such as coastal areas and islands, designing and construction of the buildings take place according to high adverse effects of water. They must be designed and constructed in a way that physical and chemical adverse effects of water decrease to the minimum level or even zero. This need is met through the selection of water and corrosion-resist materials and equipment.

Wind Direction and Speed

Wind direction is a way from which it is blowing. Knowing about the wind direction of each region, bearing the most frequency from that direction (prevailing wind), is an important factor in setting the direction of building construction aerodynamically so that in the state of heavy winds, light buildings wouldn’t be hit. In ancient times, in order to design the direction of wind wards especially in tropical regions, the length of

wind ward vents was built in the direction of prevailing wind so that wind could be used in the best way possible to cool the building. Wind speed is also important because in the case of high speed winds, there is the possibility for the detachment and physical damage to different parts of building especially light ones. Knowing about the mean of wind speed at the project site and seasonal and annual distribution of wind speed are important factors for strengthening against wind power. The more the mean of wind speed in the region, the more powerful the building must be. In projects where there are several choices in terms of region, it is a good idea to pick up the one in which wind speed is lower than other regions. These regions are identified through wind pattern plans and measuring wind speed in different points of a region. If the goal is to use wind power such as establishing wind power plants, the place of the construction shall be chosen in a way that there is high-speed wind around. It is clear that, in this case, permanent high-speed wind for most of the year or even all the year is an upward.

Rain Fall

The amount of rainfall is one of the most determining factors that shall be considered in building design, especially ceiling design. In rain areas, the ceiling of buildings must be designed as gable roof so that water erosion is reduced, due damages are minimized and there would be no water left on the roof. Otherwise, adverse effects of rain and its penetration into buildings would rise. Knowing about the rate of rainfall, especially for designing structures like dams (estimation of the maximum probable rainfall) is necessary so we can determine spillway dimension, etc. moreover, in order to design surface water disposal system across cities when it rains, knowing about the maximum urban flood relevant to return period sounds like essential.

Weather Detrimental Phenomena

It refers to so high or so low rate of meteorological factors. For instance, flood or draught shows very high or low rate of rainfall. What matters about weather detrimental phenomena in civil operations is so high rates of meteorological factors. For example, concerning rainfall, its high rate which is flood or heavy showers is

important and draught is unimportant. High warm and cold waves happening recently in different parts of the world due to climate change are considered to be important disasters. Tsunami receives high attention in coastal areas and islands. Dust storm makes limitations in the areas prone to wind slide. Limit values of weather and climate factors also happen in local conditions which require local studies and must be analysed before starting the project.

Weather Forecast

It is essential to know about weather conditions of some days ahead so that you can adjust civil operations and plan doing different steps of building operation. The most important example is to know about rainfall occurrence during working days ahead. Rainfall occurrence would challenge building operations especially in primary stages of the project and can even strand it. This limitation in later stages when building constructions take place indoor is by far reduced. One of the important uses of meteorological forecast is about dam-building workshops. Heavy rainfall occurrence in lands above the dam can cause flood in the workshop site and damage the existing equipment and vehicles and even claim human lives. Forecasting the amount of rainfall in the upper land and estimating the potential amount of the time of flood discharge, one can inform the workshops appropriately and prevent financial loss and human death. Wind forecast can also play a big role in doing civil operations and construction especially about sky scrape buildings. Wind speed goes up with height increase and the increase in wind speed is logarithmic. Working in heavy wind conditions especially in highlands would cause damage to equipment and personnel. That is why it matters. Non-liquid rainfall such as snow, hail, etc. brings about their own special problem. Forecasting this condition beforehand would help us adjust civil operations and timing for days ahead. It is worth noting that weather forecast is not always true and it can be different in terms of precision and correctness according to various conditions and factors. So, it is possible for weather forecast to go wrong. In this case, ceasing the administrative operations for a while would put the project off and cause financial loss. Considering risk management conditions, the amount of this potential financial loss comparing to the loss coming from weather detrimental

conditions and also human loss is negligible. Of course, taking all scientific forecast principles, the total amount of forecast would reduce to less than 10% in a period. Again, compared to relative potential material damages, the total potential material loss is lower.

Energy-efficient landscape design

Through an accurate and conscious energy protected landscape design, it is possible to reduce the energy cost spent for heating and cooling during summer and winter seasons at 30%.

The ground flooring of outdoor and grass has a cooling impact via vapor transportation. The materials harbouring heat in its body such as asphalt continue to expand heat following sun and they increase night time radiations. So as to reduce the cooling costs spent, using such materials that store heat and reflect lights little or shading them against direct solar rays are among the precautions to be taken.

The ground cover may also be utilized for energy conservation in buildings. Completely or partially buried, construction can moderate building temperature, save energy, and preserve open space and views above the building. If the wall and roof being covered by a layer of earth of substantial thickness sufficient to insulate the dwelling thermally and acoustically and reducing the quantity of energy necessary to maintain the interior of the building comfortable for the occupants even when the atmosphere is extremely hot or cold.

CONCLUSION

Generally, weather and climate role in civil operation and building construction is of importance in respect to looking at the past climate with the goal of building design and forecasting weather condition in the future to adjust civil operations. Looking at the past climate, the outcome of all climate factors must be taken into account and focusing on only one or two climate factors is by no means enough for all factors are

significant though they have different weights. In the discussion of weather forecast which covers predicting a range of less than 10 days, damaging limit events (high-low damage) is important since they play a part in setting civil operations. It is necessary to note that weather forecast is not immune of error. Each forecast's precision rate depends on different factors including forecast term, the accuracy of prediction model, changes of map patterns during different days and the precision of individual predictor. In our country weather forecast is done by the national meteorological department freely. But in other countries, private companies or individuals do it in return for money. Therefore, they take responsibility for what they forecast. Given what mentioned here, it is important ad essential to pay enough attention to both past climate and weather forecast in the future for civil operations. Although the administrators of small and big civil projects pay a general attention to these points, it seems that civil engineers shall take the first step to institutionalized this information and shape this cooperation with the help of meteorologists.

Climatic Orientation

Orientation is the positioning of a building in relation to seasonal variations in the sun's path as well as prevailing wind patterns. Good orientation can increase the energy efficiency of your home, making it more comfortable to live in and cheaper to run. Factors like solar heating, wind cooling and Shading can greatly make a difference. Identify your climate zone and develop an understanding of appropriate design responses by referring to Design for climate.

The placement of any object on earth's surface is like placing a ball on a slope. Now where to direct this slope or where the ball should end its movement and hit on target, is what we call proper orientation according to the function or surroundings. In this way, orientating the buildings along with the micro climate is what helps to make a building sustainable enough and not a burden on the environment around. Orienting buildings is an important criterion but another aspect to keep the interiors also climate friendly is the orientation of the voids that are the fenestrations and openings on the

structure. The building should respond well with the surroundings and in order to achieve this it is planned and oriented on site so that it resists various climatic changes around. The main four climatic zones of Kenya are:

1. Hot and Dry
2. Warm and Humid
3. Moderate
4. Cold

Other factors to considers with Orientation are: -

i. Interior orientation
ii. Vegetation orientation
iii. Exterior orientation

Good orientation, combined with other energy efficiency features, can reduce or even eliminate the need for auxiliary heating and cooling, resulting in lower energy bills, reduced greenhouse gas emissions and improved comfort. It takes account of summer and winter variations in the sun's path as well as the direction and type of winds, such as cooling breezes. Ideally, choose a site or home with good orientation for your climatic and regional conditions and build or renovate to maximise the site's potential for passive heating and passive cooling, adjusting the focus on each to suit the climate. For those sites that are not ideally orientated, there are strategies for overcoming some of the challenges. In hot humid climates and hot dry climates with no winter heating requirements, aim to exclude direct sun by using trees and adjoining buildings to shade every façade year-round while capturing and funnelling cooling breezes.

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