



CLIMATE CHANGE AND ITS IMPACT ON MONUMENTAL AND HISTORICAL BUILDINGS WITH REFERENCE TO MONUMENTS OF CHHATTISGARH

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Climate is the act of all atmospheric events such as rainfall, temperature, wind, air pressure and humidity etc. In recent years, the alterations about natural environment and climate observed in Chhattisgarh state negatively affected the monumental buildings, the cultural riches of the state that they have been worn out by various natural effects for a long time. However, since monumental buildings have great importance due to their identity of transferring old era information to the future generations, there should be taken special precautions against deteriorations on the monumental buildings. Climate-related deteriorations on the monumental buildings resulted from temperature differences between summer-winter and day-night, water movement at the building due to capillarity, abrasive effects of rain water, salt and some chemicals involved in water, particles carried by wind and air pollution. The deteriorations occurred on the monumental buildings due to climate changes have investigated for Chhattisgarh and the deterioration effects on construction materials have been discussed.

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INTRODUCTION

Architecture can be described as the sum of the social, economic, political and cultural developments. The places people live in also live for years. The representatives of architectural heritage each have its own architectural, historical and cultural message have undertaken a social duty to give cultural messages to their environments and future generations. Architecture taking place at the intersection zone of technique and art is the physical and permanent sign of social and economic life culture and national structural culture. Therefore, Chhattisgarh has many riches and should be evaluated in terms of cultural meaning within all protection and sustaining studies.¹ The historical monuments sustained from past to present have worn out due to various effects and disappeared in short periods due to lack of good care. The deteriorations on the construction materials have occurred not only because of the years but also mostly due to the environmental factors. One of the most important factors giving shape to the architecture is natural environment and the other is material of construction. The buildings are unfavorably affected from changing natural environment and climate conditions. Climate can be defined as the whole atmospheric events such as rainfall, temperature, wind, pressure and humidity that cause certain damages on the monumental buildings for years. The historical and cultural riches of nations are the values assigning the power, richness and identity of them. Each historical building and cultural value is an expression of accumulation and a bridge from past to present.²

CLIMATE OF CHHATTISGARH

The climate of Chhattisgarh is mainly tropical. It is hot and humid because of its proximity to the Tropic of Cancer. It is dependent completely on the monsoons for rains. Summer in Chhattisgarh is from April to June, and can be uncomfortably hot, with the mercury hitting the high 40's. Monsoon season is from middle and late June to October. The rains provide a welcome relief from the scorching summer heat and the whole state is covered with greens and waterfalls are at their best. Winters are pleasant with low temperatures and less humidity. The temperature varies between 30 and 47 °C (86 and 117 °F) in summer and between 5 and 25 °C (41 and 77 °F) during winter. However, extremes in temperature can be observed with scales falling to less than 0 to 49°C.

EFFECTS OF CLIMATE ON MONUMENTAL BUILDINGS IN CHHATTISGARH

Climate is the act of all atmospheric events such as rainfall, temperature, wind, air pressure and humidity etc. In recent years, the alterations about natural environment and climate observed in Chhattisgarh negatively affected the monumental buildings, i.e. the cultural riches of the country that they have been worn out by various natural effects for a long time. The traditional architecture in Chhattisgarh has been formed with natural construction materials such as stone, brick, etc. Therefore, the variations in natural environment and climate conditions in Chhattisgarh have caused unfavorable effects on architectural buildings during and after the period of May and June. The monumental buildings deteriorated due to the temperature differences of seasons and day-night, capillary movement of water inside the building, salts and other harmful chemicals, air pollution, etc.

Deteriorations on Stone-Based Construction Materials Due to Climate

In Chhattisgarh natural stones have been used as the construction materials of many historical and cultural buildings and monuments. When the atmospheric contaminants join together with the atmospheric factors such as rainfall, smog, humidity, wind, temperature and sun light etc., they affect the natural stones used for the construction of monumental buildings in various manners and cause damages and deteriorations differing with respect to the type of stones.³ The intervention decisions about the conservation of stones in historical buildings start with the identification of the present conditions of the buildings. These conditions cover the determination of geological characteristics of the area on which the building was constructed, the climatic conditions, the effects of air pollution and natural disasters as well as the condition of the use of the building during its lifetime and the interventions carried out during this period.⁴ The weathering of stone takes place due to chemical, physical, mechanical, and biological processes. Physical weathering breaks stones into smaller pieces. The types of physical weathering include salt crystallization, freezing-thawing cycles, thermal expansion, and loads, rot pressure of plants and microorganisms, etc.⁵

In general, the causes of deteriorations on the stone material due to climate can be classified as “Temperature Effects”, “Atmospheric Effects” and “Deteriorations Due to Living-Beings”.

TEMPERATURE EFFECTS

Stone has become the widely used construction material in ancient buildings due to its enormous resistance against natural conditions when compared to other construction materials. However, stone also wears out and deteriorates in the course of time because of some reasons, and also it is broken into pieces. Good or bad status of the stones used for the construction of the old buildings affects the protection and utilization of the building.⁶ The stone material of the old buildings mostly deteriorates due to temperature differences and solar effects.

Thermal Expansions

The temperature changes between day-night and seasons bring about volume changes such as expansion and shrinking. Moreover, continuous temperature changes cause the cracks and breaks on stones as a result of the material fatigue.⁶ Varying expansion amounts are the other effects of temperature on the stone material due to temperature differences between the inward and outward of stone material. The thermal expansions do not occur only because of hot weather but also freezing plays a great role on expansion. Since the volume of water increases after freezing process, the frozen water in cracks presents a cotter effect, enlarges the cracks and causes to have broken pieces of stones. When this event takes place for several times, the broken upper layers of stones will be observed. Freezing-thawing process has a significant effect on the deterioration of stones used at the

regions facing with daily and seasonal temperature differences (Fig 1.).

Solar Effect

The colors of stones change in the course of time due to the temperature differences between day and night. The faded stone surface takes a matt and pale appearance which is more frequently seen in natural construction stones. Sometimes the color changes occur as vein shaped dark spots.⁶



Figure 1. Showing thermal expansion and deposition of living organism

ATMOSPHERIC EFFECTS

Atmospheric movements and humidity are the unfavorable factors against protection purposes of monumental buildings. Even the stone material is resistant against bad weather conditions; it also goes through deterioration after a certain time period and sometimes disappears. Seriously large damages can occur on soft stones due to the particles carried by winds, and stones can fracture and break into pieces as a result of stresses sourced by temperature differences, freezing-thawing and humidity events. The contaminated atmosphere, water and organisms bring about chemical melting on stones, and usually the thin dust layer gets thick by forming a dirty layer on the stones and affects the whole structures of the stones.⁶ The atmospheric effects causing the deterioration of stone material used for monuments should be discussed under separate subtitles of “Water and Humidity”, “Wind”, “Salts” and “Air Pollution”.

Water and Humidity

Humidity is one of the most important harmful factors against stone-made Constructions as for every construction materials. Limestone dissolves by the effects of rain water and carbon dioxide. Additionally, the acid rains threatening stones are carried by rain water whose capillary rise inside the building causes harmful effects

on the construction materials. The soil between groundwater level and earth surface holds water by capillarity where this event is called as “surface water” or “capillary water” that cannot be removed by using any drainage system. The humidity rising up the building can cause serious damages on the structure. At the same time, the salts held by the building itself can result in florescence and some other effects damaging the chemical and physical structures of the walls.⁷

Wind

The seed transport and placement in the cavities and joints of roofs and walls by the help of wind factor sometimes causes to have trees grown on the facades of many neglected historical buildings. This event accelerates the deteriorations on the monumental buildings. Additionally, if wind presents its harmful effects together with sea salts and sands, serious surface weathering will be inevitable on the monumental buildings. Humid structural member involves more or less salt amount that is soluble in their bodies.² Water soluble salts are carried by water or any other ways to the pores and cracks of the stones, and as a result of evaporation of water, the remaining salts accumulate on then stone surface and at the capillary cracks of stone. The existence of water soluble salts in stone buildings causes to have mineralogical and textural deteriorations little by little in the course of time. Furthermore, salt crystallization is another primary effect resulting in deteriorations on the buildings and monuments constructed with limestone.⁸

Deteriorations Due to Air Pollution

Air pollution is also one of the most significant factor affecting the construction material of stone. Besides the considerable deteriorating effects of gas and ion solutions carried to the surface of the buildings by the help of rain water, the atmosphere movements, wind, rainfall and snow cause weathering on the outer surfaces of stones.⁶ Chemical weathering erodes the stones changing their compositions by chemical reactions such as dissolution, hydrolysis and oxidation processes of the stone minerals. Chemical weathering is mostly due to the effects of air pollution.⁴ The meteorological factors such as wind, relative humidity, fog, sun light and solar radiation cause to have faded stones. The existence of dense or loose air pollution considerably depends on the position and formation of the region on the world that air pollution is the only factor on the brightness loss of limestone.³

DETERIORATIONS DUE TO LIVING-BEINGS

Lichens and mosses appearing in winter months with increasing humidity related to climate speeds up the deteriorations on monumental buildings. The non-removal of rain water from damaged roof covers or any joints of the building lays the groundwork for the growing of mosses and plants on the building. The elimination of these serious damages will be possible only by the regular maintenance of the monumental building.⁷ Biological

weathering can be described as the disintegration of stone and stone minerals due to the chemical and/or physical effects of an organism that change the stone color or slow down the decay process of stone. In general, the biological weathering takes place by the help of plants, animals, fungus, algae, bacteria, lichen etc. In nature, more than one process takes place and it is difficult to verify the main causes of the weathering (Fig. 1). The investigation of the causes of weathering types of stones in historical buildings is an interdisciplinary work including the study of many researchers from different disciplines as architectures, engineers, chemists, biologists, archeologists, art historians, etc.⁴

CONCLUSION

There are many historical buildings such as Rajiv Lochan temple, Laxman temple, Mahadev temple, Chandraditya temple, Sita Devi temple, Shiva temple, Bhimkichak temple etc. located in various regions of Chhatisgarh. They have been constructed using stone i.e. natural construction materials that today serious deteriorations are observed on them. These deteriorations have occurred not only because of the age of the structures but also mostly due to the environmental conditions and factors. Climate can be defined as the entire atmospheric events such as rainfall, temperature, wind, pressure and humidity that cause certain damages on the monumental buildings in the course of time. Living four different seasons in Chhatisgarh cause some problems against monumental buildings. Consequently, the deteriorations related to climate conditions on the monumental buildings in Chhatisgarh present regional differences and occur due to temperature differences between seasons and day night, the capillary movement of water within the structural members of the building, the weathering effects of rain water, salts and various chemicals existing in water, particles carried by winds and air pollution. But regional temperature and precipitation caused by a team consisting of differences in structure translate it to different aspects of corruption that have been observed. For example, heavy rainfall areas of the Bastar region of Chhatisgarh in the structure of water and moisture more on source of corruption, while the temperature difference is more pronounced in the Raipur region in which such deterioration under the influence of the sun and air that have been identified.

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