

JEBT-Microbial Biotechnology

Biological Deterioration and their Chemical Conservation with Reference to Chandraditya Temple, Barsoor

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Article Info

Article History

Received : 20-04-2011
Revised : 02-05-2011
Accepted : 20-05-2011

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Abstract

Chandraditya temple is made up of sand stone which is sedimentary rock & its masonry is ashlar, but now is presently discoloured and deteriorated by growth and activity of living organism such as algae, fungus and lichen on stone surface had affected the structure badly; developing cracks as well as porosity of stones. Sand stone due to its porous nature absorbs more water in comparison to other stone & this water itself is main factor for the deterioration of stone structure. The exterior portion of temple had become blackish due to deposition of dried moss, lichen and bacterial slime. Accumulation of dust, dirt was also a base for the growth of micro vegetation which secretes organic acid for causing the harmful to the structures. This paper deals with the biodeterioration and biodegradation of Chandraditya temple by fungi and their remedial measure applied on the monuments.

Key Words: Biodeterioration, Biodegradation, Micro vegetation, Sedimentary rock, Porosity

Introduction

There are few places that have such an amazing biodiversity in nature along with as exciting a cultural tradition and heritage as Chhattisgarh. Chhattisgarh is a rich state from tourism point of view. The beauty of nature, the life style of tribal, the multifarious rock paintings, culture of a rich primitive society combined with an exciting geomorphology such as the natural caves, waterfalls and ever flowing river create an ambience that soothes the mind and nurtures the senses. The historical monuments form ruined forts, tribal palaces and exquisitely carved temples to rock paintings and caves and hill plateaus having sufficient rain which causes growth of fungus on the monuments & sculptures made of sand stone. Besides these are affected by lichen, moss, algae and other micro-vegetation and biological accretion. So the originality of beauty, and gracefulness are affected and slowly with time diminishing and if proper attentions and care are not taken to these remains then one day these may collapse also of moss, fungi, lichen etc. Most of the unbroken sculptures are of lord Shiva & Vishnu are worshiped with Hindu rituals using diyas of Ghee, Agarbatti, tilak, rice, flowers, belpatra. These oil and smoke etc. are harmful. If no scientific steps are taken timely these will be destroyed completely.



Fig : 1 (a) Chandraditya Temple (Lateral view) Before Scientific Conservation

Ancient monuments are regularly affected by the continuous colonization of micro-organisms especially bacteria, cyanobacteria, yeast, some algae species and various fungal species (Gorbushina et al., 2004). Fungi has greater role in the biodeterioration of monuments (Burfort et al., 2003). The phototropic micro-organism are common inhabitants of monuments. Opportunistic species of cyanobacteria and chlorophytes, present in soils and in the air, are commonly found on the surface of monuments (Simonoviova, 2004). Microbial activity can have an important impact on the durability of building materials. It is important to understand this activity of micro-organism in order to select appropriate treatment strategies for the repair and restoration of buildings and monuments (Gaylarde et al., 2006). The harmful effect by the colonizing of micro-organism on the monuments is scientifically known as biodeterioration. The problem of deterioration of work of art is particularly relevant in countries like India that are rich in cultural heritage. Biodeterioration can be defined as the irreversible loss of value and/or information of an object of art following the attack by living organisms (Urzi and Krumbein, 1994).



Fig : 2 (a) Chandraditya Temple (Front view) Before Scientific Conservation



Fig : 3 (a) Chandraditya Temple (Ventral view), Before Scientific Conservation



Fig : 3 (b) Chandraditya Temple (Ventral view) After Scientific Conservation

The monuments which are made of value ancient stones marble, granite and other have greater get more damaged from fungal colonizing (Winkler 2002). Not only fungi but bacteria also takes part in biodeterioration these stones (Tiano et al.,1975). So preservation of these monuments is very necessary (Gaur 1978). Blackening of rock and architectural surfaces by soot and dust has attracted attention of scientists and conservators for some time. Blackening of such substrates by diatomaceous yeast other species of fungi however, has particularly never been reported so far (Gorbushina et al., 1993). Thus the biodeterioration of ancient's Buildings and monuments depend upon many factors which includes environmental factors like light, moistures, weather, temperature etc. type of micro-organism that is its potential toward the colonization in the surrounding environments, materials of the monuments etc. All these equally contribute the biodeterioration of any monuments (Kavita Sharma, KOSHLA-3,395-397, 2010).

The stone surface of the Chandraditya temples have become blackish in appearance due to deposition of dust, dirt and dried vegetation & micro vegetation growth. The depositions area seems to be very old age depicted by the formation of secondary lichens of dull green pale white colour which are present all over the stone surface. Due to these

depositions the aesthetic beauty of the temple are affected badly. Further these depositions are very harmful for the health of the stone surface [St. Clair and M. Seaward (eds.), 2004]. It is very necessary to remove these accretions from the surface of the monument. The Chandraditya temple is situated in small village called Barsur in Dantewada district of Chhatisgarh state which is very naxal affected area.



Fig : 4 (a) Deteriorated Statue, Before Conservation

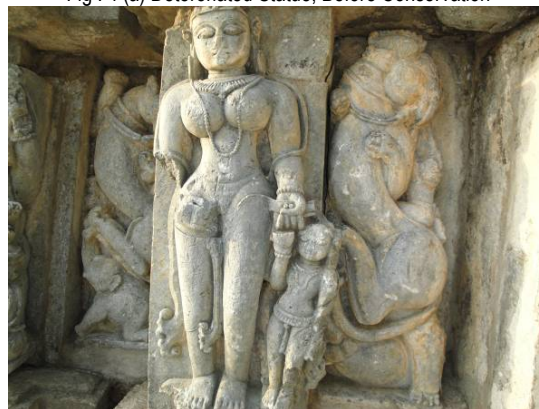


Fig : 4 (b) Deteriorated Statue, After Conservation



Fig : 5 (a) Deteriorated Statue, Before Conservation Conservation problem

Chandraditya temple built of sand stone which is porous in nature. The stone surface of the temple have become blackish in appearance due to deposition of dist, dirt, and dried vegetation and micro vegetation growth on an exterior as well as interior portions. The depositions are seems to be very old as depicted by the formation of secondary lichens of dull green

pale white colour which are present all over the stone surface. Due to these depositions the aesthetic beauty of the temples is affected badly. Further more scientific point of view these depositions are very harmful for the health of the stone surface because these micro organism secretes acid which dissolves the component of sand stone (Burford, 2003). Micro organism growth such as algae, fungus and lichen on stone surfaces had affected the structure badly, developing cracks as well as porosity of stones. Increase in humidity level due to high rainfall and also thick forest cover had affected the stone surface. The exterior portion of temple had become blackish due to deposition of dried moss, lichens & bacterial slime. Accumulation of dust and dirt was also a base for the growth of micro vegetation which secretes organic acid causing which harmful to the structure (Torraça, G., 1981). Stone chipping of sikhara was taking place which was in need of urgent consolidation.



Fig : 5 (b)Deteriorated Statue, After Conservation

Isolation of fungi

During the investigation period PDA media was used for the isolation of microorganisms. Sample were collected from the surface of temple. Few drops of sample pour in the petridishes and kept this petridishes at $28\pm 1^{\circ}\text{C}$ for 7 days for incubation (Grover et.al. 2007). At the end of incubation period fungal colonies were counted, isolated and identified with the help of available literature and finally send this culture to authentic authority: National center of fungal taxonomy Delhi for identification.

The fungal species were *Cladosporium sp.*, *Fusarium Mycelia sterilia*, *Aspergillus*, *Curvularia*, *Cladosporium*, *Mucor*, *Penicillium Chrysogenum*, *Rhizopus*, *Trichoderma*, *Sepedonium maheshwarianum*, *Emericella nidulans* species were observed.

Removal of dust and dirt

The steps taken by Archaeological Survey of India for the removal of dust and dirt accretion upkeep of stones in neutral pH and preservation and stone strengthening Strategies by soft brushing. The moss, fungi and lichen were removed by applying 2-3% solution of ammonia in water and scrubbing with nylon brush. Black patches appeared after removal of thick layer of moss, fungi and lichens which were washed out with the help of dilute solution of oxalic acid in water. A dilute solution of a non ionic detergent with liquid ammonia was applied on treated surface to remove dirt, dust and little amount of acid and ammonia if remained on the surface during

the chemical treatment. Lime wash, red ocher and iron oxide accretion were removed using dilute (10-15%) aqueous acetic acid and oxalic acid solution as per the suitability and afterwards neutralized using aqueous ammonium hydroxide solution. To Arrest further micro vegetation growth 2% aq. Solution of sodium pentachlorophenate was applied on clean dried surface (W. H. Dukes, Conservation of Stone, August, 23, 1972). The brittleness and powdering of stones were arrested by the application (brushing and impregnation till saturation) of ethyl silicate based coating material which forms glass like silica gel binder (SiO_2 aq.) with release of ethanol (evaporates) as by products. Here, noteworthy point is that the intake of stone strengthener materials was comparatively more in the case of damaged and pulverized stones. This can be attributed to the availability of more pores for penetration. The coating of stone strengthener applied on the deteriorated and flaky stone surface by simple brushing and impregnation till saturation.

Selection of preservative

It is essential that the preservative solution applied on the monuments is should be of good quality. It should be colourless and transparent and must not turn yellow or become coloured with age, but should be fairly stable for long period of time. It should also offer reasonable protection to the monument against moisture and its film should be hard and strong enough to protect the stone surface from injurious accretions. Therefore for the preservation of Chandraditya temple silane-siloxane based compound (wacker BS-290) have been chosen (Wacker- Chemie GmbH, 2002), which was diluted with Mineral turpentine oil in the ratio of 1:16 and was applied on the monument by soft paint brush. This compound is water repellent and stops settling of water on stone surface.

Conclusion

To preserve these monuments scientific treatment is very essential. But it is more essential that the identification of problem and selection of chemical should be accordance the problem of stone surface and preservative solution applied on monuments is of good quality (Agrawal, O.P.1993-94). It should be colorless and transparent and should not turn yellow or become colored with age but should be fairly stable for long parried of time. It should offer reasonable protection to monument and sculpture against moisture and its film should be hard and stone enough to protect the stone surface from injurious accretions.

Acknowledgement

Authors are grateful to Dr. P.K.Mishra, Superintending Archaeologist, Archaeological Survey of India, Raipur Circle, Raipur (Chhatisgarh) for their encouragement and guidance.

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