



Biodegrading and Bio deteriorating monuments of Ujjain: a comparison of the current status to Simhasth 2016 of Ujjain, MP, India

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Abstract

The conditions of monuments affected by biodegradation and biodeterioration before and after Simhasth 2016 Ujjain M.P. India were monitored. Maintenance activities carried out on the ancient monuments of Ujjain including Temples for 2016 Simhasth were analyzed. In this study we compared the present condition of these monuments to before Simhasth 2016 of the same. We made comparisons of these monuments by photographs of then and now by using grid counts. The visible biodegraded and biodeteriorated mean area was decreased less than 2% since the time before Simhasth (χ^2 -Square $p < 0.004$). This improvement was mostly because of eradication of scaled and biofilm areas. This manuscript is an effort to promote comprehensive restoration plans. Also regularly maintaining, conserving and restoring the monuments of ecological importance. In future, this can also serve as new tool for scientific quantification and analysis of stone damage.

Keywords: Biodegradation and Biodeterioration, Conservation, Fungi.

Introduction

The Ujjain Simhasth also known as KUMBH mela started in the 18th Century. Ujjain Simhasth is considered to be the biggest event of India. It is a fair which is held every 12 years near banks of river Shipra. The city is also popularly known as the temple city for its numerous temples from different eras. The development of Ujjain city during this period takes the city to new heights on a global level. Ujjain city is considered to be a very sacred place. In India there are 5 cities where Jantar Mantar is located, one of which is Ujjain. There are many notable sacred temples and monuments in Ujjain. But with time these ancient monuments undergo biodegradation and deterioration due to natural and human factors^{1,2}. Other than these factors, there were several other organisms responsible for deterioration of monuments of cultural value^{2,3}. When the building materials are constantly exposed to the environment then they deteriorate due to natural factors⁴. During 19th century, tourists used to carry hammers and chisels in their luggage and took home the stone pieces of monuments which they visited⁵.

For monitoring the deterioration of monuments, several new methods have been developed over time⁶. Like in the Habib Sakakini Palace, there was use of penetrating radar⁷. A study using bioluminescent low-light imaging technique was done which showed live images of microbes on the surface and viable counting was carried out⁸. Quantification of stone monuments by the use of damage indices has proved very suitable for evaluation of damage and thereby signifying preservation techniques⁹.

During the time of Ujjain Simhasth 2016 all the ancient temples and monuments were repaired and painted. But since then again

the condition deteriorated, which allowed us to make an assessment on the condition of monuments at that time to the present condition. Our objective is that by using photography we can examine the changes in a monument. For this study we conducted a statistical analysis and made comparisons from the time of Ujjain Simhasth 2016 to present time. The condition of monuments was much better during the time of Simhasth due to the refurbishment done at that time. But with time, these ancient monuments and temples were not maintained properly which became the cause of deterioration. A major difference was observed between the photographs of then and now conditions of these monuments. Microorganisms may also contribute to the deterioration of stone artifacts such as historical monuments and statues¹⁰. The microbial growth on the monuments can also physically degrade the stone by penetrating through the hyphal growth in the pore spaces¹¹.

Methodology

It is known that for Simhasth 2016, the Ujjain city was refurbished. The city prepares itself for the influx of pilgrims and tourists, a massive refurbishment and renovation work is carried out. It included all the ancient monuments and temples. As we know that stone surfaces experience degradation due to the constant exposure to environment¹².

For the purpose of this study the photographs of selected sites were collected during Simhasth 2016 and photographs of the same sites were again collected from the same location in the current time to make comparisons. This investigation is based on photographic study. We selected a few sites from Ujjain like Jantar Mantar, Bharthari Caves, Shani Temple and Siddhawat,

that had a significant importance in the ancient history. We also visited several sites on May 2018, to check the conditions then.

On each image we overlaid a grid (45.5 cells per image). This technique is commonly used in Lichen studies. Then comparisons of the expected values with the observed values from the variations on the chi-square statistic was calculated from the following form.

$$\chi^2 = \sum_{i=1}^k \left[\frac{(O_i - E_i)^2}{E_i} \right]$$

Where O is the observed value, E is the expected value and “i” is the “ith” position in the contingency table.

On each photograph and for each section of the grid we set the description as i. Surface area of monument without any visible degradation and the degrading agents. ii. Surface area of monument on which microbial growth present. iii. Surface area of monument on which degradation due to microbial growth is highly present.

The data thus collected, evaluated the total sections of grids with each condition for the statistical test. After that we computed the mean values shown in Figure-4.



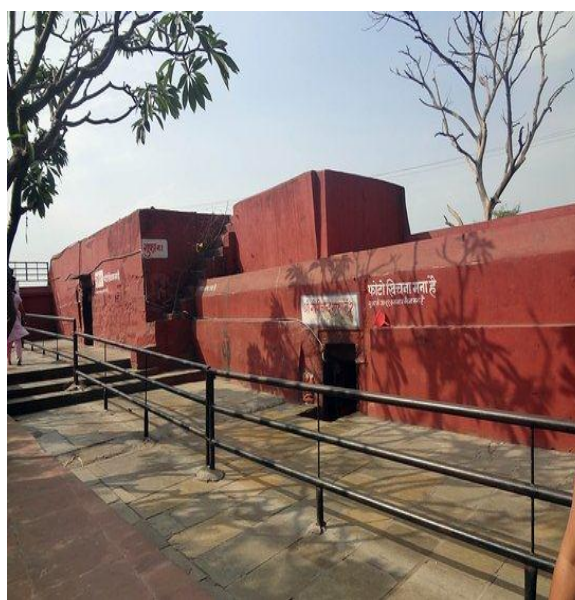
(a)



(b)



(c)



(d)

Figure-1: Photographs taken from: A. Jantar Mantar Ved shala Ujjain. B. Gopichand Gufa Bharthari Caves Ujjain. C. Shani Mandir Ujjain D. Siddhawat Ujjain¹³.



(a)



(b)



(c)



(d)

Figure-2: Photographs used for comparisons. A. Jantar Mantar Ved shala Ujjain. B. Gopichand Gufa Bharthari Caves Ujjain. C. Shani Mandir Ujjain D. Siddhawati Ujjain¹³.

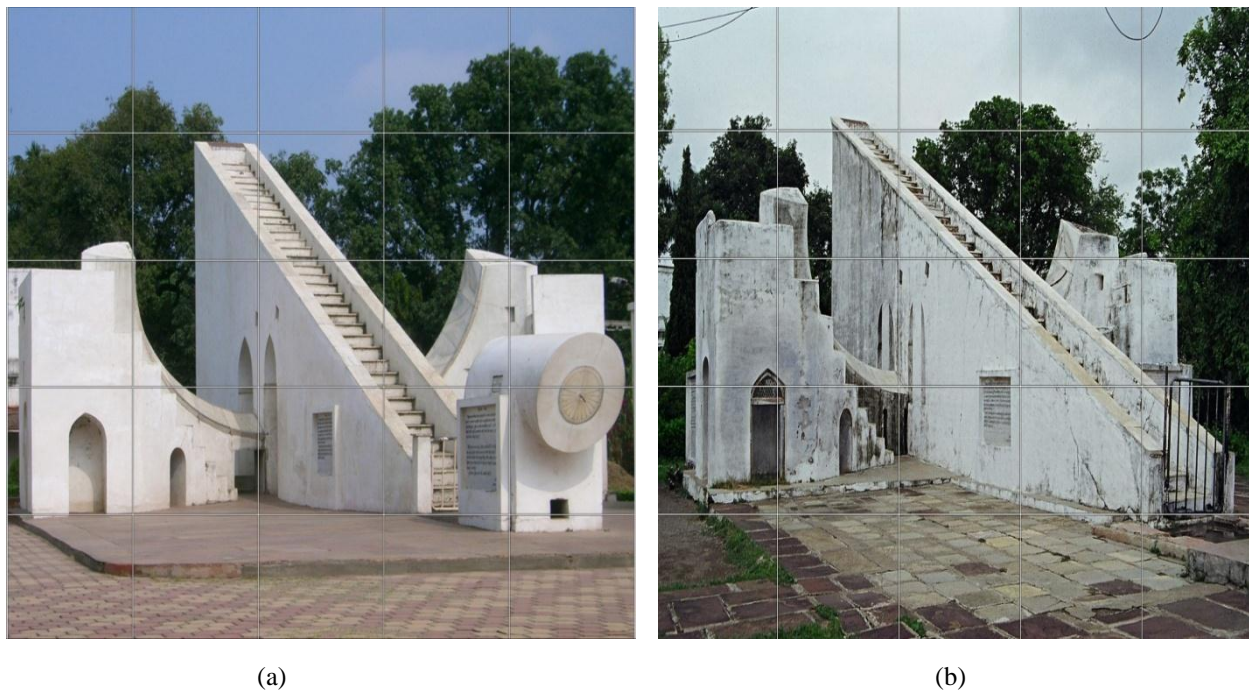


Figure-3: Sample of grid used to determine the biodegradation caused by microbes in the photographs.

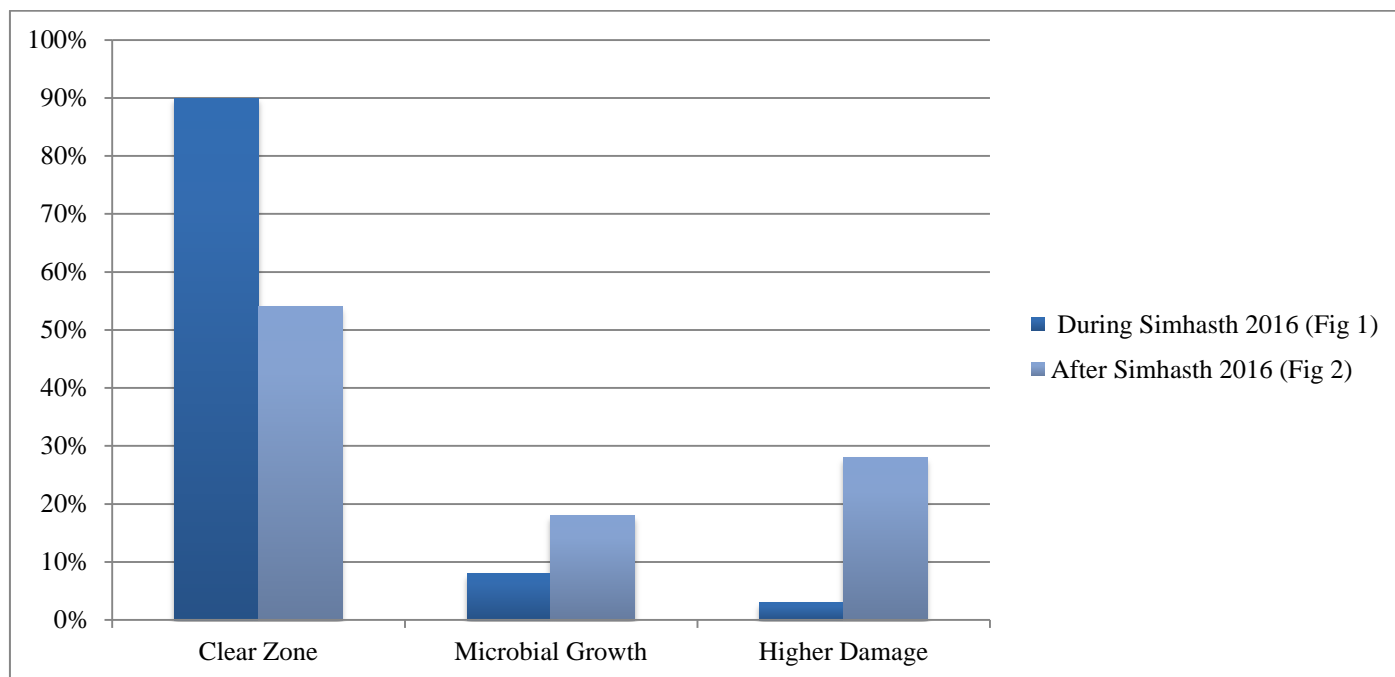


Figure-4: Calculation of mean percentage showing the surface area of monuments with clear zones, area covered with microbial growth and area showing higher damage.

Results and discussion

Black crusts, alveolisation, scaling and spalling are the deterioration patterns that affect monuments¹⁴. In order to preserve our heritage it becomes our responsibility to develop and maintain these ancient monuments all the way through¹⁵. It

was observed that negligence was one of the major causes of such depreciating condition, which can be prevented through regular maintenance. As a result of his study it was observed that the condition of the monuments were comparatively way better during the time of Simhasth 2016. The surface was found clean because of the refurbishment that included cleaning and

painting. And there was no such deterioration and degradation found. This can be seen in Figure-1. As the condition started to deteriorate over time, in 2018 the area were a bit cleaner than current time (around 25%). Most of the area was covered with microbial growth (Figure-2). The highly affected areas showed a mean value of 28% which was mainly because of fungal growth and plants. The amount of biodegradation and deterioration during current time was very high (Contingency Chi-Squared Test = 8.65, $p < 0.005$).

Discussion: The biodeterioration of archaeological monuments by microorganisms is a worldwide problem thus adequate interventions must be taken to stop or at least slow down the process of biodeterioration. Several methods and techniques have been employed from time to time for the preservation of these monuments. This study reveals that even after refurbishment, gradually the condition of stone starts demeaning with time. Similar work has been done by several researchers where they compared photographs of the paintings of ancient sites made in historic times. A comparable work was conducted by Julián Monge-Najera, Bernal Morera-Brenes in which they compared the paintings made by Canaletto from 18th century to the current times¹⁶. The stone surface gets affected by several environmental factors which results in biodegradation as concurred from the studies made by Sanjay Prasad Gupta, Kavita Sharma on Sita Devi Temple, Deorbija Chhattisgarh¹⁷. Another approach made by B. Fitzner, K. Heinrichs and D. La Bouchardiere showed the damage index on stone monuments by using the technique of damage indices¹⁸.

During the time of Simhasth 2016 all the ancient historic monuments that included ancient temples were refurbished. Due to which the deteriorating condition of these monuments improved to a large extent¹⁹. Major influence on ancient historic buildings is caused by environment which includes climatic changes, rainfall, air pollution, temperature and humidity²⁰. Although after the renovation work done in Simhasth 2016 the monuments were not taken care of and were left as it is due to which we saw major changes and differences. Colour modifications, shows us the biodegradation rate and extent of biodegradation²¹.

Conclusion

By the continuous examination of the monuments, the organisations or authorities responsible can come up with planning and decision making of monument preservation policies and strategies. By the help of this study, a constant check on monuments can be made as it allows us to make comparisons from time to time and on different parts of monuments. It was observed that the refurbishment work done on the ancient monuments helped in the restoration process and if timely such activities are carried out then the longevity can be extended for ages. Also there are allergens which can cause pneumoconiosis, skin allergy and other breathing difficulties. So by the preservation techniques, allergy causing microbes can be eradicated from the building surface alongside protecting the

monuments. After the removal of biofilms, paints with antimicrobial potential can be used. Several plants extract also shows antifungal properties which can help in controlling the microbial growth on monuments²².

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