

Deterioration Diagnosis and Microclimatic Effect of the Rock-carved Triad Buddha in Seosan (Seosanmaesamjonbulsang), Koera

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1. Introduction

The Seosanmaesamjonbulsang (National Treasures No. 84) is representative Buddha statue of Baekje Kingdom in the 6th century which has been greatly value of conservational and historical points. This triad Buddha is sculptured high reliefs on the rock surface of the medium-grained biotite granite with partly developed pegmatites and quartz vein, the outcrop of the triad Buddha statue is situated nearly vertical cliff. The rock cliff carved the triad Buddha statue is divided dozens of rock blocks with various shape along the irregular discontinuity plane (Fig. 1).

This host rock is typically acidic igneous rock and belong to peraluminous type granite. Chemical index of alteration (CIA) of the rock shows 53.88 to 56.54 and weathering potential index (WPI) of the rock ranges from -2.07 to 1.62. Now, this triad Buddha was losing original form as cultural heritage because rock surface are polluted and weakened by unsuitable conservation environments.

In this study, quantitative investigations for rock properties of the triad Buddha, detailed deterioration assesment by scientific diagnosis and structural stability assesment were carried out. Besides, this study was examined environmental factors that adding the surface damage throughout analysis surface pollutant and in-situ measurements of microclimate with temperature and relative humidity during a one year.

2. Detailed deterioration diagnosis

The host rock of the threaten to structural instability because of irregular joint systems of the rock blocks, and highly deteriorated by loss of stone materials such as narrow open cavities, exfoliations and broken-out of all over the surface. As the evaluation results of structural stability, it is confirmed that discontinuity systems in the host rock were exposed instability sloping environments due to possibility fields of plane, wedge, topping failures. Surface of the triad Buddha statue shows highly degraded by water-rock interactions owing to the chemical weathering and secondary pollutants.

Keyword : Seosanmaesamjonbulsang, biotite granite, deterioration diagnosis, microclimate

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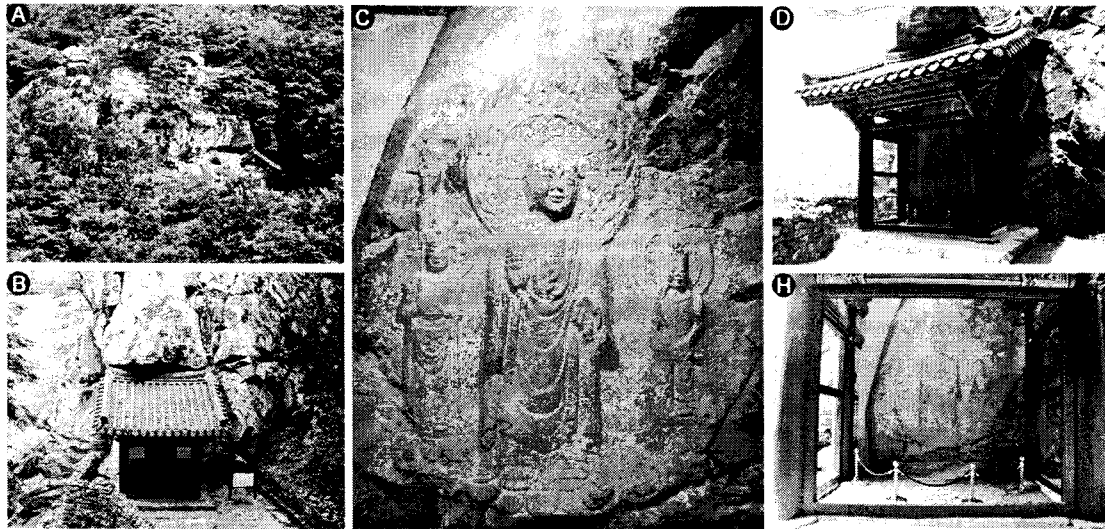


Fig. 1. Field occurrence of the Seosanmaesamjonbulsang. (A, B) Host rock of the triad Buddha is well developed discontinuity systems. (C) The frontal appearance of the triad Buddha. (D, E) Korean style wooden shelter open three walls through dismantled concrete wall by unsuitable conservation environment.

Drawing comprehensive deterioration map with detailed diagnosis and deterioration degree was quantitatively evaluated. Generally, deterioration rate of the triad Buddha surface cover with 38.96 %, however, the rate of physical weathering and surface discoloration are subdivided to 9.53 % and 24.09 %, respectively (Fig. 2A, 2B, 2C). Ultrasonic investigation results, the triad Buddha was generally highly weathered grade, when conservation treatment for the triad Buddha must considered due to distribute low velocity zone of 1000m/s along irregular joint systems (Fig. 2D).

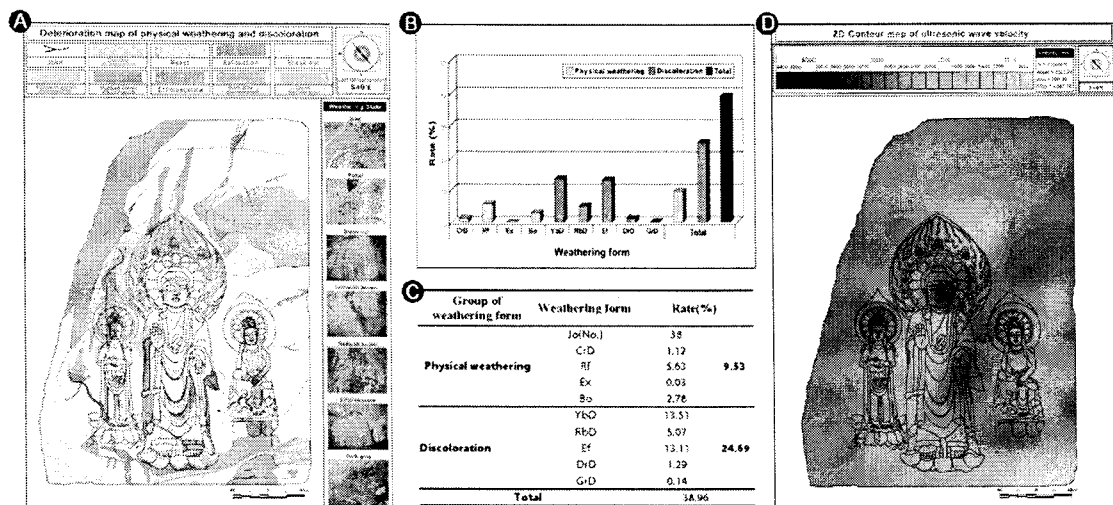


Fig. 2. Quantitative assessment of the deterioration state. (A, B, C) Comprehensive deterioration map and ratio of deterioration degree. (D) Rock strength map by measurement of ultrasonic wave velocity.

3. Microclimatic effect analysis

To inquire environmental change to indoor and outdoor of wooden shelter around the triad Buddha were monitored relative humidity and air temperature for a year (from 10/12/2005 to 10/11/2006). In Fig. 3, highly relative humidity that occurred to percent of 95 to 100 is showing four seasons. Air temperature repeated fluctuation by external weather environment change. Especially, it showed lower temperature tendency compared to Seosan region in summer and temperature distribution of below zero in summer.

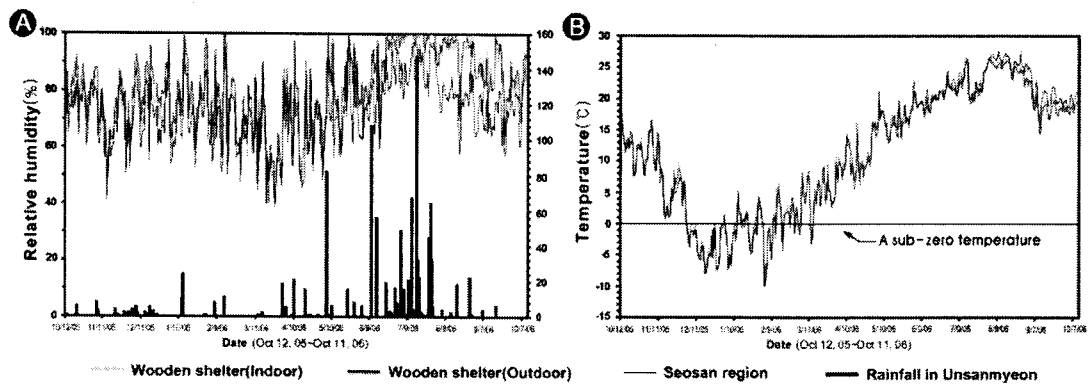


Fig. 3. Microclimatic comparison indoor and outdoor of the wooden shelter with meteorological record of the Seosan region in daily means (Oct. 12, 2005 to Oct. 11, 2006). (A) Relative humidity. (B) Air temperature.

4. Discussion and Conclusions

Microclimate formation of the Seosanmaaesamjonbulsang was caused by complex surrounding environmental factors such as rainfall which is converged than other area because of location of crowded vegetation and stream flows on creeks under the triad Buddha statue. Such highly relative humidity environment induce dew condensation on the rock surface of the triad Buddha. The dew condensation is recorded high frequency at the summer and the winter.

In the case of summer, dew condensation is long time continued due to high rainfall and relative humidity that is kept by more than nearly 95 %. There is progress towards chemical weathering throughout dissolve rock properties and alteration on the rock surface. In the case of winter, dew condensation is not kept for a long time as summer. But, in the winter, which showing a below zero may add physical weathering throughout moisture that happen by dew condensation to repeat freezing and melting.

The wooden shelter is kept moisture that is occurred to triad Buddha. Therefore, it is considered for conservation of the triad Buddha. Also, for stable conservation of the triad Buddha, a long-term monitoring plan should be devised along with comprehensive conservation measures to ensure the preservation of the triad Buddha. And, all of those damage factors should be diagnosed accurately for successful conservation planning.