PRESERVING THE OLD FORTRESS OF CORFU: GEOTECHNICAL STABILIZATION OF HISTORIC MASONRY AND ROCK SLOPES USING INDUSTRIAL ROPE ACCESS TECHNIQUES

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ABSTRACT

The Old Fortress of Corfu is one of the most significant fortified heritage monuments in the Mediterranean region, founded upon a steep limestone peninsula directly exposed to marine and climatic weathering processes. Continuous interaction between the rock mass, historic Venetian masonry, and environmental agents has resulted in progressive deterioration, including rockfalls, masonry distress, and localized instability. This paper presents the geotechnical assessment and stabilization works implemented to ensure the long-term safety and preservation of the monument. The intervention combined passive rock anchors, high-strength steel meshes, wire-rope protection systems, and restoration of historic masonry. Due to the site's restricted accessibility and heritage constraints, conventional heavy equipment could not be utilized. Instead, specialized industrial rope access techniques were integrated with geotechnical engineering methodologies, enabling drilling, anchor installation, grouting, and rock stabilization on near-vertical cliff faces. Particular attention was given to minimizing visual impact and maintaining historical authenticity while meeting rigorous engineering requirements. The project demonstrates how modern geotechnical solutions can be successfully adapted to highly sensitive cultural heritage environments, providing sustainable stabilization while preserving the monument's architectural and historical character.

Keywords: Old Fortress of Corfu, cultural heritage, geotechnical engineering, rock slope stabilization, rope access, masonry preservation

INTRODUCTION

The preservation of historic fortifications located in coastal environments presents significant engineering challenges due to the interaction between geological, environmental, and anthropogenic factors. The Old Fortress of Corfu, a landmark monument of exceptional historical and cultural importance, exemplifies the difficulties associated with protecting heritage structures founded directly upon steep coastal rock formations.

Over centuries of exposure to marine action, salt weathering, climatic loading, and natural rock mass degradation, instability phenomena have developed within both the natural slopes and the overlying historic masonry. Consequently, a comprehensive stabilization strategy was required to ensure public safety while preserving the monument's authenticity and historical value.

This paper presents the historical context, geotechnical challenges, design philosophy, and implementation methodology adopted during the stabilization works performed at the Old Fortress of Corfu.

HISTORICAL BACKGROUND

The Old Fortress of Corfu occupies a strategically important limestone peninsula characterized by two prominent peaks known during the Byzantine era as "Korypho." The fortress derives its international

name, Corfu, from these peaks and has served as a major military stronghold for more than a millennium.

During the sixteenth century, under Venetian rule, extensive fortification works transformed the peninsula into one of the strongest maritime defenses in the Mediterranean. The construction of the Contrafossa, an artificial seawater moat excavated through limestone bedrock, isolated the fortress from the mainland and significantly enhanced its defensive capacity.

Throughout its history, the fortress was occupied by Byzantine, Venetian, French, Russian, British, Italian, and German authorities. Beyond its military function, it also served as a refuge during periods of crisis, including the settlement of Asia Minor refugees in 1923. Today, the monument functions as a cultural center while remaining one of the most important heritage sites in Greece.

GEOLOGICAL AND ENVIROMENTAL CONDITIONS

The fortress is founded directly upon a highly fractured limestone promontory exposed to intense marine and climatic influences. The rock mass is characterized by steep slopes, discontinuities, weathered zones, and locally unstable rock blocks.

The principal deterioration mechanisms identified include:

- Marine undercutting at the base of the coastal slopes.
- Salt crystallization and haloclastic weathering within limestone and historic mortars.
- Rainfall infiltration and moisture-induced deterioration.
- Wind erosion and cyclic environmental loading.
- Root penetration within geological discontinuities.

These processes resulted in progressive degradation of both the rock mass and the Venetian masonry structures, creating potential hazards for visitors and heritage assets.

GEOTECHNICAL DESIGN

The stabilization strategy was developed to provide long-term structural safety while minimizing intervention on the historic fabric of the monument.

The primary stabilization measures included:

- Installation of passive rock dowels (Ø25 mm, hot-dip galvanized).
- High-strength steel wire mesh systems.
- Heavy-duty wire-rope net protection for unstable rock volumes.
- Restoration and repointing of historic masonry.
- Drainage measures for hydrostatic pressure relief.

A critical design requirement was the implementation of all works without generating significant vibration, excavation impacts, or visual disturbance to the monument.

IMPLEMENTATION OF ROPE-ACCESS GEOTECHNICAL WORKS

Preliminary safety measures

Prior to the commencement of stabilization activities, exclusion zones were established downslope to protect visitors and infrastructure. Loose and overhanging rock fragments were removed using controlled scaling techniques carried out by certified rope-access technicians.

Drilling and anchor installation

Given the absence of access for conventional drilling equipment, lightweight rope-supported drilling rigs were employed. Boreholes ranging from 75 to 90 mm in diameter and up to 6 m in depth were drilled directly into the rock mass from suspended working positions.

Grouting operations

Anchor installation was completed using enhanced white cementitious grout. Injection was performed from the base of each borehole outward to ensure complete filling and optimal bond development between steel, grout, and rock mass.

Tensioning and stabilization

Following grout curing, bearing plates and hexagonal nuts were installed and tightened to specified torque levels. The resulting system provided both shear resistance and compressive confinement of potentially unstable rock blocks.

Treatment of discontinuities

Major fractures were cleaned and fitted with discreet drainage elements to reduce hydrostatic pressure build-up. Additional reinforcement was provided through steel mesh systems and high-strength wire ropes, followed by masonry restoration using conservation-approved pointing mortars compatible with the historic limestone fabric.

RESULTS AND DISCUSSION

The implemented stabilization works successfully addressed both geotechnical and conservation objectives. The use of industrial rope access techniques allowed the execution of complex engineering interventions within an inaccessible heritage environment without the need for heavy machinery or significant landscape modifications.

The methodology reduced visual impact, eliminated the need for temporary access roads, and simplified compliance with heritage protection requirements. At the same time, the stabilization measures enhanced rock slope safety and improved the long-term resilience of the historic masonry.

The project demonstrates the effectiveness of integrating modern geotechnical engineering practices with heritage conservation principles.

CONCLUSIONS

The Old Fortress of Corfu represents a unique combination of historical significance, architectural heritage, and challenging geological conditions. Long-term exposure to marine and climatic deterioration necessitated a comprehensive stabilization program focused on both the natural rock mass and the historic Venetian masonry.

The successful application of rope-access geotechnical techniques enabled the implementation of demanding stabilization works while preserving the monument's authenticity and minimizing environmental impact. The project highlights the importance of interdisciplinary collaboration between geotechnical engineers, conservation specialists, and rope-access professionals in the preservation of complex heritage sites.

The adopted methodology provides a valuable framework for similar interventions at coastal fortification monuments and historic structures located in difficult-access environments.

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