

Erosion control & Shoreline protection

Strategies for :
Dealing with the impact of climate change on
cultural heritage.

Presenter: Wu Yuting

PRESENTER:WU YUTING



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Case introduction: Stone Old Man



Legend of the Stone Old Man story

Stone Old Man is a typical sea-erosion column landscape on the coast, standing in Qingdao City for 6,000 years. Due to its special shape, it became an iconic landmark in Qingdao Tourism, also a famous location for movie shooting.

It is also the first batch of intangible cultural heritage of Shandong Province. Unfortunately, it collapsed in October 2022 with the head falling, stones of the arms and hips falling and disappearing one after another.

Many people were shocked by the collapse of Stone Old Man!

Reason for the fall: According to experts' on-site investigation, it is believed that due to perennial weathering and seawater erosion, coupled with the recent years climate changes, resulted in the natural collapse of the upper part of the Stone Old Man.



Resilience

Step 1: Digital heritage live 3D model

In 2021, the construction of a realistic 3D Qingdao was carried out, using technology about tilt aerial photography and laser 3D scanning to "move" the city into the computer with a higher accuracy of 3 cm in the main city.

The Stone Old Man was also collected, presented a complete realistic three-dimensional model in the computer, and has the characteristics of measurable, high precision, providing reliable data for the its restoration.



Step 2: Fracture sealing and collapse remodeling

Fracture sealing:

The reinforcement technique of microbial induced calcium carbonate precipitation (MICP) compensates for the limitations of traditional repair methods in the application of engineering trauma repair methods.

The product of this technology is calcium carbonate crystals, which have good compatibility and interfacial strength with stone with calcium carbonate as the main component and can repair the fracture to the maximum extent when combined with the use of a highly mobile bacterial solution for grouting the broken area.

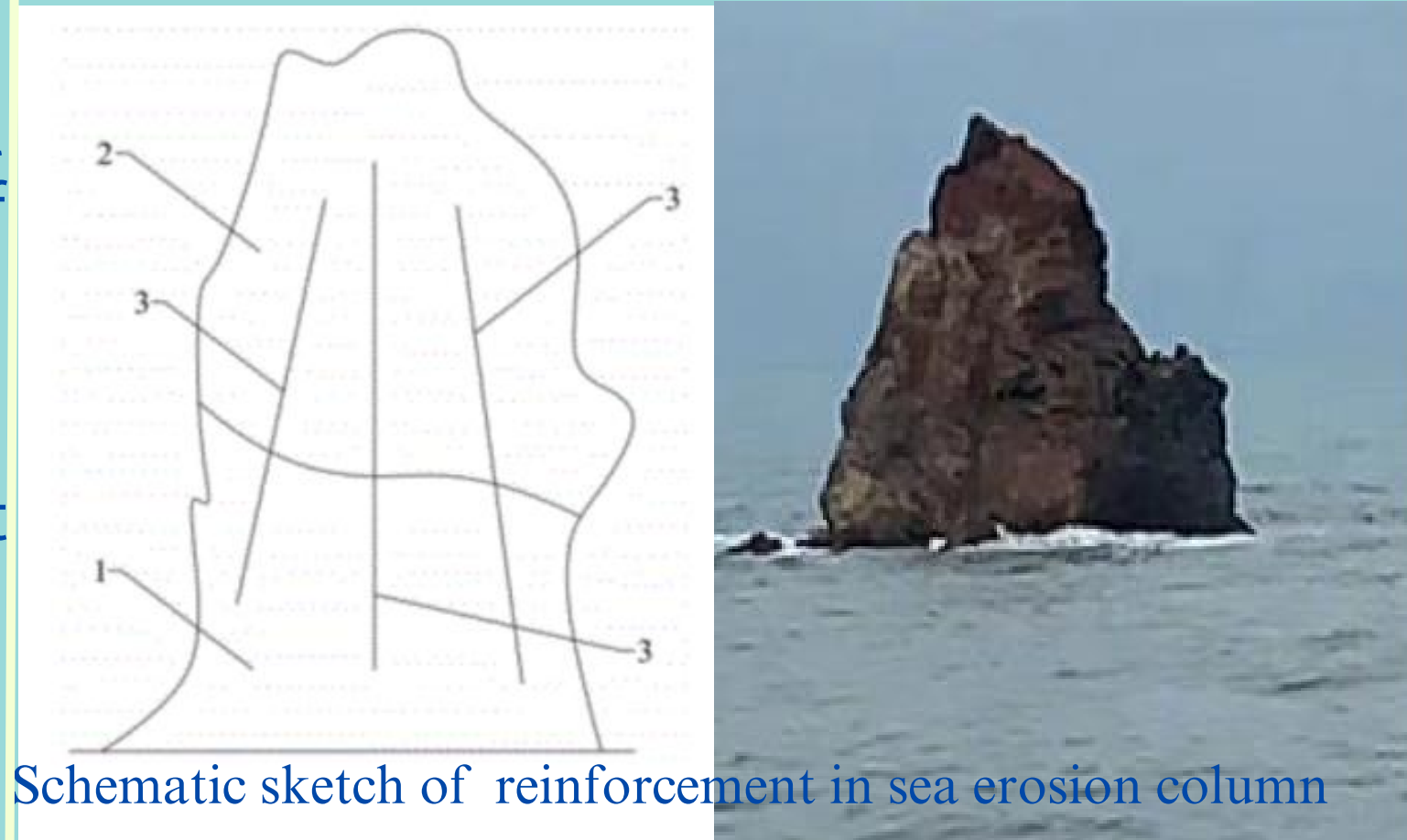
Problem: As its head and arms fell last year and collapsed seriously. The smaller parts were washed away by the sea. For the larger part the repair could not be completed with only the previous microbial grouting.

Resilience

• Remodeling of collapsed parts:
Screening classification: For the collapsed sea erosion column into several parts, the remaining base of the column is used as the basis, and other parts are divided into major and minor parts according to the screening conditions.



By carrying out four restorations in incremental steps, under the premise of the original technology MICP microbial slurry, together with the supporting and fixing effect of steel reinforcement, it makes the restored sea erosion column more stable.



Adaption

1) Lao Mountain Cultural and Tourism Department, as well as relevant associations, should carry out regular inspections. Especially in the period of frequent precipitation in the rainy season, as well as the period of wave and storm surge outbreak, the frequency and number of inspections should be increased.
2) Make full use of the advantages of AI technology to have higher accuracy and faster response time in the face of complex climate change predictions. Achieve accurate AI and manual cooperation.



Four repairs:

- 1 Primary restoration: Reinforcement to base connection with microbial slurry dip.
- 2 Secondary repair: Backfilling the recessed position of the sea erosion column with filler and grouting with microbial slurry.
- 3 Third repair: Fissure grouting to solidify.
- 4 Final restoration: Spraying microbial slurry on the outer surface of column to form an overlay, completing the restoration.

References

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Thank you!