

**Zeitschrift:** IABSE reports = Rapports AIPC = IVBH Berichte  
**Band:** 70 (1993)

**Artikel:** Structural preservation of St. Paul's Facade at Macau  
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**DOI:** <https://doi.org/10.5169/seals-53375>

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## Structural Preservation of St. Paul's Facade at Macau

Conservation structurale de la façade de St. Paul à Macao

Strukturerhaltung der St-Pauls-Fassade in Macao

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### 1 - INTRODUCTION

The St. Paul's Facade at Macau is part of a church whose construction was concluded in 1644. Its architect was the Italian Jesuit Carlo Spinola who led a team of Christian Japanese workers.

The facade built with pink granitic stones is very imposing due not only to its dimensions, but also to the fact of being marvelously sculptured with decorations both in Western and Eastern style.

The church, whose interior (columns and ceiling) was made of wood, was destroyed by a fire in 1835 and only the stone facade remained. The fire deteriorated some stones, namely those placed around the window frames of the facade. So, afterwards, these frames were strengthened with brick arches placed in their interior.

In 1935 a general restoration campaign was carried out and most of the joints between stone blocks were refilled with a strong cement mortar that covered part of the block edges contiguous to the joints.

By 1990 the facade had the following pathology:

- displacement of some stones from their original positions
- infestation by plants rooted in the joints between stone blocks
- bad drainage conditions
- dirtiness due to traffic pollution, rain water and "graffiti".

Thus the Macau Municipality and the Macau Cultural Institute formed a joint-venture in order to promote the following actions for the facade rehabilitation:

- stability studies
- preservation works

In order to valorize the monument and to establish a future museum on site an archaeological search was carried out in order to find the remains of the interior foundations of the original church.



## 2 - STABILITY STUDIES

Studies were made in order to evaluate the facade stability conditions.

First a radar search was undertaken in order to evaluate the soundness of the facade stone blocks and to verify if there were voids between them.

Then a survey to the foundations bottom was made by excavating inspection pits.

Finally, penetrometer tests were executed in order to quantify the soil capacity bellow the seating level of the foundations.

With all the collected data a stability analysis was made mainly for the severe local wind conditions (typhoons). The strongest wind ever recorded in Macau was in September 1964 (typhoon Ruby) with peak velocities of 211 km/h. The "Code of Practice on Wind Effects" of Hong Kong, edited in 1983, prescribes wind pressures that correspond to peak velocities of 214 km/h.

The conclusions obtained from the referred studies were:

- a strengthening of the foundations should be executed since only one half of its width was in contact with the granitic bed-rock. A solution with micropiles was proposed
- the resistance of the superstructure is sufficient provided that actions to correct the detected pathology are undertaken.

## 3 - PRESERVATION WORKS

The preservation works carried out were mainly:

- replacement of displaced stones using hydraulic jacks. After reaching the convenient position stones were kept by using stone wedges thus allowing the removal of the jacks before the refilling of joints with mortar
- removing of the existing vegetation by using adequate chemical products (herbicides)
- repair of damaged joints between stone blocks using lime mortar. Particular care was taken in order to place the mortar withdrawn from the vertical plan of the facade
- improvement of the drainage conditions by correction of existing mortar slopes and execution of new ones
- hand cleaning of the facade mainly using low pressure water and plastic or nylon brushes. In the case of greasy stains detergents were also employed. For the removal of the "graffitti" some organic solvents (chloride of methylene, for instance) were required
- removal of the exceeding part of the cement mortar placed in the joints during the 1935 restoration campaign. This was made by cleaning the joints to a depth larger than their width with a minimum of 25 mm. Metallic hand tools, as scratchers, hammers and chisels or wire brushes, were employed carefully in order to avoid damages on the granitic blocks. After the excessive cement mortar was removed the joints were just cleaned with compressed air.