

12<sup>TH</sup> INTERNATIONAL  
BRICK/BLOCK  
Masonry  
CONFERENCE



Ade

## CONSTRUCTION OF THE MILLENNIUM ARCH

*(this paper is to continue the paper Millenium Arch: volume I, page 157)*

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### ABSTRACT

*The article includes some of the most revealing images of the construction process employed to raise the Millennium Arch in front of the Palacio de Congresos in Madrid, which held the 12<sup>th</sup> IBMAC.*

Figures have been grouped into the following items:

- Components: (figs 1 to 8)
- Foundations: (figs 9 to 13)
- Abutments: (figs 14 to 17)
- Arch: (figs 18 to 22)
- Formwork and Striking: (figs 23 to 26)
- Finishings: (figs 27 to 31)

## 1. COMPONENTS

Figure 1. Assembly of "umbrella" forms or rib framework guides for the oblique cylinder (14m diameter x 7.5m high).

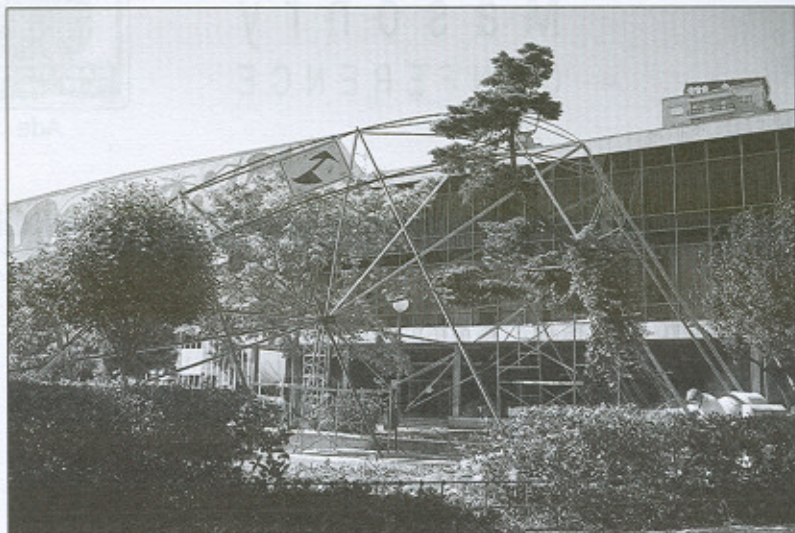


Figure 2. Circular arch segment between the "umbrella" rib guides (2.92m long).



Figure 3. Circular arch guide fixed between the rib guides, indicating the course strips employed to support the brickwork in its precise position (2.92m long).

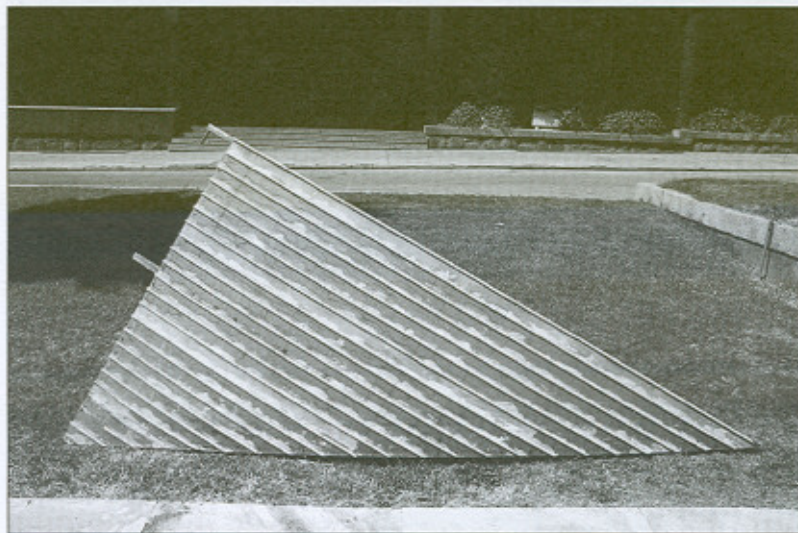


Figure 4. Allwall Flowerbrick manufactured by INCECOSA (Grupo ALMIRAL) of 285x137x49mm.

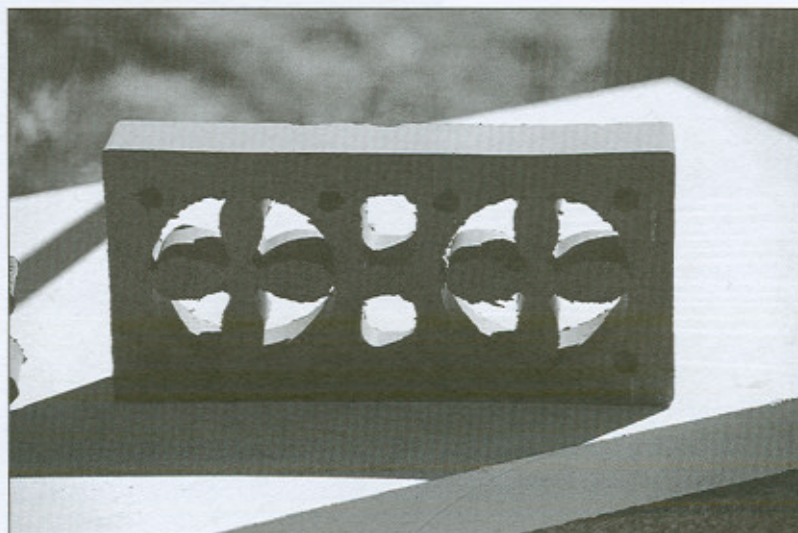


Figure 5. Lateral opening in the Allwall Flowerbrick to house vertical reinforcement, through the removal of the internal "petals".



Figure 6. 10mm diameter ACERINOX corrugated stainless steel bars placed in bed joints.

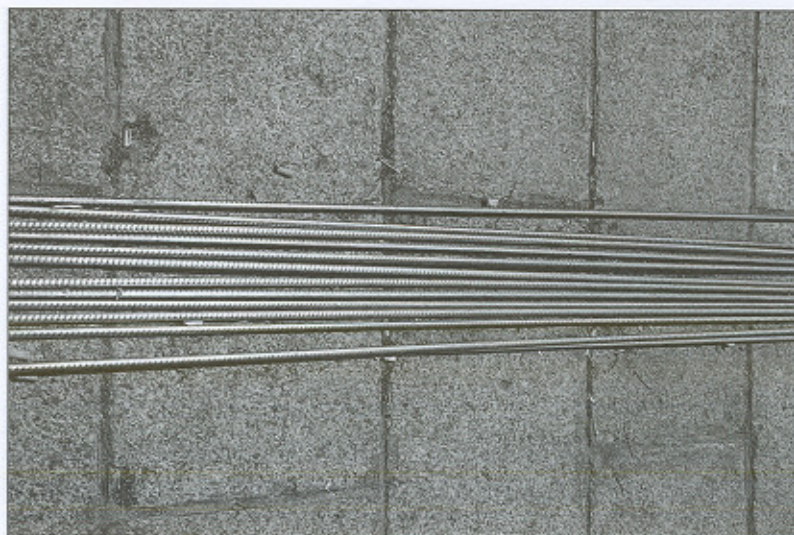


Figure 7. 10 mm diameter corrugated stainless steel hoops for the Arch area

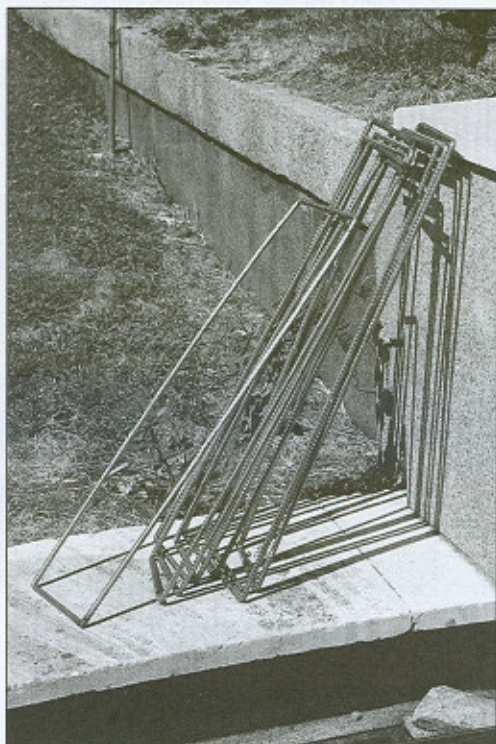


Figure 8. BEKAERT bed joint truss reinforcement, type Murfor RND 5/S-200mm.

M-80 Mortar in side walls and M-160 mortar in the arch beam of the central Arch.

## 2. FOUNDATIONS

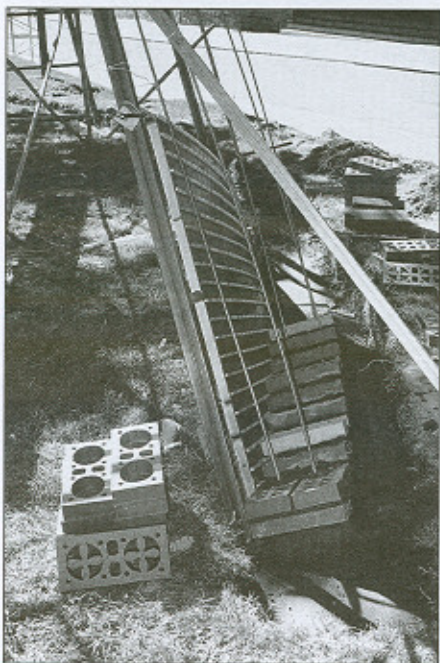


Figure 9. Triangular edge guide for raising of brickwork above foundations.

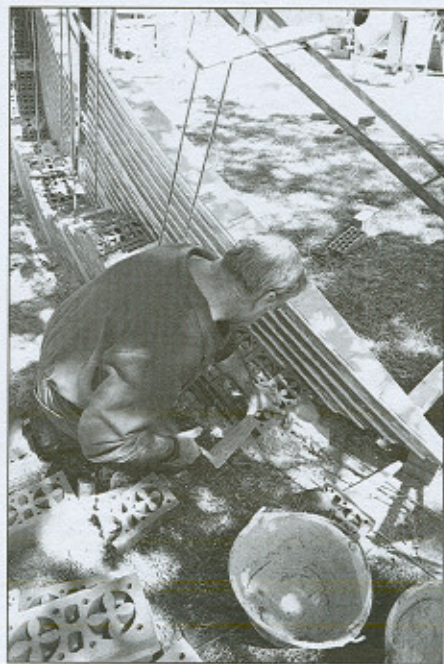


Figure 10. Springing of course at angles of  $30^{\circ}$  over strip foundations.

Figure 11. Trust type bed-joint reinforcement distributing loads over the strip foundations.

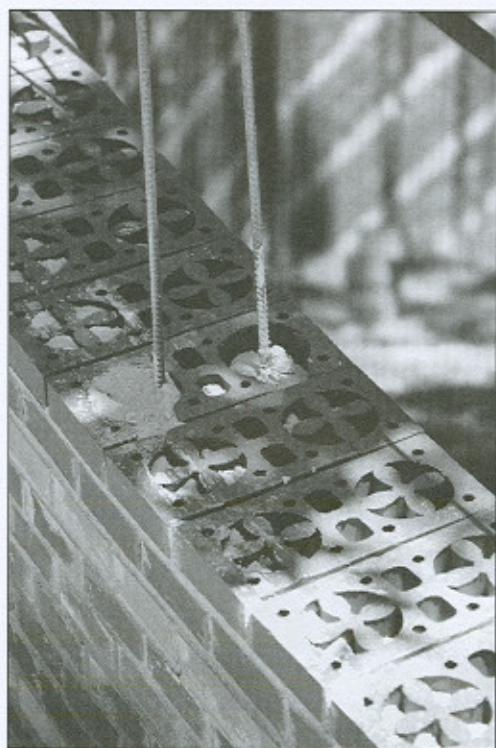
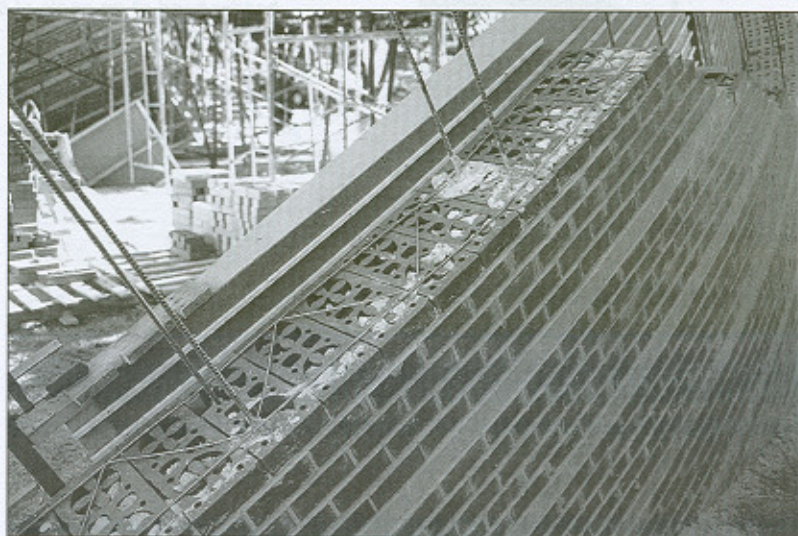


Figure 12. Flowerbricks opened laterally to house vertical ties.



Figure 13. Springing of the one brick thick leaning jamb of the Arch in header bond at an angle of 60° to the vertical.

### 3. ABUTMENTS

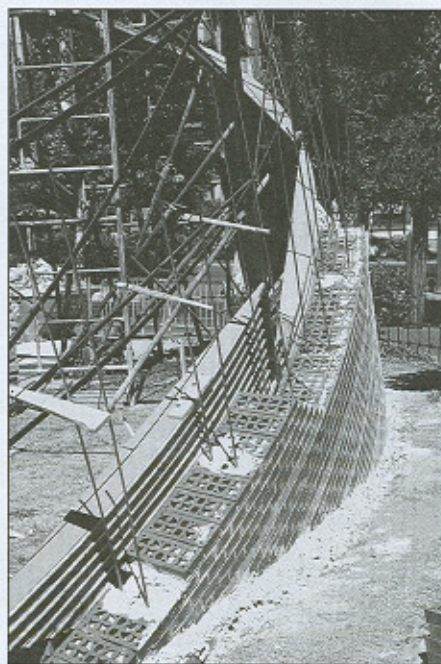


Figure 14. Right abutment under construction with sloping courses and seen from its external concave face.

Figure 15. Left abutment under construction with sloping courses and seen from its internal convex face.



Figure 16. Detail of the abutment with its vertical ties embedded within the Flower bricks and the bed joint reinforcement set at 30°.

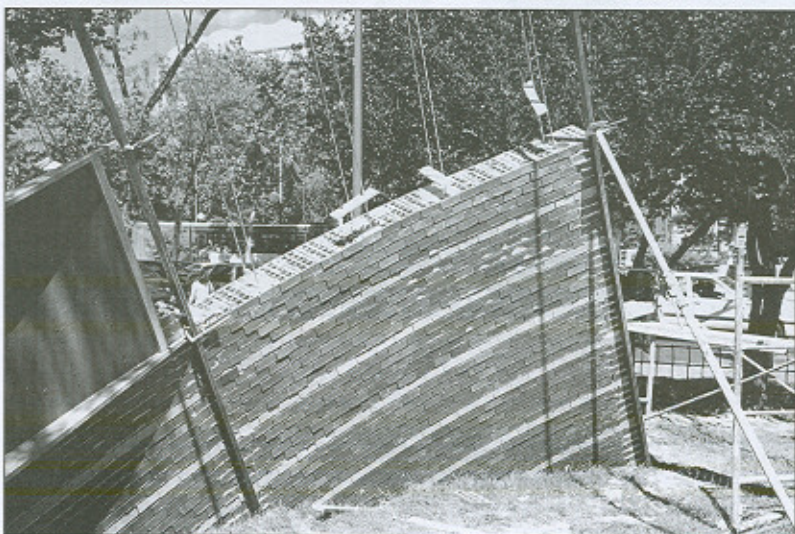
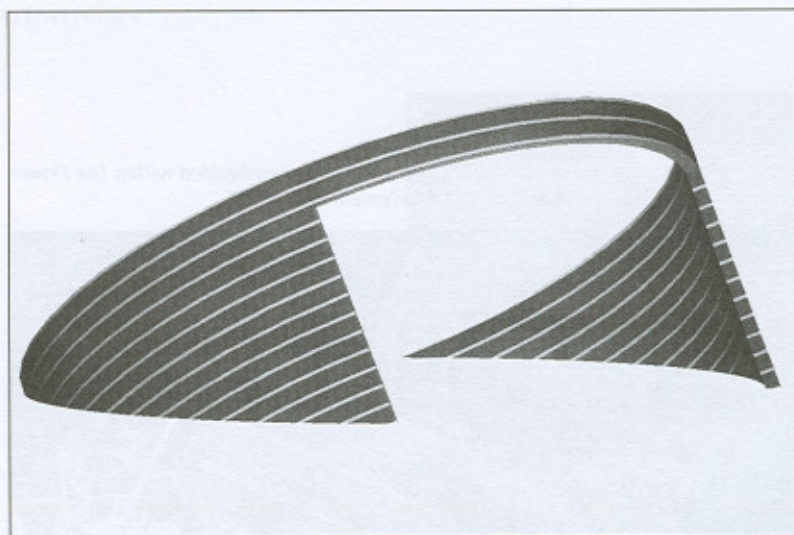
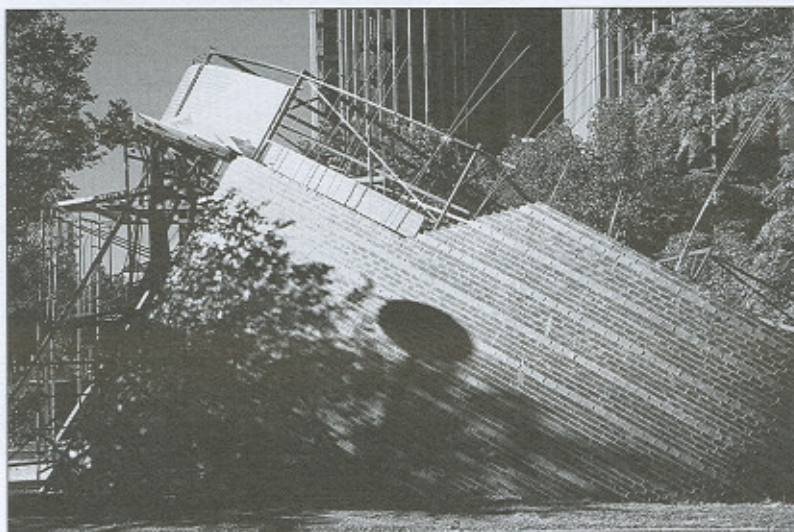


Figure 17a-17b. View of the right sloping abutment being propped until the Arch is completed and full stability obtained.



#### 4. ARCH

*Figure 18a-18b. Layout of the four course guides of the Arch and two end sections at each side fixed to the framework "umbrellas", together with the propped boards or arch centres supporting the first course of brickwork.*

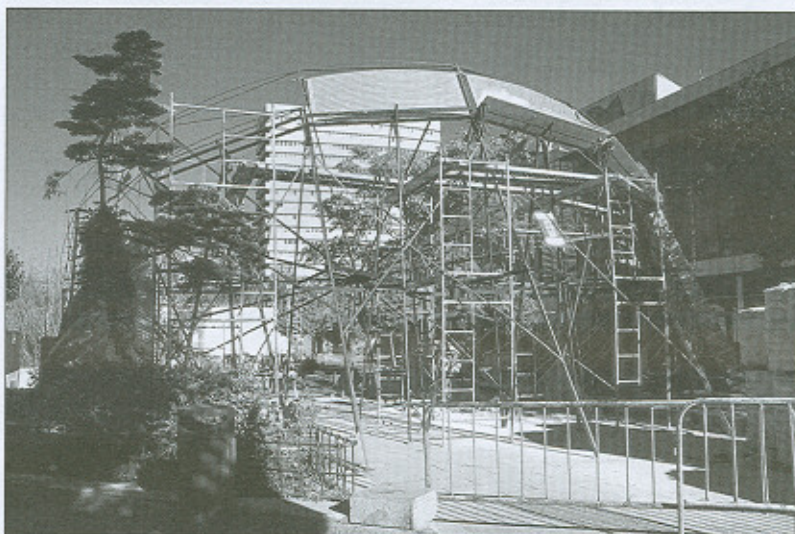
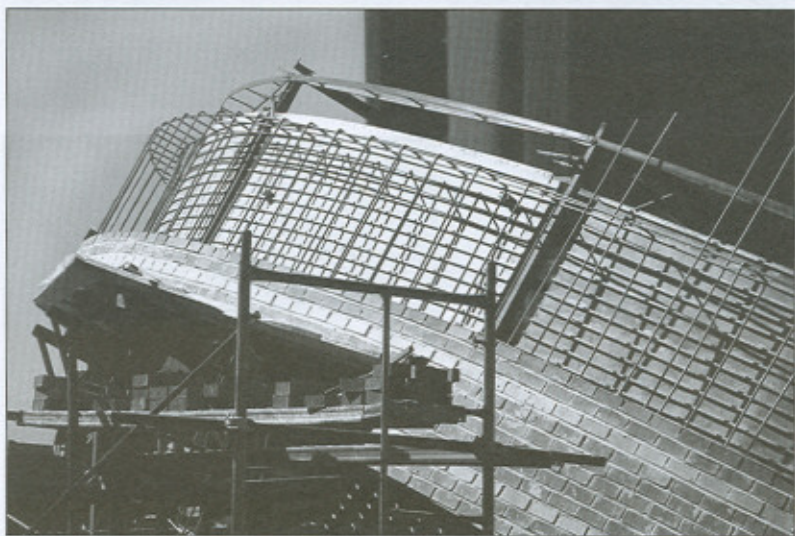
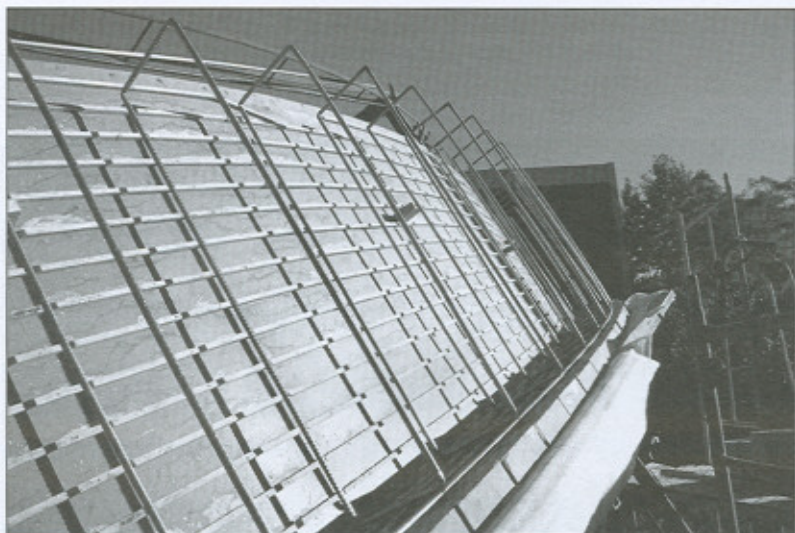
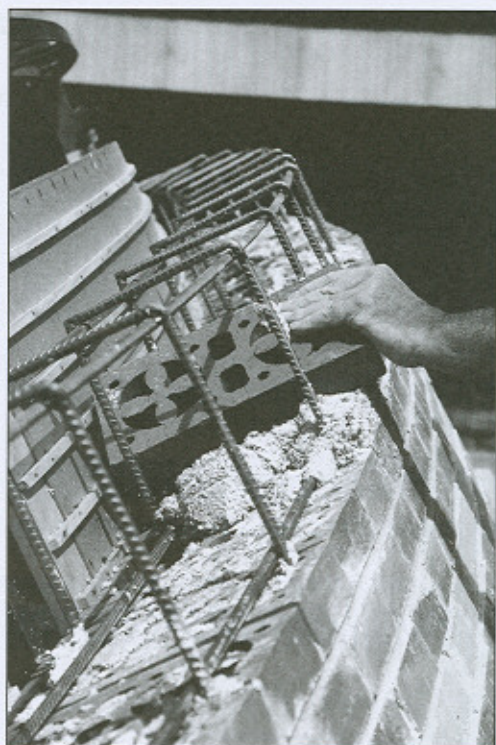


Figure 19a-19b. Springing of the Arch above the formwork with the vertical hoops set at regular spacings.





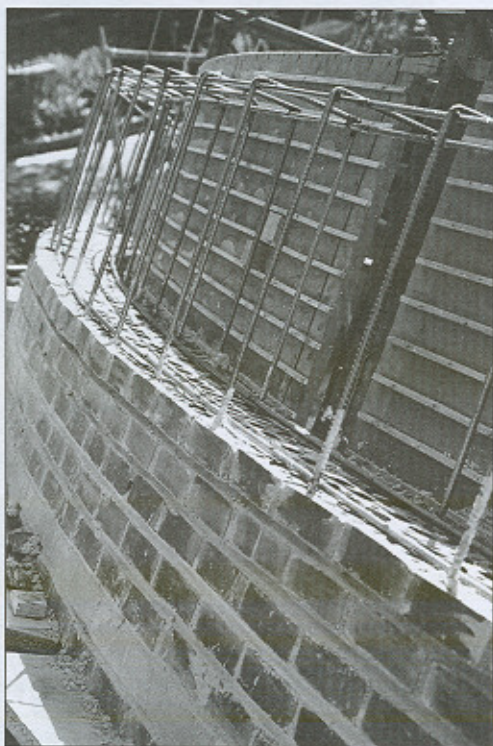
*Figure 20. Location of the Flower brick between two hoops.*



*Figure 21. Placing of the laterally opened flower brick to receive the hoop*



Figure 22a-22b. Laying of the continuous longitudinal bed joint reinforcement.



## 5. FORMWORK AND STRIKING

Figure 23. Oblique view of the arch centres supported on edges in the steel prop structure of the Arch, note the 5cm spacing between the arch centres and the struts that are filled by wedges.

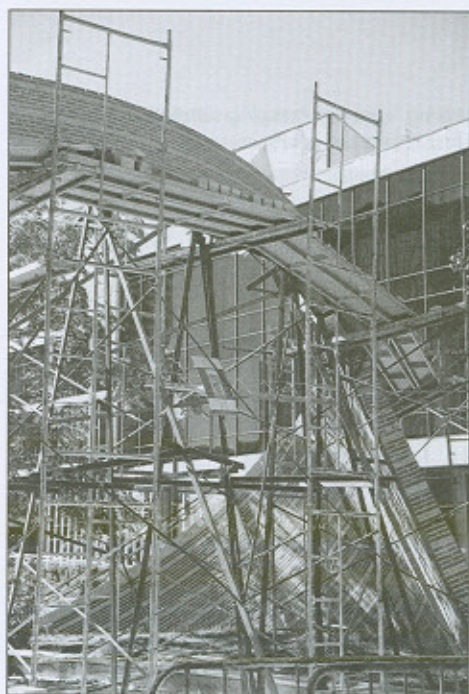


Figure 24. Completed and propped Arch awaiting final setting prior to striking.

Figure 25. View of the Arch during the striking process, with the “umbrella” guide partially dismantled.

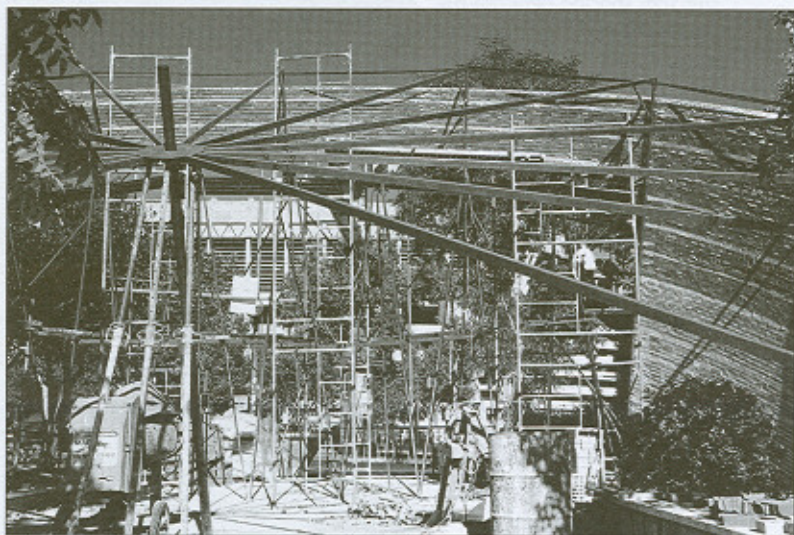
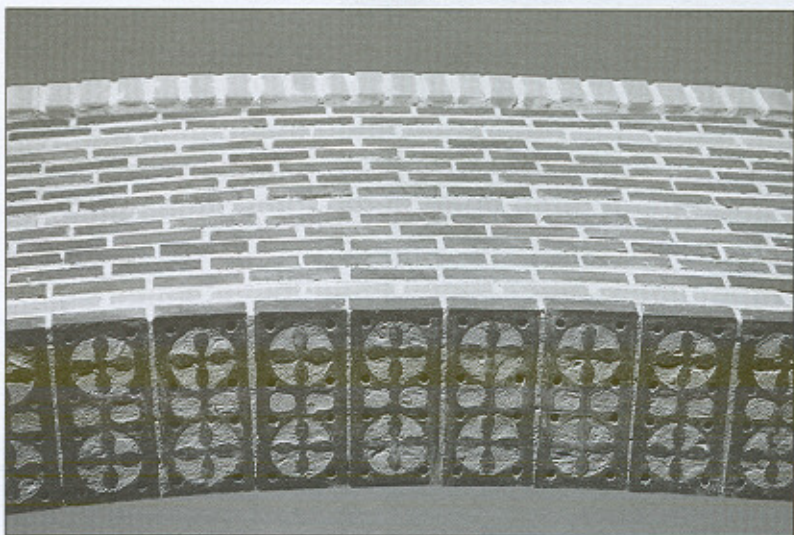
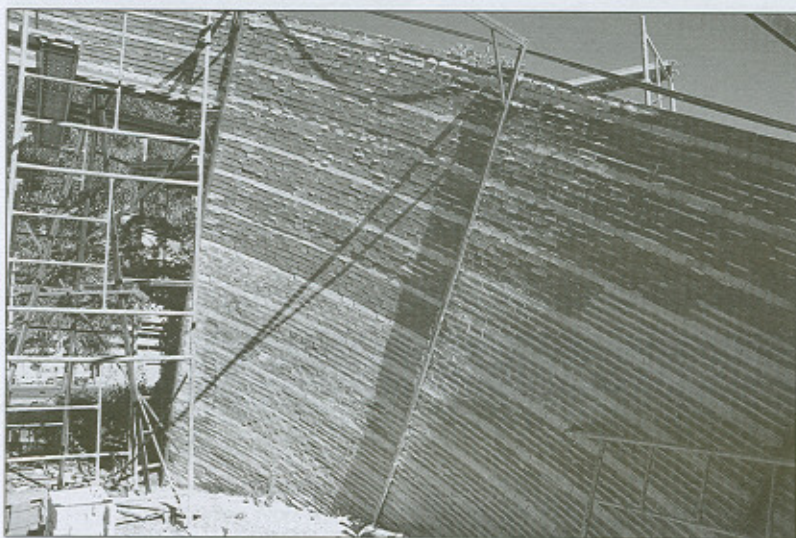


Figure 26. Lower view of the Arch after striking, showing hanging unopened flower bricks anchored to the first reinforced course.



## 6. FINISHINGS

*Figure 27. Internal convex view of the Arch showing: the lower courses pointed after removing the guide work the upper courses raked by the guide strips, and prior to pointing.*



*Figure 28. External concave view of the Arch indicating the header bonded coursework with pointed bed and vertical joints.*

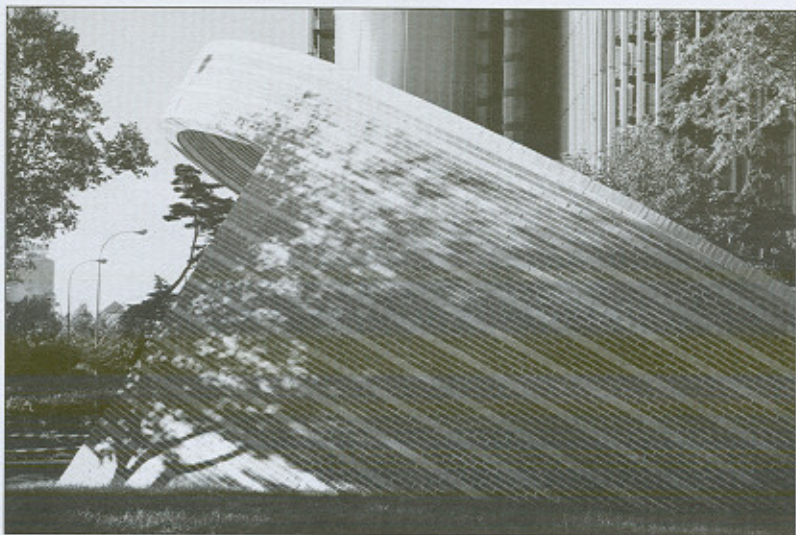


Figure 29. Soldier coping of the Arch set above a rebated course which will house strip lighting and/or guide rails for the fixing of posters on the face of the Arch.

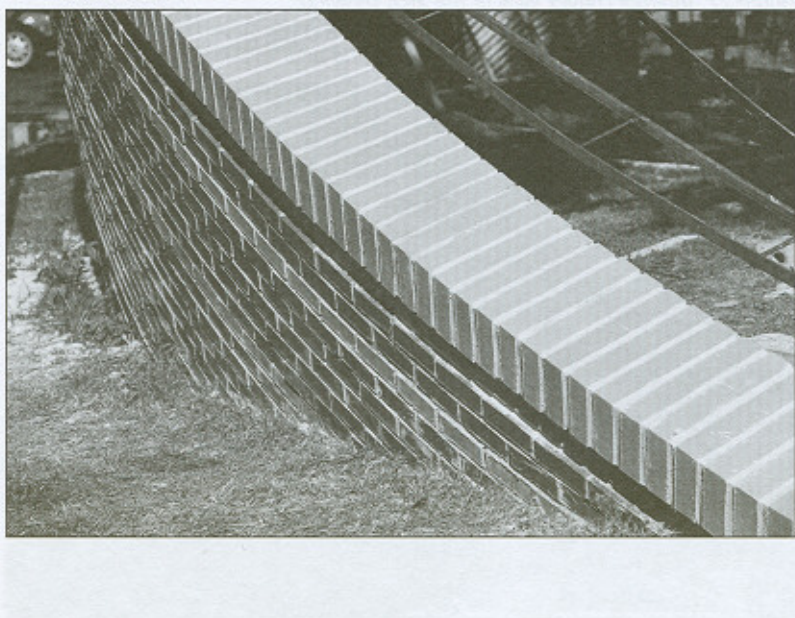


Figure 30. External concave view of the Arch in header bond with bands of yellow brick set every six red courses. Vertical and bed joints are of similar thickness and are pointed in mortar.

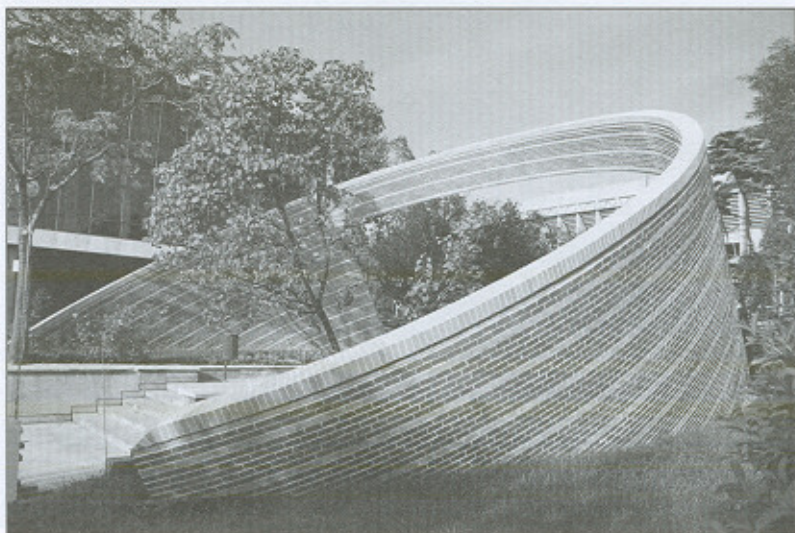


Figure 31a-31b. Internal convex view of the Arch in header bond with bands of yellow brick set every six courses. Note the raked vertical and bed mortar joints.

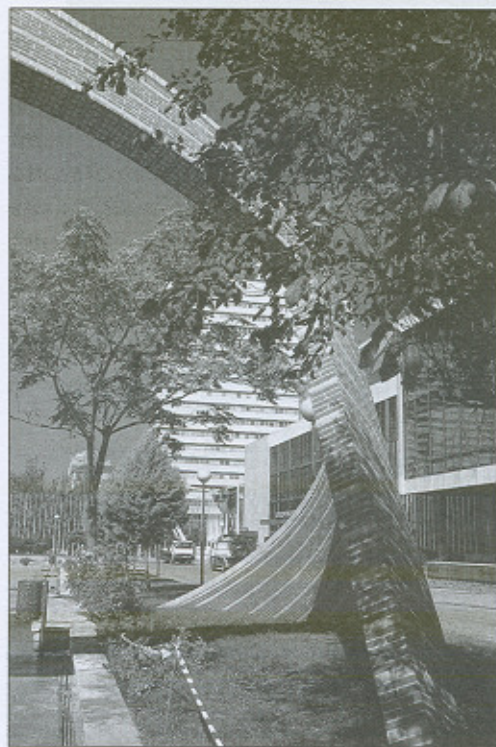
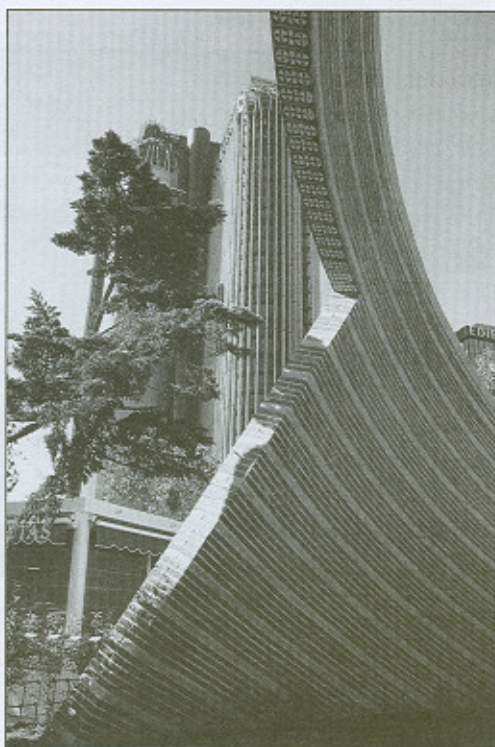


Figure 32. General view.



Figure 33. 2000 Millenium Arch.

