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Le Corbusier – Plans
DVD N°11

Notice
"1950 - Studies in Sunlight - Tower of Shadows (Chandigarh)"

Daniel Siret

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Studies in sunlight

With the commission for his projects in India, Le Corbusier's somewhat empiric approach to control of sunlight and the arguments that he had used up until Marseilles (1) were no longer operational. The harsh Indian climate demanded careful thought as to construction methods and the resulting levels of comfort. The architect was soon aware of this, as we see in the idea of the « Grille climatique » (Climate chart) that emerged late 1951 (2). Although it was probably never really applied, at the least it served to formulate the problems faced by buildings at Chandigarh, and to investigate cooling techniques that would secure, in particular, adequate protection against sunlight. This research owed a great deal to the work of Iannis Xenakis, a gifted engineer and surveyor who joined the rue de Sèvres atelier in 1947 (3). Xenakis brought a new dimension to studying the geometrical problems of solar exposure in Corbusian architecture, no doubt owing to the musical and structural experiments that he conducted in parallel.

The first traces that point to new research into methods for determining the effects of sunlight date from January 1952, and coincide with the efforts made to develop a climate chart for the Indian projects. We see there the azimuths and heights of the sun at Chandigarh, according to different planes of projection (FLC5666, FLC5667, FLC5670, FLC5671). In the course of 1952 this research led Xenakis to perfect an original solar diagram in the form of a synthetic abacus, which enabled the rapid drawing in of shadows cast at the three significant periods (winter and summer solstices, equinoxes). Presentation panel FLC7096 dated 4 June 1952, shows the first example of this solar diagram made for the latitude of Ahmedabad, where several projects were already under construction. The erasures bear witness to the difficulty in geometrical construction. Six months later (December 1952), Xenakis drew a similar diagram for the latitude of Paris (49° North, FLC30662) (4). It is this drawing that is reproduced in the *Oeuvre complète*, as a sort of demonstration of Le Corbusier's *savoir-faire* in control of sunlight (5).

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1. See the article 'Sunlight', DVD 7, vol. 2
2. See the article 'Climate chart' in the present volume.
3. See S. Sterken, « Travailler chez Le Corbusier : le cas de Iannis Xenakis. Le conflit comme stratégie créative », in J. Quetglas : *Massilia, 2003. Anuario de estudios lecorbusierianos (28)*, Barcelona: Fundación Caja de Arquitectos ». See also by the same author : « Une invitation à jouer l'espace. L'itinéraire architectural de Iannis Xenakis », as well as the biography of I. Xenakis, on the Friends of I. Xenakis website (http://www.iannis-xenakis.org)
4. This drawing provides a method for the graphic projection of the shadow cast from a given point onto a horizontal plane. The three diagrams on the right indicate stages in the method once the azimuth and height of the

In 1953, Xenakis proposed a new solution for representing solar data at the solstices and equinoxes (FLC5665). In this diagram, the heights of the sun are not represented directly, but by a system of graduations associated to a yardstick reproduced in the margin, which enables easy projection of the shadow cast by a vertical of known height. The personalized caption attached to the drawing is interesting : *« Chandigarh. Shadow of a straight line graduated in centimetres perpendicular to the horizontal plane represented by this sheet (…). Drawn by Xenakis, 9-53, for Tobito, his friend »* (6).

Geometrical solar research broke off at this point, perhaps because Xenakis came to be more closely involved with other projects of the atelier, in particular the Couvent de la Tourette. Not until June 1956 did I. Xenakis and A. Talati take up the work again. On 23 June Talati wrote up a study of geometrical theory (7); it expounded the elements for understanding the projection technique that Xenakis had used to construct his solar diagram four years earlier. On 26 June (FLC5664), and then on 28 June 1956 (FLC31348), Talati drew several solar diagrams using Xenakis's method, for the latitude of Chandigarh. A complete diagram for this latitude was drawn up by Xenakis himself on 13 September 1957 (FLC5696) (8), no doubt for purely demonstrative ends, since most of the Chandigarh projects were already designed by then.

Tower of shadows

While studies of sunlight are clearly in evidence in many of the Indian projects (9), the most consummate example of this approach is without question that made for the Tower of shadows, also known as the 'Tower of 4 horizons', with which Le Corbusier graced the esplanade of the Capitol at Chandigarh. The Tower rises at the North corner of the 'Fosse de la Considération', not far from the 24 solar hours' diagram. Like the Open Hand and Monument to the Martyrs, the Tower is a symbolic attribute of the Capitol and has no specific function. Le Corbusier described it as *'a very open hall, very high and shadowy'*, its sombre atmosphere intended to invite meditation (10). It can also be seen as a sort of manifesto for the brise-soleil, demonstrating, as the architect noted, *'that the sun can be controlled at all four cardinal points of an edifice and even manipulated in a hot country to reduce temperatures'* (11). The

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sun are known for the date and hour under study: the ray of sunlight is traced in plan following the azimuth, as is shown in the bottom drawing, then its trace is drawn in elevation in height (thrown in the frontal plane), as shown in the drawing in the centre; and lastly, by projecting down onto the horizontal plane, the ray of sunlight's point of impact is determined for the given time. However ingenious it may be, the construction is not difficult to understand. But the rest of the drawing is more complex. To understand it, we need to refer to the study written by A. Talati in June 1956 (FLC F2-16-9). What we see are lines that correspond to the graphic determination of azimuths and heights of the sun for a given latitude, at the solstices (winter and summer) and the equinoxes. Readers can follow the stages of geometrical construction in Talati's text, and see them at work in the drawing done by Xenakis.

5. *Oeuvre complète*, Vol. 6, 1953-1957, p. 74. The diagram is presented under the title *« Schéma pour la détermination de l'ensoleillement (exemple) »* and even though it was calculated for the latitude of Paris, it is shown opposite the project for the Tower of shadows at Chandigarh.

6. Presentation panel FLC5698 is a preparatory version of it, with no specific caption.

7. Etude théorique des problèmes d'ensoleillement (lumineux), 23 June 1956, FLC F2-16-9

8. See also non dated presentation panel FLC5674.

9. See for example panels FLC2646, FLC2830, FLC3308, FLC6130, FLC3062, FLC3735, FLC2640, etc. A thorough inventory of these drawings and commentary on them would be too fastidious in this notice.

10. *Oeuvre complète*, Vol. 6, 1953-1957, p. 74

11. *Oeuvre complète. Les dernières œuvres*, p. 76

demonstration is indeed impeccable: the positioning of the Tower's brise-soleil, built in the mid-1980s, thirty years after they were designed, let practically no sunlight inside, as our laboratory simulations have shown.

The first thought directed towards this project appears to date from the early 1950s. For example, in December 1952, at much the same time as Xenakis drew his solar diagram for Paris, Le Corbusier noted in his Sketchbook : *'urgent / Get Xenakis onto the Tower of 4 horizons to settle the brise-soleil question with precision'* (12). In spite of the note of urgency, studies for the Tower were not done until over three years later. Design seems to have gone through two quite different stages, first in January 1956, then in January and February 1957. In January 1956, the general form was fixed. It is a volume with an almost square base, open on three levels (with no intermediate floors), and with a crowning level set at an oblique angle (cf. axonometric view FLC5749) and a long access ramp. As Le Corbusier wrote: *'the edifice lies exactly north-south and deliberately breaks the symmetry of the immense esplanade'* (13) (FLC5815). The choice of an oblique crown may be intended to demonstrate the effectiveness of the brise-soleil not only in the four cardinal directions of the main corps, but also in diagonal directions. The brise-soleil devices that compose the façades are in fact adjusted in three dimensions, according to the direction faced: vertical cross walls set at various slants provide protection early and late in the day, when the sun is low on the horizon. The remainder of the time, horizontal wing walls of varying depth block the sun's rays.

The work of adjusting these brise-soleil appears to have been intense. Presentation panels FLC5760 and FLC5765 of 19 January 1956 refer to *'studies to be done for the Tower of shadows'* according to directions faced and the forms given to the brise-soleil. These studies are contained in various preparatory drawings that show the angle of the sun on each elevation: North-East façade (FLC5802), South-West façade (FLC5803), East façade (FLC5804), North façade for summer sun (FLC5805), South façade (FLC5806), North-West façade (FLC5807), South-East façade (FLC5808). Vertical brise-soleil of variable width are proposed (panel FLC5792). The brise-soleil on the highest level have varied forms (panels FLC5770 and FLC5777 show a serrated design). Notes accompany some of the sketches. For instance, for panel FLC5768 (26 January 1956), the architect has noted *'vertical brise-soleil are practically useless since hot South East sun penetrates from both two directions* (14).

The project for the Tower seems to have gone into a dormant phase after this. On 21 January 1957, exactly a year after the first study, Talati jotted on a notepad *'Finish the Tower of shadows Chandigarh Esplanade'* (FLC5820). In five hand-written pages complete with sketches dated 31 January and 11 February 1957 (FLC5819), Talati began a critical review of the propositions formulated a year earlier. His thought becomes discursive; the effects of horizontal wing-walls and vertical cross walls are examined hour by hour and carefully commented on according to the directions faced. These notes are abound in indications such as: *'East Side: horizontal brise-soleil at 2.26, from 140 to 182 deep. With vertical brise-soleil there is no need of horizontal brise-soleil'* (15). He compares and comments on different variants, as for example : *'West Side. Summer. Possibility I. Sunlight does not penetrate until 5 pm. Vertical brise-soleil no*

12. *Carnets 2 1950-1954*, sheet 920 (December 1952)
13. *Oeuvre complète*, Vol. 6, 1953-1957, p. 74
14. Literal transcription.
15. Literal transcription.

longer work after 5 pm and even horizontal brise-soleil hardly work because the angles of solar heights are less than 30°). Possibility II. In the contrary case, the sun is completely blocked after 2.30 pm. Up until 2.30 pm, it is the horizontal brise-soleil that work. They help let the wind pass freely' (16). This theoretical investigation finds expression in presentation panels FLC29122, FLC29123, FLC29124 and FLC29125 which show varied tests of brise-soleil both for the main corps (brise-soleil of varying depth and spacing) and the highest floor (brise-soleil of variable thickness, with or without vertical cross walls North-East side). The corresponding sections and façades are drawn (FLC29126, FLC29127, FLC29128, FLC29129, FLC29130). The mode of shading chosen for these drawings confers a certain mystery on volumes. Presentation panel FLC29131 establishes the definitive site plan, while panel FLC29132 shows the axonometric that was published in the *Oeuvre complète* (but without solar trajectories, effaced in the publication). It is probably to this same period that the eleven undated panels FLC5728 to FLC5738 belong.

All told, the Tower of shadows project alone gave rise to over a hundred drawings. It appears as a brilliant demonstration of the brise-soleil in Corbusian architecture. With the warlike vocabulary that the architect was fond of using, presentation panel FLC5239 (1957) proclaims *'the conquest of shadow and coolness'*. If we grant the architect's victory in securing shadow (after twenty years of effort), we must be more circumspect as to his success where coolness is concerned. Exposed to the sun of India, the concrete of the wing walls and cross walls absorbed heat rapidly. Heat thus accumulated in the brise-soleil by day was partly given off at night. In finding its geometrical accomplishment, the principle also showed its limits, which were due to the very material that enabled it to be built.

16. Literal transcription.