55 CREATING NON-ORTHOGONAL ARCHITECTURE

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The application of curved lines and surfaces in architecture, with their characteristic associative qualities, is receiving more and more attention. To realise these shapes at a reasonable price, one must make use of the newest techniques and stimulate innovation. This requires knowledge of the relation between function, form, means of materialising and structure of the market.

55.1 TWISTED SURFACES

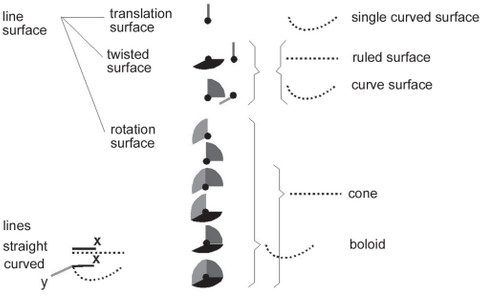
In order to realise double-curved surfaces in their pure geometrical shape, various problems related to complex shaping were dealt with in phases, in a series of surfaces with an increasing degree of plasticity and complexity. This Chapter focuses on twisted surfaces. As they consist of straight lines, they are to be placed between the freely double-curved surfaces and the unfoldable surfaces, like single-curved surfaces and cones.

This kind of surface can be described by moving a straight line along a curved path. ‘Ruled surface’s’ are twisted surfaces, constructed by moving a straight line and additionally rotating it. ‘Curve surfaces’ (a new kind of surface) are twisted surfaces too, but are constructed by moving and rotating a curve. Characteristic for twisted surfaces is that they always have a component of the rotation perpendicular to the movement vector. Twisted and double-curved surfaces have many similarities in their geometry and way of producing. The latter are, because of the different curvatures of neighbouring lines, more complex.

Twisted surfaces are archetypal forms, important to designers because they imply a great increase of the available semiotic vocabulary inherent to the use of shapes in architecture. Linked with the degree of transforming, the connotations of twisting range from associations with strangling, getting caught in a tight situation when the degree of twisting is big, to that of a romantic desire to break out of it, when the surface is twisted only slightly.

The different kinds of surfaces have specific names. Similarly it is useful to differentiate the various kinds of building volumes. In the sequence of volumes of increasing geometrical complexity, the following names may be included:

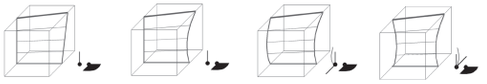
- Ortho’s, shaped orthogonal
- Rotaters, rotated shapes: Cylinders, Domes, Globes, Cones, etc.
- Twisters, twisted volumes with a straight rotation axis
- Tordo’s, with at least one twisted surface connecting with its rules to an orthogonal superstructure
- Blobs, freely double-curved surfaces



545 New scheme to differentiate between shapes

Many more specific names may be included, like Pyramids, Cubes, Morphers, etc. This Chapter is restricted to twisted shapes. Parallel to developing a scheme to organise the various twisted surfaces and volumes, their use in architecture was studied, and a building system developed to materialise them.

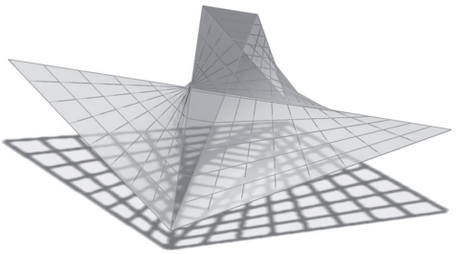
If twisted surfaces are to connect to an orthogonal built structure, the structure may be represented by a cube showing the starting position of the rule (red) that is manipulated to construct the surface, with icons depicting the vector of movement and direction of rotation. Additional directions of rotation may be added. They imply that the surface will no longer connect with straight lines to horizontal surfaces (floors) or parallel vertical surfaces in which columns or walls usually lie.



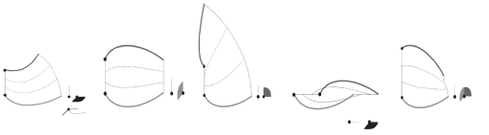
546 Four basic types of twisting

Four basic types of twisting can be defined when moving along a straight line:

R1 Two straight sidelines (a hyperparaboloid)
R2 One straight and 1 single-curved sideline
R3 2 sidelines curving in opposite directions
R4 2 sidelines curving in the same direction

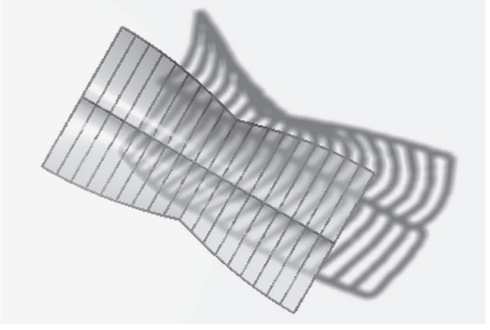


547 Example of a combination of two ruled surfaces type R1

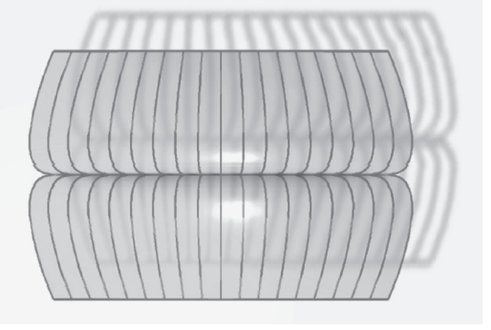


548 Five basic curve surfaces

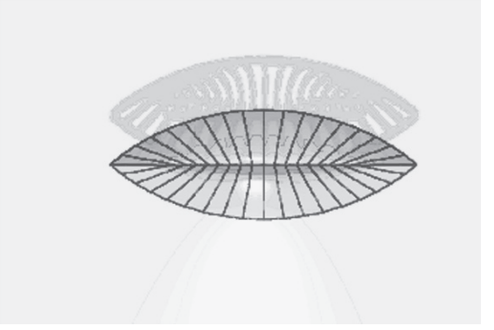
Similar way to ruled surfaces, curve surfaces can be described with icons, instead of mathematical formulas.



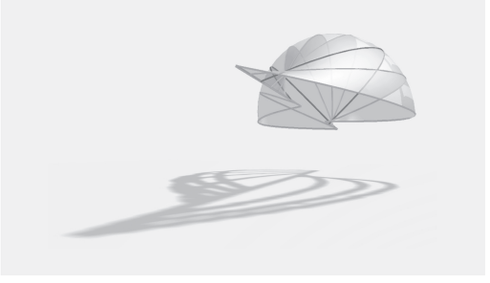
549 Curve surface K1



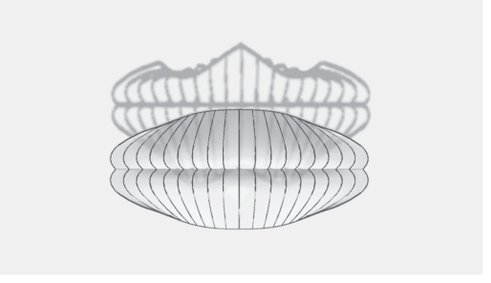
550 Curve surface K2



551 Curve surface K3



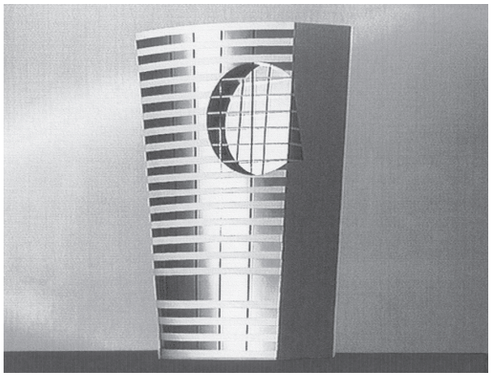
552 Curve surface K4

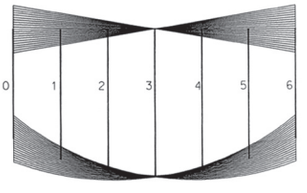


553 Curve surface K5

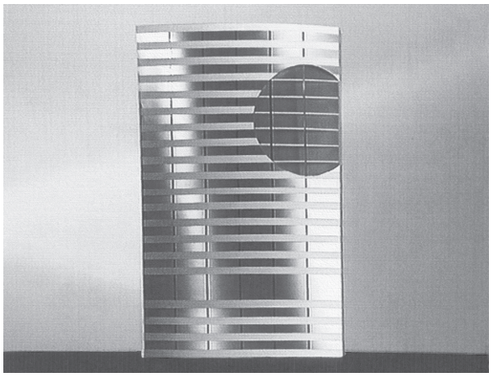
55.2 EXAMPLES OF TWISTED SURFACES IN ARCHITECTURE

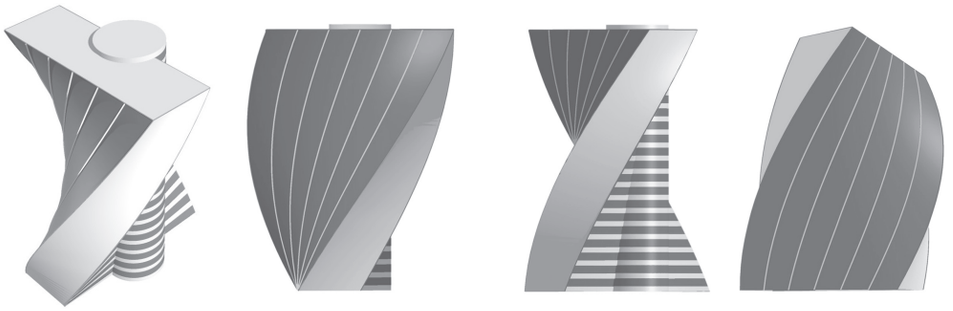
This high-rise 'tordo' with twisted (and flat) façades, with floors and walls meeting under straight angles, is relatively easy to materialise, due to the straight lines in the twisting surface connecting to the superstructure. The façades at the front and backside of the model are a ruled and a curve surface.





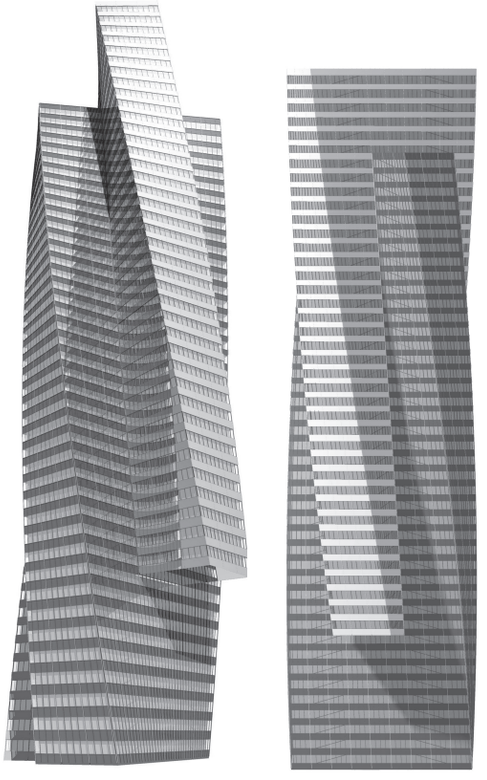
554 Tordo 1



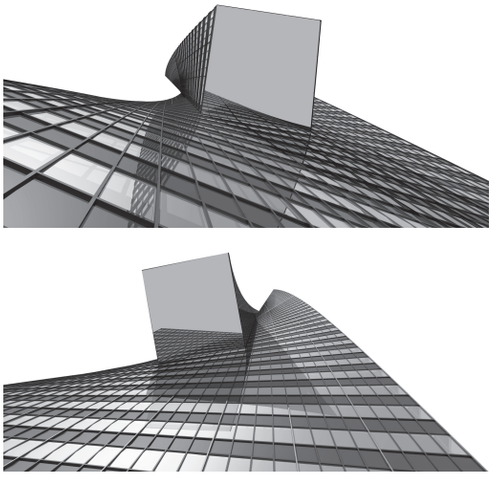


A ‘twister’ has floors positioned around a vertical axis; in this 20 floor high model the twisted volume has been combined with a cylinder. In the core some building components (like elevators) rise vertically, while other components (like sanitary units and stairs) rotate in conjunction with the officewings. The varying positioning of the components results in a different plan in the core on each floor.

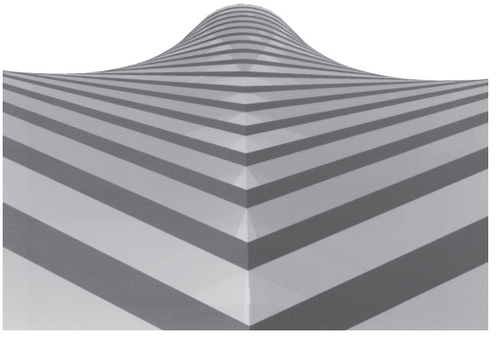
555 Twister 2



The two perpendicularly inter-secting volumes of this 150m high twister, offer a playful contrast of façade finishing. The building is conventional in use; as a result of the only slight twisting of 0,5’ per m1, the façades hardly incline. The volume as a whole looks spectacular, with the many slightly twisted elements, adding up to the considerable twist of 70’. There is an enormous repetition of parts. The structural design was made by ABT Engineers.

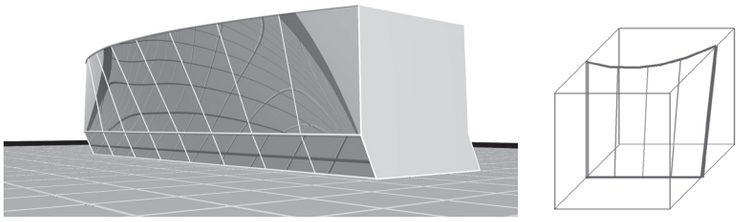


556 Twister 3



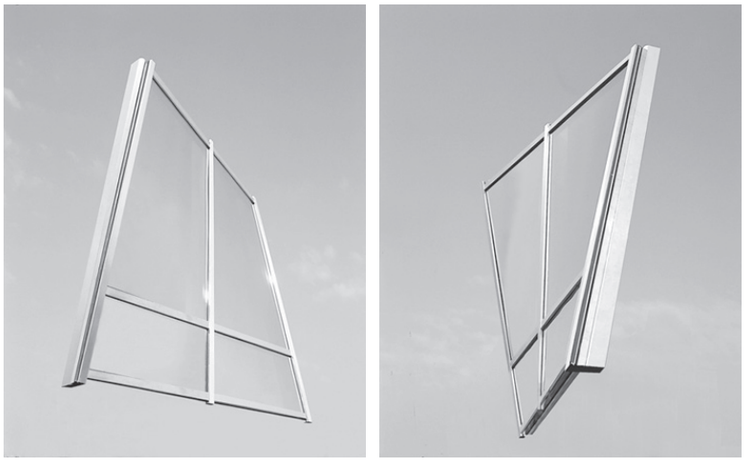
To study an alternative for the superstructure, this symmetrical composed 60m high twister was designed. Two wings rotate in opposite directions around a cylindrical core. Because of the contrary rotation of the wings, the floor plans in the core vary on each floor. The concrete core is essential for the stability. The reflection of a twisted façade in a twisted façade, results in unexpected images.

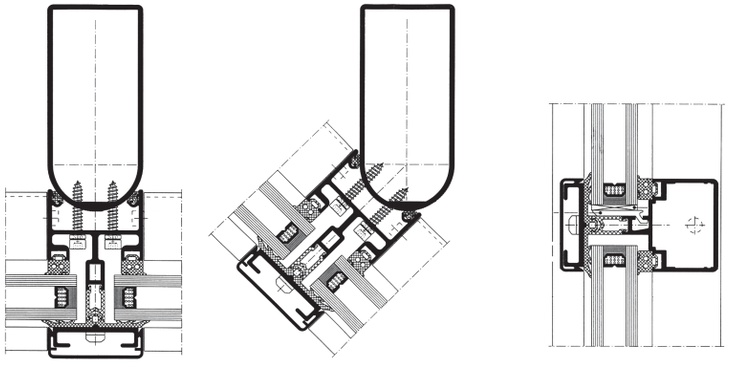
557 Twister 4



558 Low-rise tordo 2a

This is a low-rise tordo, with a ruled surface façade type R2. The moving reflections of cars, or pedestrians, will distort and slow down or accelerate.





559 The reyno twist window frame-system

An industrially produced framing system for twisted façades was designed, with warm bent twisted glass (both a world-wide first). The frame combines a stiff backing profile (for example positioned everywhere parallel to floor and wall), with a glazing profile parallel to the glass surface (twisting or if preferred freely-doublecurved). The system was developed in collaboration with:

Reynolds Architectuursystemen, Reynolds Special Products and Van Dool Constructies.
Van Tetterode Glasatelier, Eijkelkamp and Glaverned.
Hellevoort Visuals