Hyperboloid

More Details

A few years after the inauguration of the Eiffel Tower in Paris, the Russian engineer Vladimir G. Shukhov presented a brilliant construction concept in 1896: in the Russian city of Nizhny Novgorod, he built a tower from simple, crossed steel girders, which used up extremely little material, was stable and cost-effective. While 10,000 tons of steel were used for the 300-meter-high Eiffel Tower, Shukhov was able to use his method to design a 350-meter tower with only 2000 tons of steel. In his work, Shukhov (1853-1939) was inspired by a structure that already bore a name in mathematics: the “hyperboloid”.

The hyperboloid is a mathematical surface that, at first sight, resembles a barrel that is squeezed in the middle. Many mathematicians are fascinated by it because you can create its curved shape using only straight lines. In our experiment, these straight lines are the yellow strings that are stretched between two rings. If one were to add more strings, little by little, a nicely closed area would form. Mathematicians call this surface “hyperboloid”. By moving the lower ring of the exhibit, many more of these “surfaces” emerge. Each of these is an eye-catcher – regardless of whether it is slightly rounded or has a particularly slim waist.

The name “hyperboloid” is derived from the very similar name of a related mathematical curve, the “hyperbola”. The hyperbola is a curve consisting of two symmetrical parts. The parts look like tilted archways with the tops facing each other (Fig. 1). But how does the hyperboloid result from this? The answer is quite simple: You could put the hyperbola on a disc and rotate the disc very quickly. A new figure that corresponds to the shape of a hyperboloid would appear automatically.

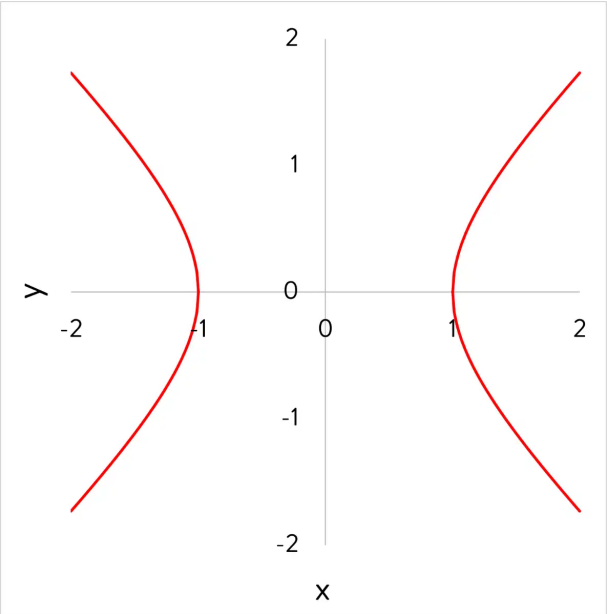

Fig. 1: A hyperbola, described by the equation $x^2+y^2=1$.

Shukhov's design concept triggered a veritable boom in construction. Numerous structures and architectural elements in the form of hyperboloids are still being built today. They range from simple cooling towers (Fig. 2) to gigantic sculptures (Fig. 3) or bridge structures all over the world. In all constructions, the straight lines play a crucial role: they are load-bearing elements that lend stability to the structure. For the construction, crossed steel girders that are arranged on a ring are usually chosen. As a result, one obtains an aesthetically pleasing framework that can be lined as desired.

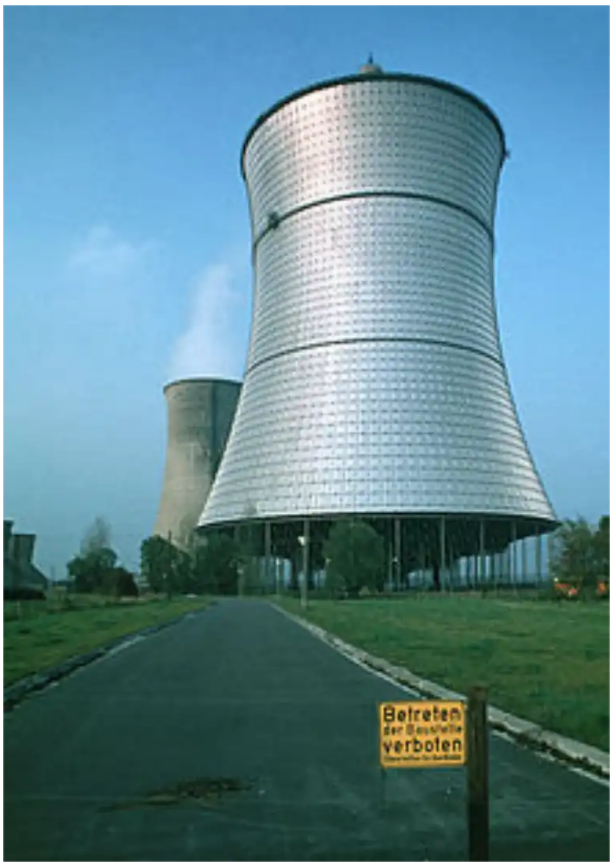

Fig. 2: Cooling tower of the THTR-300 nuclear power plant in Hamm.

Fig. 3: Kobe Port Tower in the Japanese city of Kobe.