UT126

Urban Tree

The Urban Tree derives its name from its shape but also from its function. To us, a tree is one of the most elegant natural objects on this planet. Its shape is visually elegant and structurally efficient. A tree provides shade, it is incorporated in the local water system and it has a cooling effect to its surroundings. The design team has united these properties in an impressive, appealing and apparent concrete sculpture: the Urban Tree. Not only does it show what concrete is capable of in structural terms and its positive contribution to the urban climate of cities, but the material is also applied in such a way that social activity is stimulated.

The sculpture is meant to be situated on paved urban squares. It will function as a social gathering point. People will be attracted by the Urban Tree because of its appearance and at the same time, the sculpture offers a pleasant and interesting place to relax after having a stroll through the city. The Urban Tree will be a hollow and open concrete object and part of a water buffer system (Fig. cross section). This is very useful especially in places with a stony character, like cities. The umbrella shape of the Urban Tree stores rainwater which will fall onto the square. The stored water will be gradually transported towards the edge of the umbrella and then fall down onto the ground.

A drainage system will be used to collect the rainwater from the sides of the square and direct it to a subterranean pump. This pump is situated in a small buffer tank and it pumps the water to the main buffer, the Urban Tree. A second pump will pump the water to a gutter at the top edge of the umbrella shape. When water is actively pumped into this gutter, it flows over the edge and falls down on the concrete tiles enabling it to evaporate and cool the local environment. This will have a positive effect on the well-being of the visitors of the square. Water which does not evaporate will flow back to the drains underneath the umbrella. In this way the water is recycled back into the system, like a tree's roots absorb water which has fallen off its leaves.

As soon as the falling water from the top edge of the umbrella reaches the concrete tiles, different figures will be unveiled. This is made possible due to the use of smart concrete which reacts when it comes into contact with moisture (Fig. 1). The figure indicates the time during day and night. The gutter at the top edge of the umbrella is divided into twelve sections which can be filled by the pump independently. By successively filling the different gutters during the day, a time variable water curtain will shift clockwise around the sculpture. (Fig.2). The Urban Tree takes the function of a sundial and displays the time to the visitors of the square. Moreover the situation stimulates bodily interaction with water which adds entertainment to the square.

The structure of the Urban Tree is designed to be as efficient as possible by minimizing material usage and steel reinforcement. This goal could be obtained by using membrane forces (Fig. 3) in combination with hoop forces (Fig. 4). This will avoid bending moments to carry the dead and imposed vertical load which implies that there is no need for thick surfaces. An optimal dome makes the best possible use of this principle and therefore the geometry of the Urban Tree is derived from this type of dome (Fig. 5). To obtain the optimal umbrella shape, the optimal dome is cut in half and shifted. For the two halves of the dome to make equilibrium at the top (Fig. 6), the structure will need a tension ring there to hold the two halves in place (Fig. 7). This tension ring also fulfils a second function. To prevent the overflowing water from sticking to the concrete surface (Coandă effect), a delicately designed sharp edge is needed (Fig. 8). This edge is incorporated into the shape of the tension ring.

Next to an efficient vertical loadbearing system, the smooth rounded shape and the small wind surface of the sculpture will lead to minimal lateral loads. Therefore it is possible to use a slender cross-section with little reinforcement. In this way the structure will be as much pure concrete as possible. Although the structural principle is different, the construction follows the philosophy of a tree: minimal material usage in an elegant way.

By means of the Urban Tree, the design team has created an elegant, efficient and smart concrete sculpture which provides a pleasant local environment, stimulates social activity in cities and contributes to the local water system.

Figure 1: Smart concrete; the concrete unveils figures as soon as it comes into contact with moisture (source: http://traces.co.kr/tc/236)

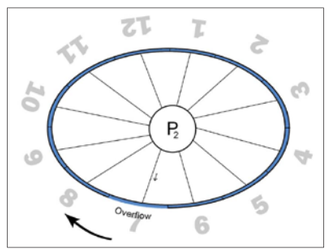

Figure 2: The second pump will pump water to a gutter at the top edge of the umbrella. The gutter is divided into twelve sections. These sections are corresponding with the hours of the day. As soon as a section is actively filled with water it flows over the edge and is falling unto the ground.

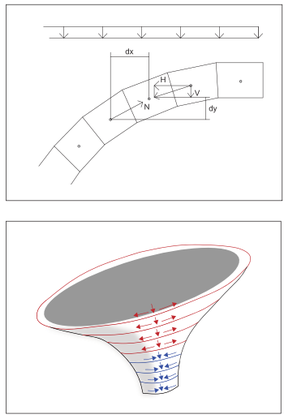

Figure 3: Membrane forces to carry external load

Figure 4: Hoop forces in the structure

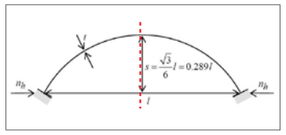

Figure 5: Geometry of an optimal dome

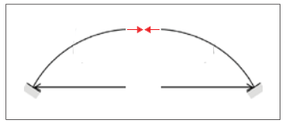

Figure 6: Equilibrium in top of the dome

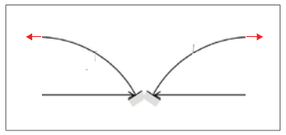

Figure 7: Shifted halves, tension ring required

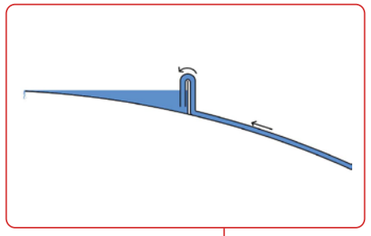

Figure 8: A delicately designed shape is needed to prevent the overflowing water from sticking to the concrete surface.