

Innovation and development of decorative concrete

Zhang Baogui, Beijing Baogui
Stone-Art Science and Technology Co. Ltd

Summary

This paper discusses innovation derived from projects relating to sculpture, rockery, ceiling panels of the China National Theatre, and lightweight concrete decorative panels. In terms of multi-discipline integration to achieve economic, artistic, environmental and durability benefits, plus the advantages of lightweight concrete decorative panels, we have worked towards a new understanding of dynamic design, in order to coordinate individual requirements and industrialised manufacture.

Key words: innovation, ceiling panel of China national theatre, lightweight concrete decorative panel, pulling on loricae and pulling on silk.

INTRODUCTION

In recent years there has been dramatic development in the use of decorative concrete. Increasing numbers of people are turning their attention to it: from sculpture art to lightweight panels, from handmade to machine-fabricated methods, from single enterprise to social cooperation, decorative products represent different images in different situations.

In 1988, we created our first decorative sculpture made from cement and stone powder. This was highly acclaimed by specialists who were impressed to see what appeared to be aesthetic stone artwork that in fact was actually made from cement. This initial success encouraged us to expand our innovations and motivated us to push forward with our work. Following on from our initial work, reconstituted stone decorative products were hung on the walls of buildings No.14, 15 and 17 in the Diaoyutai National Guesthouse.

In 1998, Professor Wu Liangyong of Qinghua University, who was impressed with our skills and approach, invited us to fabricate a phoenix sculpture. We used polystyrene slabs to make the moulds, and cement and stone powder to make the sculpture. After 18 years of research and development, we have now completed many projects and in the process have accumulated considerable knowledge. For example, we now have sculptures located in the China Historical Museum, Diaoyutai National Guesthouse, Beijing International Conference Centre, Shandong Yanzhou, to name but a few. Some of the sculptures are abstract and some are lifelike; some have a stone effect and some have a metal effect. But crucially they are all made of concrete.

China National Grand Theatre

For the ceiling panels of the China National Grand Theatre, we spent about 800 days and nights gathering information to accomplish the task. Before signing the contract, we spent 600 days planning and preparing for technological discussion, data testing, machine and tool amelioration, material development and research, manufacturing flow perfection, storing, curing, packaging and transportation.

The ceiling comprises 164 separate panels, each with an area of 3420×2260 mm. As each piece is different, the tolerance for any errors across the diagonal of each finished product is less than 2 mm; any undulation is limited to 480 mm; average thickness is 24 mm; and the weight of each product is approximately 800 kg. This means that, in total, the ceiling panels weigh more than 100 t.

Although each ceiling panel is a separate entity, they are all interlinked. The most obvious qualities of the ceiling are the effects of light and shade and its wonderful acoustics. The ceiling was designed to resemble ocean waves and draped woollen cloth and is very modernistic.

As well as the need to guarantee the strength and disposal of the structure, it was also required to embed 6 mm diameter reinforcing steel T-bars. There are 20 embedment points in all, the designed load of each point being 50 kg; the destructive load achieved was 1000 kg.

The 164 ceiling panels are suspended in space, with transverse gaps of 40 mm, longitudinal gaps of 80 mm, and error tolerance of 2 mm. There are numerous wires strung between the gaps for attaching sound equipment and lighting.

Innovations

In order to manufacture striated decorative concrete panels, we began with the dual benefits of concrete and glassfibre-reinforced concrete (GRC): on the one hand, we utilised an exposed aggregate imitation stone effect; on the other hand, we utilised the strength of alkali-resistant (AR-)glassfibre. Light concrete decorative panels do not possess high load-bearing capabilities, its compressive strength being only 40 MPa and its flexural strength being only 15 MPa. However, by adding AR-glassfibre this problem can be overcome.

At the beginning of 2005 we began to develop decorative concrete panels for Lasa Railway Station: from initial plain to final striated; from the 'copper bracket' connection of plain concrete panels to the rigid frame connection of lightweight concrete panels; from single striated to the developed characteristic Tibetan pattern 'BaBao' (meaning eight kinds of treasures in Tibetan Buddhism). Through the process of manufacture, we became skilled in colour, texture, width of striation, type of joint, quomodo of node.

When considering building panels, the obvious choice for most designers and builders is fair-faced concrete. Thick panels have remained popular because of their perceived strength and protection.

However, modern designs have become more adventurous, looking to concrete finishes that resemble the appearance of silk. Panels manufactured with GRC are thin, lightweight, large-span, economical, and of course safe, and lend themselves to the demands of new and exciting designs. This is what we have been researching and developing and it is what architects and investors demand.

As for decorative panels, as well as rigid concrete, flexible concrete should also be developed, in order to achieve large spaces in buildings. This would not only economise resources but would also reduce the load borne by buildings. Taking a 1 m² panel for example, for fair-faced concrete the thickness is 50–90 mm and the weight is 150–240 kg/m²; in contrast, for a lightweight concrete decorative panel, the thickness is 15–40 mm and the weight is 30–60 kg/m². Their compressive strength is almost equal, but the flexural strength of a GRC panel is higher than that of a fair-faced concrete panel. The combination of light weight and high strength is a remarkable characteristic.

Further work

After our success with lightweight concrete panels, we went on to develop concrete shades, the height of each shade being 4 m, width 600 mm and thickness 150 mm; the shades are hollow and grey.

For Meng Lianggu Museum we developed red striated panels, which are embedded with large numbers of cartridges. This represents a style culture innovation.

The contradiction between individual design and industrialised manufacture is present not only in the art world but also for more general customers. We are continuing to searching for ways of resolving this problem. To change static design into dynamic design is a difficult challenge; however, it is imperative that we find a solution.

The decorative concrete that we have developed is just the beginning. And we are constantly striving to push the boundaries.



Lasa Railway Station: Stria Panel



Beijing: Rockery



Beijing Uptown: Sculpture



Diao Yutai National Showplace



Beijing: Dialog



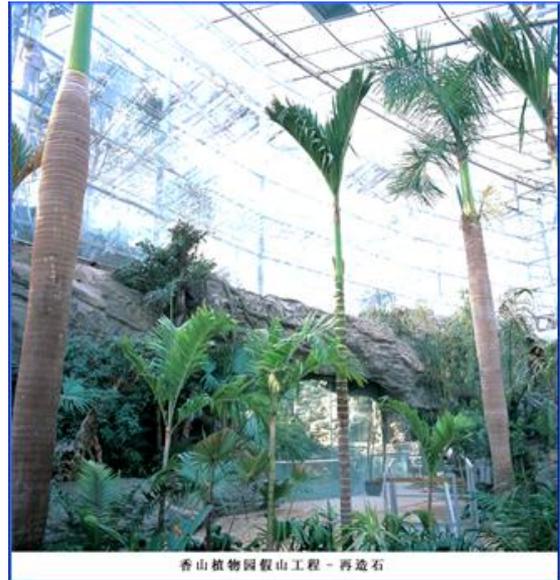
Shandong: Phoenix Sculpture



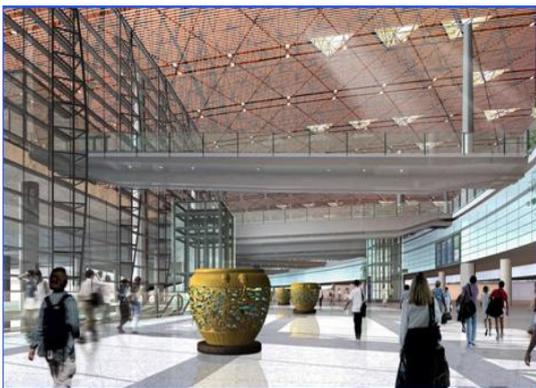
Qinhuangdao: Fairyland of Bird



Shandong: Phoenix Sculpture



Xiangshan, Beijing: Rockery



Capital Airport, Beijing: Sculpture



Capital Airport Beijing: Sculpture



Scree: hollow, thin shuck



Central Garden



China Academy of Sciences



China Restaurant



Natural State