Recent Large-scale Sport Facilities in Guangzhou

In the beginning of 1999, two very large-sized stadium projects were commenced in Guangzhou aiming to facilitate the city to be the host of the 9th People Republic of China Athletic Meet, which will take place in autumn, 2001. The first project is the Guangzhou Olympia Stadium located in Huang Chun, about 5 km east of the Guangzhou East Station. The second one is the Guangzhou Gymnasium located in the southeast corner of the Bai Yun Airport along the Guangzhou-Chonghua highway.

1. Guangzhou Olympia Stadium
The Guangzhou Olympia Stadium is a 80012-seated facility situated in a 30 hectares site, with total building area around 145,000 m2. The facility comprises an approximately 260m x 200m oval-shaped stadium structure complex with auditorium, standard track lanes, soccer field, arena, VIP boxes, concourse and a 7-storey guest house; a series of practice gymnasium, as well as other related guest, carparking, servicing and supporting facilities.

Except for the roof structure, the stadium complex is designed by the Design Office of the South China University of Technology. The roof and the theme design of the overall stadium outlook is done by the NEB Design Corporation of the United States. The main contractor is the Guangzhou Province Construction Group Ltd. Total cost of the project by 1999 estimate is about 1 billion YMB.
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The stadium structure is so designed to resemble the outlook of a mumian flower ( ), the city flower of Guangzhou. At the same time, due to the slimy, rhythm undulating roof, the stadium also looks like roofed by a waving silk ribbon from afar. This roof has a covered area of about 32,000 m², and with a total weight of about 9,500 tons, including the main steel frame and the decking materials. It is supported on twenty-one 4-legged column towers, representing the entrance into the 21st Century. To form the main frame of the roof, a pair of cantilever steel truss is placed on top of each column tower. Each pair of truss is further linked up to the adjacent trusses afterward by secondary truss systems, to form the averaged 4m deep roof frame.

The main trusses slightly tilt inward and cantilever into the field side for about 52m and outward for 10m. At the outward tip, each pair of truss is tied down by a pair of stay-cable, 300mm in diameter, and based onto the lower part of the column tower. Each column tower measured 8m x 4m at the stand level and with a clearance of about 13m from the upper part of the stand to the underside of the cantilevered truss. The column towers are constructed of Grade 35 concrete.

The other feature of the stadium structure is the elegantly arched column clusters and rib beams that support the auditorium stand. There are altogether 12 sets of column clusters, most of them are not exactly identical in headroom, shape and section. Very stringent quality and dimensional control are thus required during the design and casting process of these columns. To ensure the accuracy of the design and dimensional control, all of the structural elements in the project are surveyed and set-out using computer software such as AutoCAD.
**Guangzhou Olympia Stadium**

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The construction period allowed for this project is around 33 months and works are phased roughly into three stages. The first 16 months is for general foundation and the stadium structural works in reinforced concrete. It takes another 12 months for the installation of the steel roof structure and the related decking works. The remaining period is for final touch-up, services installation and other external or ancillary works.

The Stadium is expected to be opened for the 9th Athletic Meet in October this year on time.

A. **Guangzhou Gymnasium**

This is also a supporting facility for the 9th People Republic of China Athletic Meet as competitions, training and residence purposes. The stadium complex comprises of a main stadium, a practicing gymnasium, an activities center for public, administration building, athlete residence, roadways and other servicing and supporting facilities. The complex has an overall coverage of about 24 hectare of land. Besides serving as a sport facility, the gymnasium can also be used as an integrated cultural and recreational center for general public of Guangzhou.

The largest structure in the complex is the 10020-seated main stadium, which is a fully covered structure of size about 39,500 m² and with roof spanning 160m longitudinally and 110m laterally. The practicing gymnasium is 151m x 70m spanned, with a covered area of about 19,400 m². The activities center is the smallest out of the three large-spanned structures, it has a covered area of 9050 m² and spans about 140m x 30m.
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All the three structures are designed with a longitudinally arched steel truss girder as the main supporting frame, and with multi-foci spine trusses spanning from the reinforced concrete perimeter wall to the central main truss to form the elliptic dome of the stadium structures. The roof is cladded by an aluminium framed, double layered translucent plastic sheet to maximize the utilization of nature light for daytime illumination.

The three stadiums are partly submerged into ground (please refer to drawing provided) and the effect of buoyancy is catered for by the provision of a series of anchor piles. Other geotechnical difficulties encountered during construction include the existence of lime stone cave in the sub-soil, active ground water, strata of loose made ground and soft clay etc. Foundation systems employed are mainly 1m to 2m hand-dug caissons for the auditorium structure, which further seated onto a reinforced concrete raft and tied down to ground with 150mm mini-pile to resist the buoyancy and uplifting effect.

The photo series provided in this article serves to give a general illustration, in particular, of the later stage of the construction, as well as some details for the structural arrangement of the stadiums.
The preparation of the 110-ton cantilever truss before lifting to the roof level for installation. The truss arrives site in 3 to 4 smaller sections, which are prefabricated off-site, and connect into one piece on spot.
Lifting the 110-ton truss frame for placing onto the column tower.
One of the cantilever trusses is placed in position. The truss is supported at this stage by a complicated falsework system of steel tubular scaffold. The 500-ton capacity crawler crane on the left, which has been used in the construction of the Passenger Terminal Building in Chek Lap Kok for lifting the roof modules, is used in this project for lifting the trusses.
Detail showing one of the completed column towers before the placing of the cantilever truss.
Viewing into the field of the stadium as in June 2000, by the time only part of the roof system had been installed.
The field and the auditorium stand as viewed on the top level of the stand as in January 2001. Note the falsework erected on the left that serves as temporary support for the partially completed roof.
Detail of the column head arrangement with the cantilever trusses and other secondary trusses in position. Note also the provision of steel brackets on the surface of the column tower for the fixing of metal cladding as finishes to the structure at a later stage.
The auditorium stand as seen under the covered roof. Except for the inner and outer apron, the underside of the roof frame is in open design for the ease of maintenance.
A closer look inside the 4m deep roof truss system.
Guangzhou Olympia Stadium

Typical column-roof detail showing the elegance of the design.
Detail of the adjustable anchors and the stay-cables that tie the cantilever truss roof to the base of each column tower.
Detail of the dead anchor at the base of the column tower.
Workers secure the remaining infilling members of the roof at the final stage before the laying of the roof deck. The buildings as seen in the background are one of the famous tourist spots of Guangzhou, the Guangzhou World Fair.
Guangzhou Olympia Stadium

Close up seeing the beautifully curved roof – an inner curve.
Close up seeing the beautifully curved roof – an outer curve from underside.
Close up seeing the beautifully curved roof – an outer curve on an elevated level.
Guangzhou Olympia Stadium

A very interesting sight formed by shades of light due to the slightly undulating surface of the roof deck. Note also a very eye-catching feature on the roof surface – a 20m diameter circular skylight, below which situated a 7-storey guest house.
The splendorous projecting roof forming a slot that defined the main entrance to the stadium.
Detail of the roof decking with the corrugated aluminium alloyed decking panels and the provision of a storm water channel.
Guangzhou Olympia Stadium

An elevation as viewed from the entrance driveway seeing the approaching roof on two sides that form the stadium entrance and one set of arched column clusters that support the auditorium stand.
The RC structure under the auditorium stand that housed the other essential facilities of the stadium complex. The underside of the stand supported by the arched columns and rib beams can also be seen here.
The outlook of the stadium structure as in May 2001. Upon the removal of the falsework that temporarily supporting the roof, the slim roof will form a very interesting sight that resembles a silk ribbon waving on top of the stadium base.
The elliptic-shaped roof frame of the Practicing Gymnasium (foreground) and the Activities Center as seen on the podium top in June 2000.
Close up of the roof dome of the Activities Center. The central truss girder forms the most eye-catching element as viewed from this direction.
A mock-up section of the central truss girder on display.
A mock-up of the typical roofing module showing the aluminium framing and the translucent roofing panels.
Guangzhou Olympia Stadium

Guangzhou Gymnasium

Internal framing detail of the central truss girder of the Activities Center at the elliptical tip.
Close up of the central truss girder frame viewed on the exterior. Note also the bearing arrangement of the roof frame that seat onto to the perimeter wall by the use of structural bearer pads.
An interior view of the auditorium inside the Main Stadium in June 2000. The steel posts in the center of the auditorium are temporary support for the central truss girder before the final completion of the entire roof system.
Interior view of the Main Stadium as in February 2001 with the roof system and other concrete structure practically completed.
Guangzhou Gymnasium

Detail of the VIP platform and the auditorium stand.
Laying of the floor screed on top of the stand platforms before the installation of the auditorium seats.
Close up of the roofing work at the junction of the central ridge formed by the main truss.
Guangzhou Olympia Stadium

Guangzhou Gymnasium

The overall layout of the Guangzhou Gymnasium.
Guangzhou Olympia Stadium

Guangzhou Gymnasium

Typical section cut transversely across the Main Stadium.