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HIGH TENSION – TENSILE ARCHITECTURE
NEW STADIUM PROJECTS

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1 INTRODUCTION

Since 2008 several stadia are newly planned and under construction or finished, others will be expanded and modernized for the FIFA 2014 World Cup in Brazil. In this paper three projects are presented. To develop designs for three different stadia at the same time and to represent the designs locally, requires appropriately staffed and experienced teams, but also a clear definition of the design parameters. These parameters differ in each project and so are the resulting designs new and refreshing variations of the familiar theme.

2 MARACANÃ IN RIO DE JANEIRO

The Estádio Mário Jornalista Filho, as it is called correctly, built in 1950 was completely reconstructed for the 2014 World Cup. Besides the tiers and the facilities underneath, particularly the roof construction was affected. The original concrete cantilever roof merely spanned the upper tier of the grandstand and therefore it no longer met the requirements for a modern stadium. During the design process several expansion options were developed to keep the existing roof structure. In the end the poor condition of the structure turned the balance in favour of a complete renewal of the roof.

New specifications included the demand for almost 70 metres roof depth and the continuous use of the listed concrete substructure. After the demolition of the roof the substructure comprised the dominant building supports and the facade columns, as well as a continuous ring beam on eaves height.

To maintain the appearance of the original stadium the roof structure was to be kept low at the inner and outer rim, and the shaped roof was meant to be floating just above the stadium bowl. This has been achieved by the design of a cable-net roof which is based on the design principle of a spoked wheel. A combination of one or more continuous outer compression rings and a pre-strained cable-net, consisting of inner tension rings and radial connection cables, form a stable roof slab which can transfer compressive loads and suction forces, as well as horizontal loads (deriving from wind friction or alternating wind suction and pressure forces).

The design of the Estádio Jornalista Mário Filho is based on a new option of this construction type.

Figure 1: Photography of the Maracanã Stadium

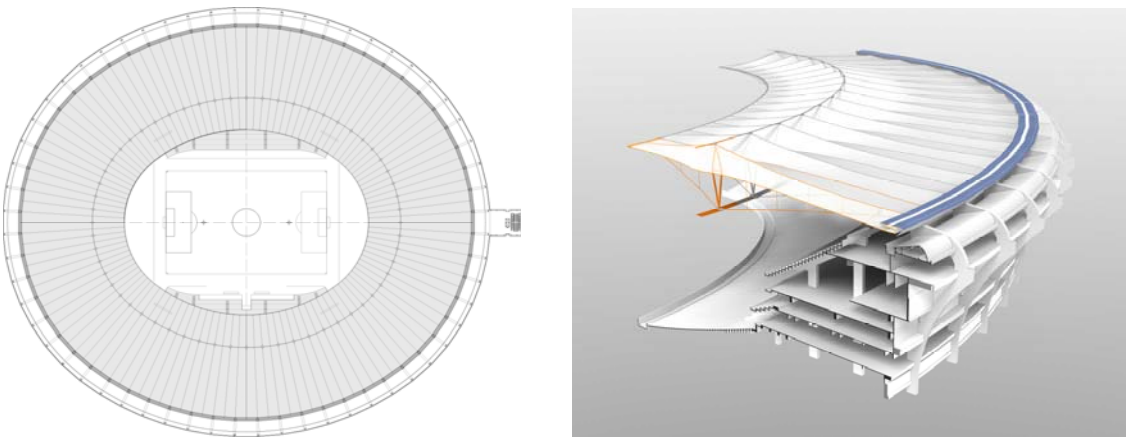

Figure 2: Floor plan and 3D-section of the Maracanã Stadium

3 MANÉ GARRINCHA IN BRASÍLIA

During the redevelopment of the existing national stadium Estádio Nacional De Brasília

Mané Garrincha in Brasília its capacity has been extended from 45,000 to 70,000 seats. The stadium is located prominently in the western part of the Eixo Monumental. The East-West axis through the city accommodates many renowned buildings by Oscar Niemeyer, e.g. the national congress, the national museum and the cathedral. Against this architectural background characterised by concrete buildings, the natural consequence is to use this material also for the new stadium roof. Hence, all member subjected to high compressive forces are made of concrete.

The design of the roof structure is a combination of the suspended roof and the spoked wheel principle. The suspended roof comprises a lightweight cable and steel structure that is supported by a concrete compression ring with an outer diameter of 309 m. Three concentric circles of columns with 96 concrete columns in each circle support the compression ring. The access structure for the stadium bowl has been integrated in this jungle of columns. A ramp system takes the spectator up to the gallery, the so called `Esplanade´ to access the upper tier of the stadium stands.

Figure 3: Photography of the Mané Garrincha Stadium

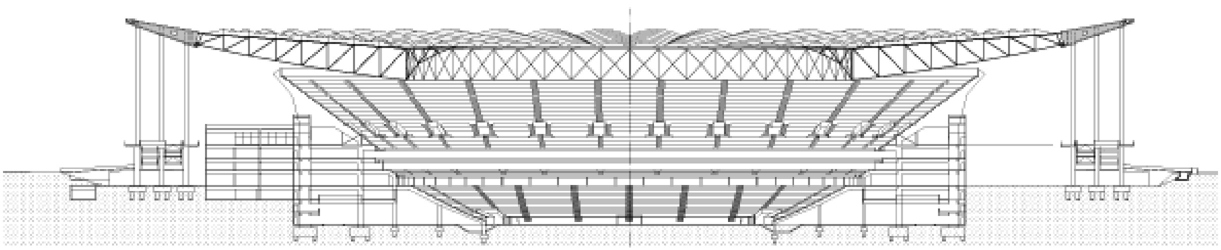

Figure 4: Cross section of the Mané Garrincha Stadium

4 ARENA DA AMAZÔNIA IN MANAUS

Amongst other facilities the already existing sports complex consisted of the football stadium Vivaldo Lima and a so called `Sambadromo´ where dazzling carnival parades are held every year.

The football stadium used to be an earth wall stadium; the overhang of the concrete structure covered only a part of the grandstand. Thus, a great many spectators were not shielded from the daily occurrence of heavy showers, typical for the Amazon region. But it goes without saying that rain protection is a requirement in the FIFA regulations. This was one of the reasons to design a completely new stadium building which holds approx. 47,000 people.

During the design of the dominant façade and roof structure the interdisciplinary team thoroughly dealt with the given conditions and parameters, and managed to achieve a perfect symbiosis of architecture, technology and functionality.

Diagonally intersecting beams, with rounded edges in the area of the nodes, generate a diamond-shaped roof area with an organic appeal. The fact that the roof area is visually not separated from the façade faces enhances the architectural and structural integrity of the design.

Figure 5: Rendering of the Stadium in Manaus (gmp Architekten)

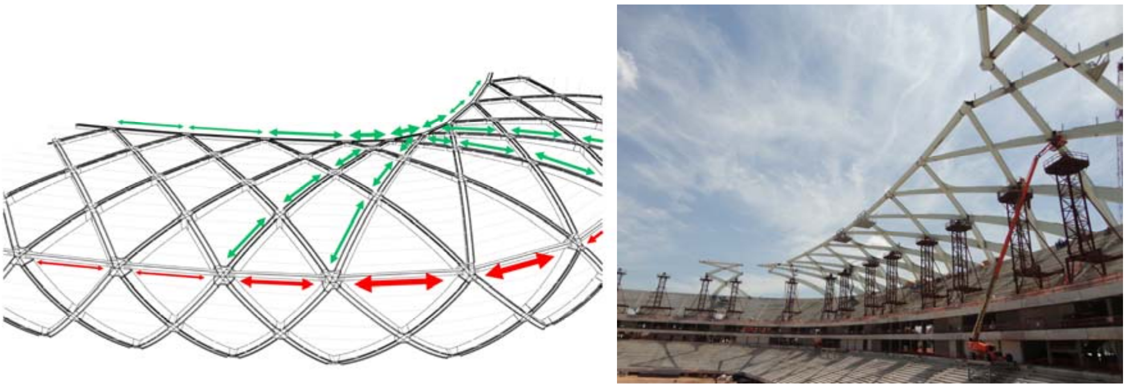

Figure 6: Principle of the force flow and actual site photo of the Stadium in Manaus

4 PROJECT DATA

<u>Maracanã Stadium, Rio de Janeiro</u>

Client	EMOP, Rio de Janeiro
General contractor	Consórcio Maracanã
Concept and design of roof	schlaich bergermann und partner Knut Göppert with Knut Stockhusen and Thomas Moschner and Miriam Sayeg
Planning of photovoltaics	schlaich bergermann und partner
Redesign of bowl	Fenandes Arquitetos / Associados
Wind tunnel tests	Wacker Ingenieure
Completion	April 2013
Capacity for the World Cup	81,550 (incl. VIP boxes)
Covered gross floor area	45,500 m²
Steel Structure	2,300 t
Cable structure	410 t
Surface of membrane	46,500 m²

<u>Mané Garrincha, Brasilia</u>

Client	Novacap, Brasilia
General contractor	AG + VIA
Architect	gmp Architekten von Gerkan, Marg und Partner Castro Mello Arquitectos, São Paulo
Concept of roof and design	schlaich bergermann und partner Knut Göppert with Knut Stockhusen and Stefan Dziewas and Miriam Sayeg
Wind tunnel tests	Wacker Ingenieure

Completion	March 2013
Capacity for the World Cup	70,000
Covered gross floor area	67,000 m²
Steel Structure	2,200 t
Cable structure	410 t
Surface of roof	47,000 m²

<u>Arena da Amazônia, Manaus</u>

Client	Manaus Government
General contractor	Andrade Gutierrez
Architect	gmp Architekten von Gerkan, Marg und Partner
Concept of roof and design	schlaich bergermann und partner Knut Göppert with Knut Stockhusen and Sebastian Grotz and Miriam Sayeg
Wind tunnel tests	Wacker Ingenieure

Completion	March 2014
Capacity for the World Cup	46,000
Covered gross floor area	25,000 m²
Steel Structure	6,600 t
Surface of membrane roof and façade	31,000 m²