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SWAN RIVER PEDESTRIAN BRIDGE IN PERTH – STRUCTURAL DESIGN STORY FROM THE CONCEPT TO THE CONSTRUCTION

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Summary

This paper resume the story of the design of the new “Swan River Pedestrian Bridge” now under construction in Perth, Australia. The bridge is formed by three steel decks connected with cable hangers to three steel arches, the central span is 144[m] and the two lateral 84[m]. The geometry of the steel arches follow the free form shape designed by DCM Architects, in order to achieve an iconic image as required in the tender of 2014.

Studio Majowiecki has been involved as structural designer from the tender phase to the executive design in the team of York Rizzani Joint Venture. During the concept phase of the tender proposal many static and architectural schemes have been analyzed in order to find the solution that combine in the best way the requirements in terms of aesthetic image and structural efficiency.

Due to the complex geometry of the bridge it has been necessary to adopt particular solutions for the design and analysis of the arches and deck structures, such as the joints between the steel elements of the lattice structures, the connections between the membrane cladding and the chords and some details that allow the completion of assembly procedures.

Keywords: bridge design; membrane cladding; space reticular frame; punching shear verification; erection sequence

1. Story of the architectural and structural conception

In February 2014 the government of Western Australia called on industry to submit expressions of interests to design and build the bridge that will connect Burswood Peninsula, near the new Perth Stadium to East Perth. York Rizzani Joint Venture (YRJV) involve DCM Architects and Enigma Engineering (Studio Majowiecki and Ingeco from Bologna) for the architectural and structural design of the footbridge from the concept to the construction phase.

Denton Corker Marshall architecture started the first conceptual studies in the 2014, shearching the best solution in terms of iconic image of the bridge and integration in the landscape. An intensive exchange of informations and proposal between DCM architecture and studio Majowiecki has lead to the definition of a structural geometry composed by three arches. This solution has been interpreted architecturally as the sinuous shape of two swans with the heads connected.

The structural forces are expressed clearly and uniquely in the black and white articulation of the arch ribbons reflecting both structural interdependency and the symbolic coming together of diverse cultures.

The design can remember the shape of two swans, a group of snakes or a dolphin shape, which are perfect for this river environment. The team proposal won the competition since it was considered as the best in terms of interpretation of tender requirements, such as iconic figure and integration in the landscape (Fig. 1).

Fig. 1. Final render of the structure

The bridge is formed by three steel decks connected with cable hangers to three steel arches. The geometry of the steel arches follow the free form shape designed by the architects. The total length of the bridge is about 400[m] with a central span of 144[m] and the two lateral of 84[m].

The main arches are connected at the top by an hinge joint that allow a rotation in the longitudinal plan but ensure a rigid connection in the transversal plan. This kind of restrain and the particular geometry of the arches leads to the static behavior of the semi arch as a cantilever beam supported at the end, this structural behavior is due to the geometry that does not follow the thrust line of the arch but achieve an iconic architectural figure.

2. Specific aspects of the design

In the tender phase the design considered a global welded structural system (factory and site welding). Due to site assembly difficulties, YRJV decided to proceed with bolting segmentation of the arches that are made up of different types of steel trusses using circular hollow sections (CHS). Australian Standards do not explicitly address a method to perform punching shear checks; therefore the checks have been developed accordingly to: Eurocode 3 Part 1-8 Design of Joints.

Arches cladding is made up of pre stressed fiberglass membrane fabric coated both sides by PTFE layers and supported by steel purlins. This kind of cladding required an addressed structural mathematical model in order to evaluate the forces transmitted by the membrane to the steel structure and the membrane deformations.

The erection sequence of the steel arches start with the construction of temporary towers. Then the arches arrive transported by barges on the river and have to slide in order to match the erection inges at the pier base. The dynamic aspects of wind and pedestrian action are described in the paper “Wind and pedestrian vibration assessment on the new Swan River Pedestrian Bridge” also submitted in the Footbridge 2017 conference.

3. Conclusions

In free-form architectural objects, whose shape has no direct connection with structural principles, phenomenological design uncertainties play a very important role. Those uncertainties are introduced into designs that attempt to extend the “state of the art”, including new concepts and technologies, and so in this kind of structure in order to guarantee the required reliability level, special expertise is needed in the design and construction phase. That’s why for the Swan River Pedestrian Bridge, due to the complex geometry, it has been necessary to adopt particular solutions for the design and analysis of the bridge structure, as shown previously in this paper.