FOOTBRIDGE IN THE CAMPUS OF THE UNIVERSITY OF AVEIRO
- conception, design and construction -

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Summary

Architectural planning, structural conception, design and construction of the Cycling and Pedestrian Bridge over the salt-marsh of S. Peter, inside the campus of the University of Aveiro, are explained.

Keywords: footbridge; urban planning; structural concept; structural design; shape optimization.

1. Urban and architectural planning

The footbridge shown in Figure 1 was designed by Architect Carrilho da Graça and Structural Engineer Adão da Fonseca / AFAconsult and built in 2003 over the salt-marsh of S. Peter in the Aveiro University Campus. It connects the university departments in the “Santiago” platform with the university main refectory and sport facilities in the “Agra do Castro” platform.

Fig. 1 – Perspective of the bridge with low tide in the salt-marsh of S. Peter

These two platforms are not levelled, but the steel bridge platform is horizontal. Although the north end of the bridge is in level with the land platform, an unexpected horizontal ramp into the bridge is provided (Figure 2). The footbridge is 4 m wide and straight along its 324 m length (Figure 3). At the south end, an even more unpredicted lateral reinforced concrete ramp (Figure 4) provides the pathway for wheelchairs and bicycles to the land platform. The abutment at this end contains several staircases leading either to the land platform or to the salt-marsh margin.

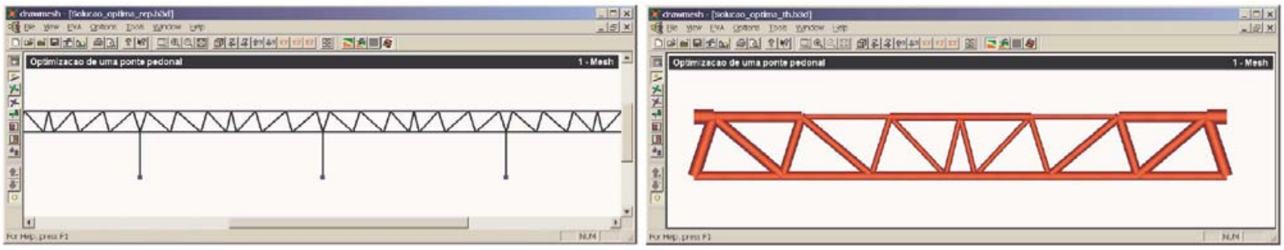
Figs 2, 3 and 4 – North lateral ramp, footbridge platform and south lateral ramp

2. Structural concept and design

Flat land in the Aveiro district is traced by many railway truss bridges that mark the landscape. Also, very severe budget constraints advised a truss solution would be the best option for this footbridge. Notwithstanding, Figure 5 reveals that unusual trusses were designed for this bridge

Fig. 5 – Detail of the longitudinal trusses

The parallel longitudinal trusses were defined by a “shape optimization” mathematical programming algorithm for minimum steel weight as criteria for both the truss geometry and the cross-section area of each bar (Figures 6 and 7). It might be said that mathematical structural optimization generated the architectural design of the bridge.



Figs. 6 and 7 – Figures taken from the “shape optimization” algorithm

Spans and columns were also optimized to global minimum cost, for which cost of piling was included. Longitudinal trusses are 4 m high, and the bridge has nine spans of 36 m. For structural and durability reasons, truss and column bars are SHS profiles with the exception of HEA 200 and HEB 200 profiles used in the truss inferior chord, for they support also the transversal pavement slab. For aesthetic reasons, cross-section external dimensions of SHS bars are all equal to 140 x 140 mm^2, with optimization defining plate thickness (5, 8 or 12.5 mm). In columns, SHS 150 x 5 mm^2, 300 x 6 mm^2 and 300 x 12.5 mm^2 profiles are used.

Pavement of the bridge is provided by an asphaltic covered mixed steel-concrete (Figure 8).

This bridge is not prone to vibrations induced by pedestrians.

Fig. 8 – Pavement under construction

3. Construction

This footbridge was mounted at its permanent position with temporary props on top of a hydraulic shoring embankment, offering no special difficulty beyond the need to have the utmost care with the natural life environment of the salt-marsh.

4. Acknowledgements

Structural design of this footbridge was done together with Structural Engineer Rui Oliveira at AFAconsult, where, at the time, we were both practicing. Structural Engineer Alvaro Azevedo / FEUP developed the “shape optimization” application.