TIMBER BRIDGES IN THE INTERNATIONAL LANDSCAPE

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Summary

Timber is the oldest building material used for bridges .In combination with modern engineering and construction techniques it is possible to span distances up to 130 meters. Timber is also a material with the lowest impact on the environment. Because of the relative light weight it is ease to prefabricate large elements which can be transported easily to the site, and in combination with fast installation on site it is a very attractive building material for footbridges

Keywords: timber:footbridge:design:LCA

1. Introduction

A recent study by Ernst and Young comparing steel, concrete , timber and glass fibre reinforced plastic pedestrian bridges shows that a timber footbridge has the lowest impact on the environment, also because of the potential energy by burning at the end of the life cycle.

Fig. 1 Indicator of environmental costs

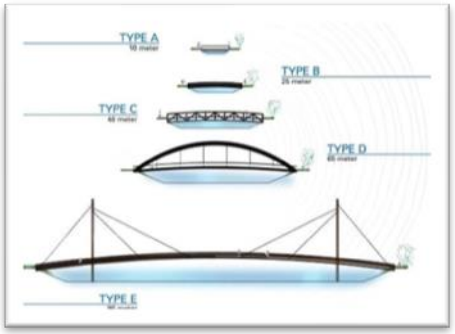

Fig. 2 Possible spans of timber bridges

Also because of the lower costs of timber footbridges it is interesting to use this building material.
Figure 2 shows the possibilities in spans in relationship to the type of structure

Some recent projects which have been build, or are under construction in Europe will be presented.

2. Arch bridge Frederikssund Denmark

Photo 1 Arch bridge over J.F.Willumsensvej Frederikssund Denmark

2.1 Location and design

Over the main road through Frederikssund near Copenhagen a timber arch bridge has been build with a length of 40 meter and a width of 2,50m between parapets. The arches are designed as a 3 hinged arch with a bow foot distance of 24 meter and a height of 15 meters. The underside of the bridge deck has been designed 6 meters above road level, so there is no need to take into account for an impact load from collision. The bridge has been designed according to the Eurocode and the complete structure has been build out of FSC certified azobe.

2.2 Fabrication and construction

The arches are composed of lamellas of 40 mm thick for the strongly curved upper part and of lamellas 90 mm thick for the bottom part. All the lamellas are connected with hot dipped galvanised dowels.

Photo 2 Dowel laminated arches

Photo 3 Dowel laminated bridge beams

The beams for the footbridge itself are made of lamellas of 145 mm thick and are dowel laminated with hot dipped galvanised dowels of 24 mm

2.3 Method of erection

Because of the large volume of traffic on the road the bridge had to be installed in 2 nights, with a road closure of maximum 8 hours. This meant that all components had to be prefabricated as far as possible. The total bridge has been transported in 4 truckloads from the Netherlands to Denmark

Photo 4 Transport of arches

Photo 5 Transport of bridge sections

First of all the 2 arch sections have been brought into position and after fitting together the topconnection the arch construction was already stable after 2 hours of crane deployment.

Photo 6 Setting up the arches

Photo 7 Setting up the arches

Photo 8 Setting up the bridge sections

Photo 9 Setting up the bridge sections

This kind of fast installation times are only possible because the size of the elements which also this can be achieved because of the relatively low weight of the elements

2.4 Acknowledgements

Client:	The Danish Road Directorate (Vejdirektoratet)
Engineer:	Timber bridge - Wijma Kampen bv, The Netherlands Concrete substructure - Cowi A/S Denmark
Fabrication and installation:	Wijma Kampen bv, The Netherlands

3. Truss girder bridge Wenduine Belgium

Photo10 View from the Koninklijke Baan

3.1 Location and design

Photo 11 Situation trussgirder bridge Wenduine

Photo 12 Topview

To pass the road and railroad alongside the shoreline between Wenduine and Blankenberge in Belgium a timber trussgirderbridge has been build (beginning 2014).

The quirky architecture will realize a continuous contact with the blowing sand and the sea breeze, the salty atmosphere of the beach and sea. The wooden construction there will be random and chaotic look like and thereby refer to wreckage that washed up in the dunes.
The bridge is designed as a trussgirder, which means the timber elements are under compression and tension. The connections are realized by means of steel buses and steel pins with a diameter of 65 mm.

The total length of the bridge is about 80 meters (in sections of about 13,5m) and a width of 4 meters between the handrails. The bridge is supported by concrete columns with spans of approx. 13meters

3.2 Fabrication and construction

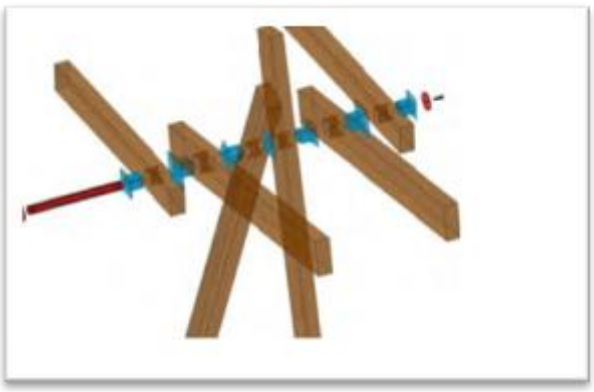

Fig. 3 Connection detail

Photo 13 Connection detail

The trussparts are made out of azobe (ekki) with dimensions of approx 120x250mm, with a maximum length of 6 meters. The complete construction has been designed in 3D and therefore it was possible to machine all parts completely by CNC machines. This was also necessary because of the 600 different parts.

3.3 Method of erection

Construction started by assembling all the timber and steel parts on ground level and building sections of about 14meters with a maximum weight of 36 tonnes. This meant that road closures only took a couple of nights.

Photo 14 Before lifting

Photo 15 After lifting

3.4 Acknowledgements

Client:	department KUST of the Agency for maritime and coastal services
Architect:	West 8
Engineer:	Arup
Main Contractor:	Westconstruct
Fabrication and installation:	Wijma Kampen bv, The Netherlands

4. Cable stayed bridge The Netherlands

Figure 4 Artist impression

4.1 Location and design

The city of Harderwijk is an ancient fishing port on the coastline of the IJssellake. To connect the city with a new residential area a highway has to be crossed. Because of the fishing history with old wooden fishing boats the crossing had to have the look of an old wooden fishing boat, a so called Botter.

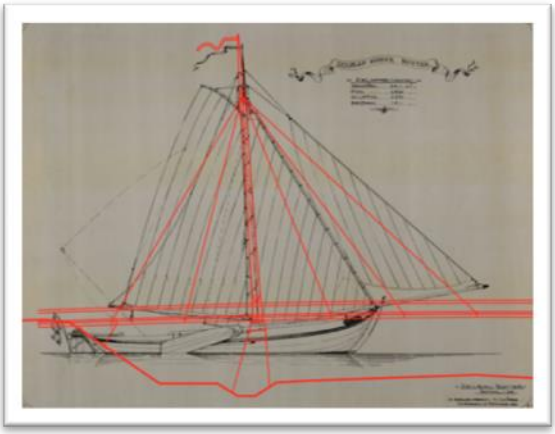

Figure 5 Botter + design bridge

Figure 6 Design

The bridge has been designed in wood with 2 wooden masts to get the appearance of 2 Botters.
The length of the bridge is 77 meter divided into 11 sections of 7 meter. Free span between the masts is 49 meter, and the width is 4,50m to allow for cyclist and pedestrians.

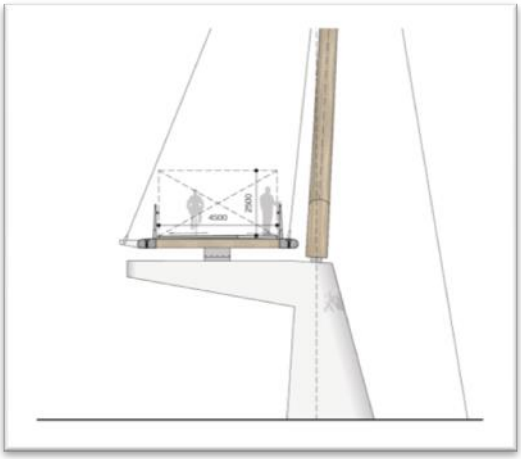

Figure 7 Cross section

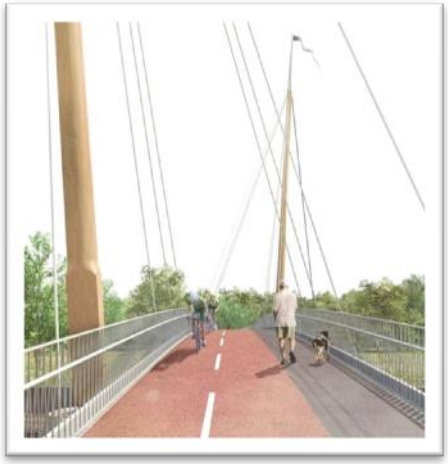

Figure 8 Artist impression deck

4.2 Fabrication and construction

Because of the high horizontal forces on the bridge deck of 1600 kN, caused by a collision of a truck, the bridge has mainly designed in this horizontal direction. To allow for this high force the bridgedeck had to be mainly designed in this direction, and is performed as 11 timber floodgates horizontally projected and connected to each other, to get a horizontal stiff entity.

Photo 16 Timber floodgate

Photo 17 Timber floodgate horizontal

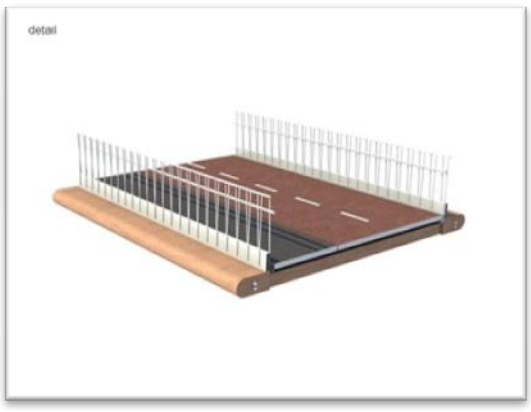

Figure 9 Deck section

Figure 10 Artist impression

The bridge deck has a total thickness of 400 mm, so it is a very slender construction height in relation to the length of the bridge of 77 meters

These bridge deck elements are worn by steel ties and the 2 timber pylons, which are made out of ekki logs of 22 meter out of one piece with a diameter approx 1meter. After shipping from Africa to the Netherlands the logs are shaped a hugh wood lathe.
At the time of this Conference the bridge is under construction.

4.3 Acknowledgements

Client:	gemeente Harderwijk , the Netherlands
Architect:	Zwarts en Jansma Architekten
Engineer:	foundations Wagemaker, timber bridge *Wijma Kampen bv*
Main Contractor:	Heijmans Civiel
Fabrication and installation:	Wijma Kampen bv, The Netherlands

5. References

[1] BECO, *LCA study concrete, steel , timber and GRP footbridges,* 2013

6. Author Data

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