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MARKARFLJOT FOOTBRIDGE - A SLENDER LONG SPAN SUSPENSION BRIDGE IN WINDY SURROUNDINGS

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Summary

A light suspension bridge was the winner of a design competition in 2014 for a crossing of a glacial river into Thorsmork, a remote nature reserve near the Eyjafjallajokull glacier in Iceland. The enterprise was engaged by the Icelandic Road Administration and the local organization Friends of Thorsmork with the main objective of providing safer access to one of Iceland´s most popular tourist destinations. The footbridge design, developed by EFLA Consulting Engineers and Studio Granda Architects, is presented in the paper. It was commenced with the motivation to create a structure that would cause the least possible intrusion in the vast, untouched landscape. The bridge is a single 158 m long span, borne by locked steel cables. As part of the design process it has been verified by an iterative process and 1:12 scale wind tunnel tests that the slender design can be suitable in the windy conditions expected at the site. The tender documents were finalized in 2016. The latter half of required funding is currently being sought by the project owners.

Keywords: footbridge; structural concepts; conceptual debate; aesthetics; cable supported; dynamics; planning; response

1. Introduction

Thorsmork nature reserve in the south of Iceland holds a special place in the hearts of many Icelanders. However, access to the area is restricted. The main access route is a treacherous track along the southern bank of the great glacial river Markarfljot, which remains closed during the winter. There is therefore a requirement for improved accessibility to the area and in light of this, the project stakeholders have initiated the planning stages of direct access by a footbridge from the northern bank of Markarfljot. Road connection to the area on this side of the river is much easier than the track of today.

Fig. 1: The proposed Markarfljot footbridge.

2. Design criteria

Although the bridge is primarily to be built for pedestrian use (according to EN 1991-2) and will not be open to vehicles, it has been specified that the bridge should be designed for a 4-tonne service/emergency vehicle. Vibrations should be accounted for according to SÉTRA Guidelines or the Icelandic Road Administrations´

Guidelines for pedestrian comfort. Wind loading is as prescribed in EN 1991-1-4, base value of v_b = 40 m/s. Width between railings is set at 2.5 m and clearance of the deck over the riverbed is to be 4.0 m.

3. Structural system and adaptation to existing surroundings

The formation of the bridge is simple and modest. The bridge ends land naturally onto rock-anchored abutments buried into the existing rocks. The bridge is 158 m long between abutments. The sag of the main cable system (two LC steel cables Ø90 mm) and bridge deck is 2.9 m at mid span. Underneath, a pair of secondary Ø65 mm LC cables are employed in a parabolic shape, both vertically and horizontally, with the cable plane tilted down and out from the edges of the bridge. The secondary cable system provides stability against static wind loading and reduces vibrations due to pedestrians and dynamic wind load.

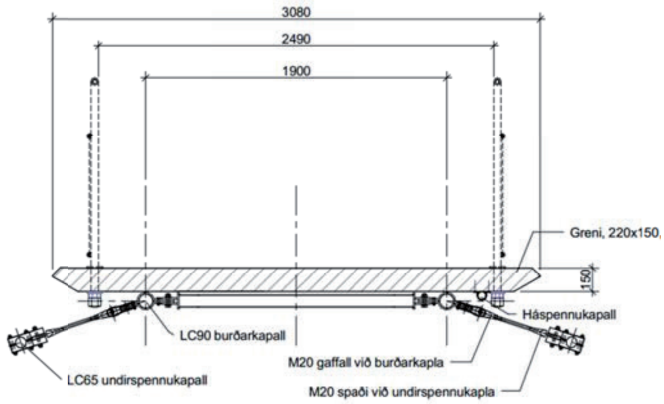

Fig. 2: Deck section

The deck is 2.5 m wide between railings. The deck beams are made of locally sourced spruce clamped directly onto the cables. Timber was conceived as a natural choice of material for a bridge deck at this location with the forests of Thorsmork considered by many to be the core of the area´s natural beauty. The bridge railing is made of cylindrical posts at 2 m intervals and a stainless-steel wire netting stretched between them.

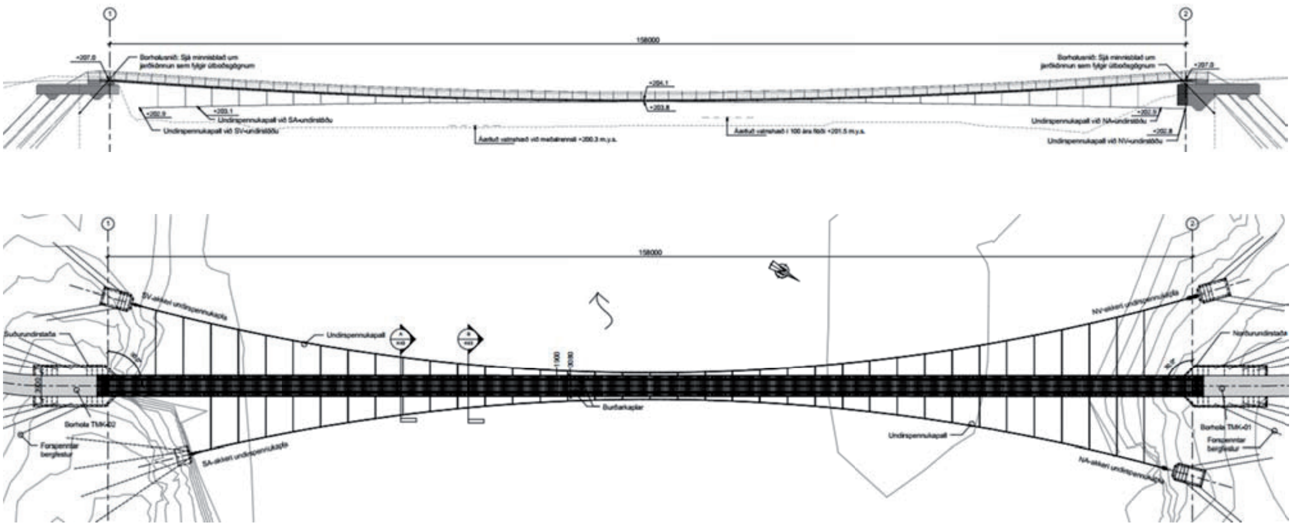

Fig. 3: Elevation and plan view

Uncertainties associated with the dynamic behaviour of the bridge have been addressed in the design. At an early stage, it became evident that the wind load anticipated in the area would cause concern in terms of vibrations of the deck and global structural stability. An iterative study using finite element analysis was used to optimise the dynamic response characteristics of the structure. On completion of this study, wind tunnel testing on 1:12 scale model was carried out by Force Technology in Copenhagen. The results of the first phase of the testing lead to some changes being made to the bridge cross section. Following these changes, the second testing phase demonstrated dynamic stability up to ≈50 m/s wind speeds. It has further been verified that the dynamic characteristics of the structural system are acceptable with respect to pedestrian induced vibrations.

4. Discussion

The bridge location is highly sensitive, both in terms of its natural environment and the significant place it holds in the heart of nature lovers in Iceland. The design team has therefore endeavoured to specify a structure that has minimal intrusion into the special landscape of the area. This has resulted in a very slender bridge structure, whose dynamic characteristics have had to be especially evaluated.