Zeitschrift: IABSE reports = Rapports AIPC = IVBH Berichte

Band: 83 (1999)

Artikel: Deflection monitoring of prestressed concrete bridges retrofitted by external post-tensioning

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DOI: https://doi.org/10.5169/seals-62855

Deflection Monitoring of Prestressed Concrete Bridges Retrofitted by External Post-Tensioning

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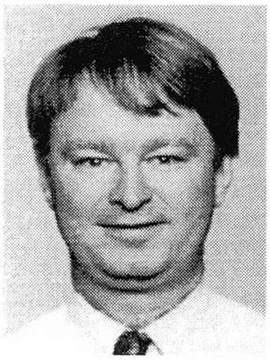

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Keywords: prestressed concrete, in situ measurements, bridge monitoring, long-term deflections, bridge retrofitting, external post-tensioning

Abstract

Additional post-tensioning has become one of the leading techniques for the retrofitting of bridges, in particular prestressed concrete box girder bridges. This paper describes the use of external post-tensioning for the retrofitting of three Swiss highway bridges. These bridges are variable depth prestressed concrete box girder bridges built between twenty and thirty years ago by the balanced cantilever method. Monitoring of these bridges long-term deflections showed that the downward girder deflections were large and did not stabilise as expected. In all three cases, the decision to retrofit was governed by serviceability considerations, namely deflection control, rather than structural safety considerations. External post-tensioning has proven well suited for this type of intervention. Findings of the long term monitoring of the bridge deflections are presented, with an emphasis on the effect of the additional post-tensioning on the bridge behaviour in the years following the retrofit. The situation of the Fégire Bridge is described briefly in this abstract.

Example: Fégire Bridge

Construction of the cast-in-place Fégire bridge was completed by the balanced cantilever method in 1979. The bridge is 512 m long, its three main spans are about 107 m long, and it does not feature intermediate joints. The bridge was retrofitted in 1995 with additional post-tensioning to counter excessive vertical deflections that were not stabilising as expected. The additional post-tensioning is parabolic (fig. 1) and consists of 2x4 cables with an initial prestressing force of 28'000 kN. The additional cables are unusually long since they are anchored at both abutments. The massive anchorage blocks were designed for the case that a future retrofit would double the additional post-tensioning installed to date.

The long-term deflections of the girder of the bridges reported in this paper are monitored with a hydrostatic levelling system. This simple and robust system was developed by IBAP and is operational in over 10 bridges. The measurements of the vertical mid-span deflection of the central span of the Fégire Bridge are presented in fig. 2. They show the instantaneous upward deflection at mid-span (middle span) caused by the post-tensioning is just under 30 mm. The previous downward tendency clearly observable in fig. 2 appears to have been reversed by the additional post-tensioning.

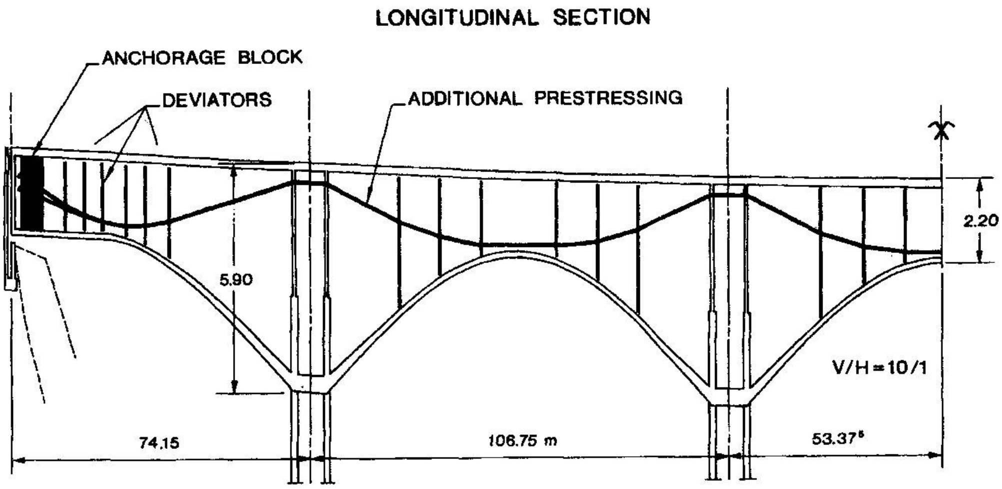

Figure 1: Additional post-tensioning for the Fégire bridge

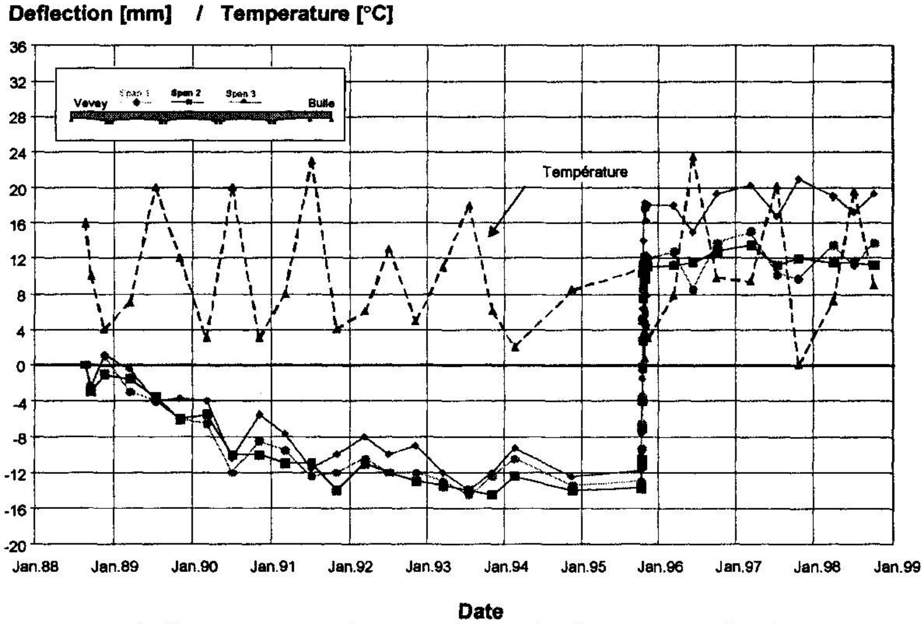

Figure 2: Long-term deflections at mid-span of span 2 of the Fégire bridge

Conclusions

The Lutrive, Chillon and Fégire bridges were retrofitted with additional post-tensioning to counter excessive long-term deflections. on the basis of these examples, it appears that:

- The addition of external post-tensioning can be a successful retrofitting technique for structures with serviceability limit state problems, such as excessive long-term deflections. It is a relatively flexible technique which can be fine-tuned to achieve the required results. It is for example possible to reverse a downward deflection trend, as shown in the case of the Fégire bridge.

- Long-term monitoring of concrete bridges can be very useful. In the examples reported in this paper, the deflection monitoring data proved extremely valuable for the evaluation of the bridge, and for the selection and design of the retrofitting scheme. It also continues to provide valuable feedback on the actual behaviour of the retrofitted bridges.