

Structural performance assessment of post-tensioned concrete beams by embedded continuous fibre optics

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ABSTRACT

Prestressed concrete structures have numerous advantages over conventionally reinforced concrete, though the usage of post-tensioned structures has declined over the last two decades. By distributed optical fibre sensors, key performance indicators of the post-tensioned concrete specimens were monitored and evaluated. Initial losses and long-term effects affecting prestressing force, deflections and cracks were tracked and compared to theoretical calculation methods. It was found that the theoretical calculation methods mostly agreed well with results from the distributed optic fibre sensors. The loss of prestressing force due to mechanical creep and relaxation was overestimated in theoretical calculation methods by approximately 6 %, while the loss due to friction was overestimated by 0.6 %. Regarding deflections, the relative error ranged from 0 % to 3.3 % and 0 % to 2.9 % for the reference specimen and post-tensioned beam respectively.

Keywords: Post-tensioned concrete, Distributed optical fibre sensing, Prestressing force, Rayleigh backscattering, Crack monitoring, Performance indicators.

1 Introduction

In the beginning of the 1900th century usage of concrete structures was commonly connected with issues as creep and shrinkage. These effects were not well understood at this time [1] and to solve these issues and delay cracking of the concrete, development of prestressed concrete structures started to take place. Even though there are several benefits using post-tensioning [2,3], in later years

the usage of this type of system in concrete bridges has decreased, see Figure 1. There are several possible explanations for this development, such as the complexity during construction and longer construction time, as well as difficulties to perform structural assessments on old bridges. To be able to determine the functionality and safety of these structures, information about the residual prestressing force in the tendons after time is needed which still is limited to achieve.