Measurements of the transmission length of pre-tensioned strands

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ABSTRACT: This paper reports the main results of an experimental programme which was conducted to analyse a type of bond test for the evaluation of the bond characteristics of seven-wire low relaxation strands used in pre-tensioned structures. The experimental campaign highlights that the concrete strength marginally influences the transmission length.

1 INTRODUCTION

International standards (Eurocode 2, FIP Recommendations, ACI) give the relationships to calculate the transmission length over which the prestressing force is fully transmitted to the concrete in anchorage regions of pre-tensioned structures. The assessment of this length is, however, very complex because it is influenced by several parameters. Moreover, the characteristics of strands, with reference to mechanical strength, relaxation and surface conditions, have changed over the last decades. Various researchers (Rose & Russel 1997, Cousins et al. 1992) have provided useful indications on this aspect, but the results also appear very scattered.

In this context, the main results of an experimental campaign that was carried out to study the bond characteristics of strands are here discussed. For this purpose, a testing procedure, which can simulate most of the phenomena that occur around the pre-tensioned strand at release, is adopted.

2 EXPERIMENTAL PROGRAMME

The experimentation consisted of 8 tests on seven-wire low relaxation strands of the 1860 class, 9.5 mm (3/8") nominal diameter, inserted into cylindrical concrete specimens with a diameter of 150 mm and a height of 600 mm (Fig. 1). The mean compressive strength of the concrete was determined, at the release of the strands, on 4 cubic specimens, which were previously prepared with the same concrete, and varies about from 20 N/mm² to 55 N/mm².

2.1 Testing method

The tests were carried out in three consecutive phases:

– tensioning of the strand;
– casting and curing of the concrete specimen;
– gradual release of the pre-tensioned strand by introducing a downwards constant rate displacement of the jack in such a way as to produce the progressive decrease of the tensile force.

2.2 Measurement instrumentation

This includes (Fig. 1):

– the potentiometric transducer T1 placed at the lower part of the strand, above the lower steel plate.
During the release phase it allows the force acting on the lower part of the strand to be determined indirectly;

- two potentiometric transducers, T2 and T3, from which the slips of the strand, with respect to the top and the bottom of the concrete specimen, respectively, can be obtained once the elastic deformation of the steel is deducted from the measurement;
- ten strain gauges that permit the mean strains, \( \varepsilon_i \), to be measured along a generatrix of the cylindrical specimen. They are numbered in mounting order from the top to the bottom.

3 EXPERIMENTAL RESULTS

During the gradual force release in the pre-tensioned strand, the bond force, \( F_b \), is calculated as the difference between the force, \( F_{\text{top}} \), that acts on the part of the strand above the concrete specimen and the force, \( F_{\text{bot}} \), that acts on the part below the concrete specimen. This force represents the resultant of the elementary forces that arise along the interface between steel and concrete.

The mean strains \( \varepsilon_i \), referring to specimen n. 1, are shown in Figure 2 as a function of the bond force \( F_b \). Strain gauges 1, 2 and 3, close to the top of the specimen, register a markedly non linear initial trend. Quite constant mean strains are shown afterwards. The non-linearity of the curves reduces as the measurement is carried out at a distance far from the top of the specimen.

Figure 3 shows the trend of the mean strains, \( \varepsilon_i \), as a function of the distance of each strain gauge from the top of the concrete specimen, for various values of the bond force, \( F_b \). From this diagram, the extent of the transmission length, \( l_{bp} \), can be assessed as the distance, from the top of the specimen, of the measuring base over which the experimental curve assumes a horizontal trend. Beyond this distance the reduced variability of the mean strain of the concrete in fact indicates the exhaustion of the phenomenon of transmission of forces between steel and concrete.

The transmission length is also shown in Figure 4 as a function of the strength of the concrete at release. It appears to be slightly influenced by the strength of the concrete.

4 CONCLUSIONS

The experimental results show that the compressive strength of concrete slightly influences the transmission length of seven-wire strands at release.

REFERENCES


