

## RESEARCH PROJECT GACR

### THE DEVELOPMENT AND EVALUATION OF FIBRE REINFORCED CONCRETE TO FULFIL ACTUAL REQUIREMENTS ON PRECAST LINING OF TRANSPORT TUNNELS



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<b>Recipient (leader):</b>	<b>Czech Technical University in Prague (doc. Ing. Matouš Hilar, Ph.D.)</b>
<b>External cooperation:</b>	<b>3G Consulting Engineers s.r.o., Metrostav a.s., Červenka Consulting s.r.o.</b>

Segmental tunnel lining is usually applied to mechanised tunnelling using full-face tunnelling shields (the TBM technology). The segments are traditionally reinforced by steel cages. The research project is focused on problems of steel fibre reinforced concrete (SFRC) segments to apply this technology in the Czech Republic. A variety of samples were produced and tested in the initial phases of the research, serving for the comparison and selection of suitable composition of steel fibre reinforced concrete mixture. The influence of different batching of steel fibres on the resultant behaviour of SFRC was subjected to comparing. The properties of steel fibres were laboratory tested and assessed (unconfined compressive strength tested on cubes, flexural strength tested on beams). Some parameters of SFRC were derived back by means of advanced numerical modelling using the Finite Element Method (FEM) in the ANTENA programme. Traditional reinforced concrete (RC) segments and SFRC segments were tested at the Klokner's Institute of the Czech Technical University in Prague.

The pre-cast segments for loading tests were produced using moulds for the production of segments for mechanised excavation of running tunnels of the Prague metro Line A extension. The lining ring has the inner diameter of 5.3 m and outer diameter of 5.8 m and thickness (segments) of 0.25 m. One lining ring is 1.5 m long (the width of one segment). The shape of all segments is identical. Two rings were produced for the testing purposes using steel fibre reinforced concrete without steel rod reinforcement, with the batches of steel fibres of 40 kg/m<sup>3</sup> and 50 kg/m<sup>3</sup>. Traditional RC segments with 105 kg/m<sup>3</sup> of the reinforcement were also tested to allow comparison. The values of acting forces, the magnitude of deformations measured by installed potentiometers and signals from strain gauges glued to the surface of segments were recorded during the testing. A hydraulic testing machine Amsler 10000 kN 1523 (metrology number KÚ S 07 010 M) was used for the testing. The values of acting forces, the magnitude of deformations measured by installed potentiometers NOVOTECHNIK TR10 a TR25 were recorded during all tests. In addition, signals from Mikrotechna strain gauges type X350 with the grid length of 100 mm, which were glued to the surface of segments. A PEEKEL Autolog 2100 data logger was used for data gathering.

15 m (10 rings) of SFRC segmental tunnel lining fulfilling all relevant requirements was installed on the Prague metro Line A extension.

