

INTRODUCTION

JKP Static Ltd. was engaged to optimize a traditional rebar cage reinforced concrete segmental lining by means of Finite Element Analysis (FEA) using macro synthetic fibres. The aim of this work was to reduce or replace the original steel reinforcement of the segmental lining, in order to make the precast production process faster and more economic. The outer diameter of the tunnel was 2950mm, the thickness of the segments was 180mm.

The numerical calculations were performed by Atena Finite Element software, the effect of the macro synthetic fibres was modelled as tension stiffening on the tension surface.

BASIC DATA

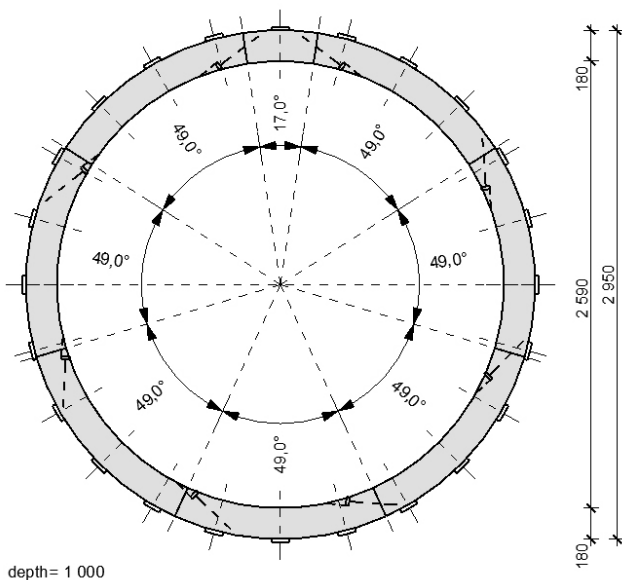


FIG 1 – Geometry of the tunnel

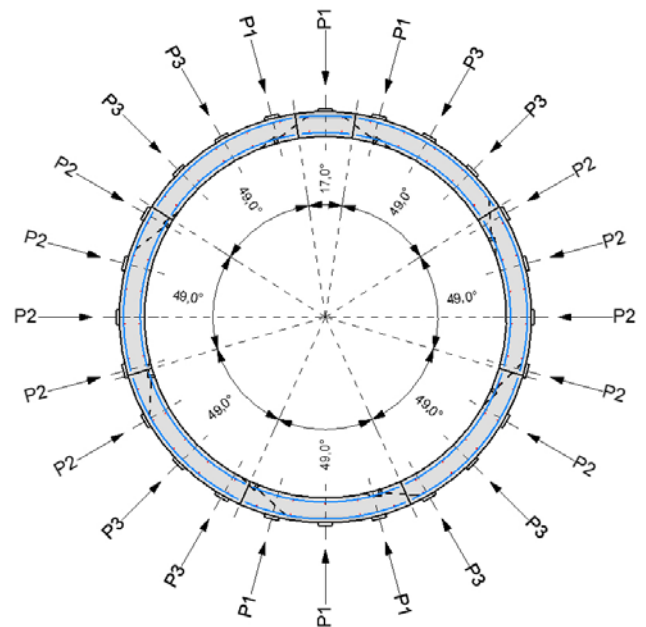


FIG 2 – Loading configuration of the tunnel

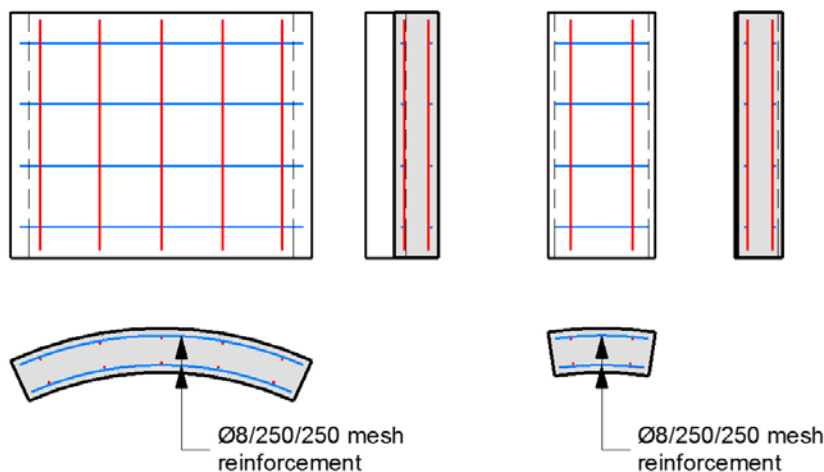


FIG 3 – Original reinforcement of the tunnel segments

FINITE ELEMENT ANALYSIS

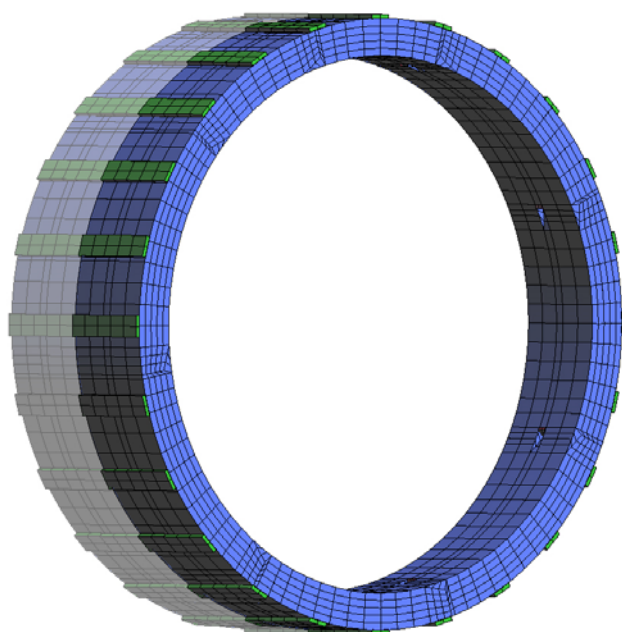


FIG 4 – Finite element model of the tunnel

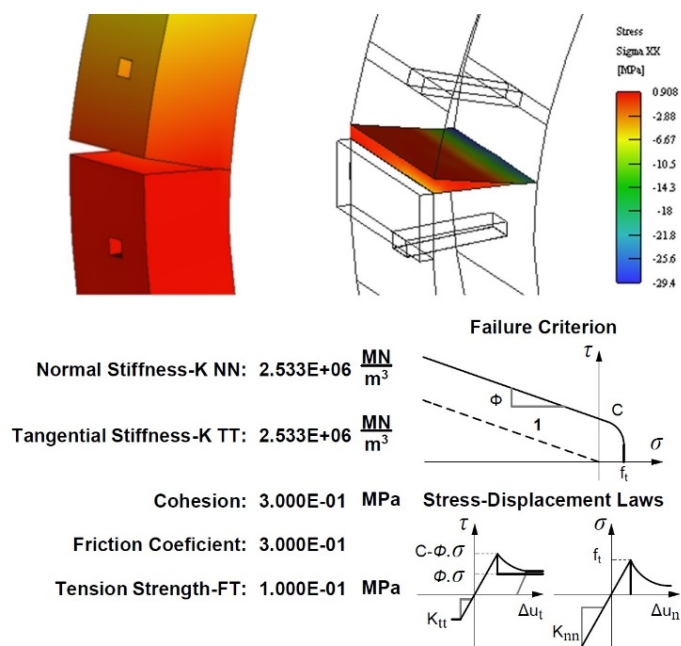


FIG 5 – Connections of the segments (opening joints)

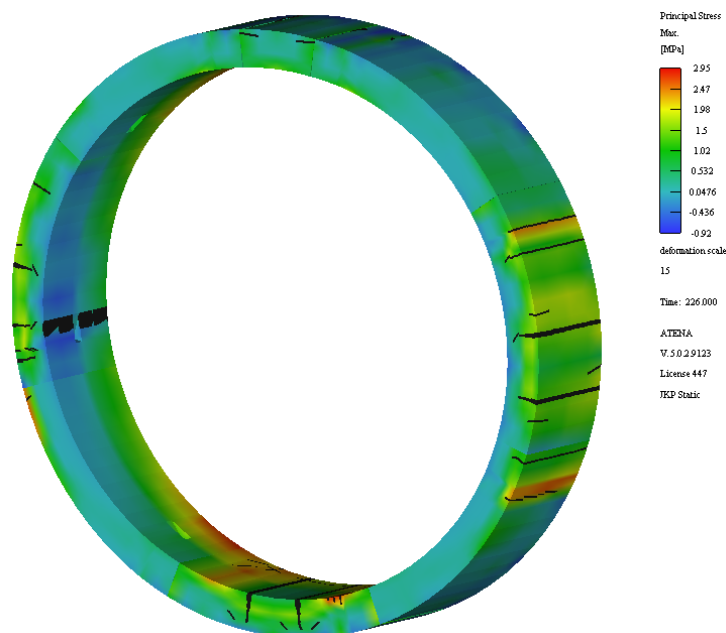


FIG 6 – Principal stress and cracks in the model

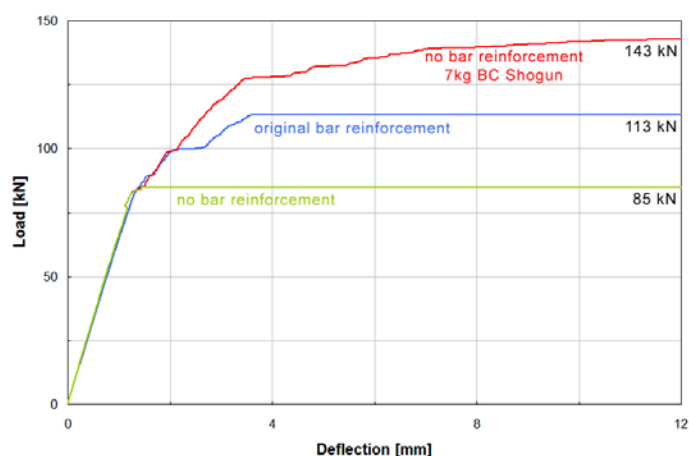


FIG 7 – Load – Deflection diagrams of the results

CONCLUSIONS

A full scale TBM segmental tunnel ring was modelled with an advanced material model in FEA. By using the modified fracture energy method an accurate material model can be used for FRC. Low-stressed steel bars within the section were replaced with 7kg/m³ of BarChip Shogun macro synthetic fibre. This, in return, leads to significant cost savings in both material and labour, as well as a reduction of the production cycle times.