

# Synthetic Macro Fibre Reinforced Segmental Tunnel Linings

## Durus® S500

### Durus macro synthetic fibres can replace steel

Underground tunnel construction is at the forefront of a growing number of major civil engineering projects around the world. Segmental tunnel lining elements are used in combination with Tunnel Boring Machines (TBM) as a proven method of tunnel construction.

A TBM will bore the tunnel and install the precast segments to form a ring which supports the excavation as construction progresses. This is a very effective way to construct tunnels.

Durus synthetic macro fibres have proven to be a very attractive alternative to conventional steel rebar reinforced and steel fibre reinforced segments. FRC is used to improve the mechanical response of precast tunnel segments. The structural use of the material is regulated by national codes and by Model Code 2010.

Full FRC & combination designs will reduce or completely eliminate the amount of steel needed in these precast elements, allowing a reduction in weight and production cost of up to 40%.

### Outstanding performance

From Full scale testing, Durus S500 has been proven to be a valid alternative to steel reinforcement. Without needing to change the existing mix design and without effecting the desired workability, Durus S500 has been shown to exceed performance requirements. It outperformed the results of 30kg of high performance steel fibre.

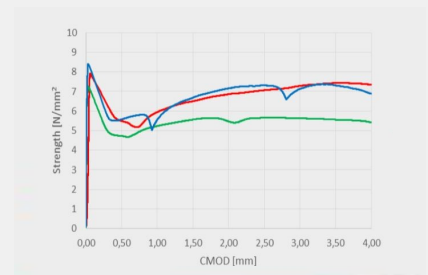
While design performance required 3.5MPa @ 0,5 CMOD, beam test samples taken from the full scale tests showed results of more than 5MPa on average. Performance requirements for a ratio  $F_{3}/F_{11}$  of 0,9 was also exceeded.



Trial precast segmental lining elements reinforced solely with Durus S500



Beam test with Durus S500 - EN 14651



Performance of Durus S500 in beam tests of full scale segmental lining elements

## Advantages of using Durus macro fibres

### Safety

Durus S500 eliminates any risk of abrasion and puncture injuries to production operatives from steel fibres during closing, de-moulding and handling of the finished elements. It therefore greatly improves health & safety during the production process and on the construction site.

### Durable reinforcement

Durus synthetic macro fibres are manufactured with a life in excess of 100 years. As the fibres are made from virgin PP the product is chemically inert and does not corrode. It will maintain performance even when larger crack widths occur as the fibres are not affected by water intrusion.



The use of Durus macro fibre reinforced concrete did not require any changes to the current production process.

### Higher impact resistance

On average, during the production and installation of high strength segmental lining elements, 1 out of 6 elements will be damaged during transport or installation.

Because Durus S500 combines a consistent fibre distribution throughout the whole volume of the concrete with high performance properties, it will increase the impact resistance of the elements and therefore significantly reduce rejection of any elements due to damage.



During trials, opening of segment moulds confirmed a high quality surface finish of elements containing Durus S500.



Fullscale trial elements were broken to ensure consistent dispersion of Durus S500 macro synthetic fibres throughout the whole volume of the units.



Durus S500 is a high performance macro synthetic fibre with proven performance in precast element trials.