

BarChip Reinforced Precast Segmental Lining

Santoña Laredo Subfluvial Water Tunnel, Spain



Project Details

In order to protect significant ecological marshlands from urban sprawl a new wastewater pipeline is being constructed in northern Spain. The objective of the project is to collect and transport wastewater from multiple municipalities to existing treatment facilities for environmentally friendly processing and disposal. Incorporated in the infrastructure project is the Santoña Laredo Subfluvial Water Tunnel.

Design Details

The 1.5 km long segmentally lined tunnel is driven by a 4.3 m diameter TBM. The EPB machine used for construction has a maximum thrust of 16,725 kN. The universal rings have a 5 + 1 segmentation and a length of 1.2 m. Internal diameter of the lining is 3.5 m with a thickness of 250 mm.

The segment reinforcement consists of 5 kg/m³ of BarChip48 structural synthetic fibre. 16 kg of steel bar, as additional bursting reinforcement, is placed at the jacking face and the radial joints of the segments. The steam cured segments have a characteristic concrete strength of 45 MPa.

Economic Benefits

Originally, the segments were reinforced with 95 kg of rebar cages. Switching to BarChip fibre eliminated 83% of the steel reinforcement. The remaining bursting ladders are solely for jacking forces and ring ovalisation where the synthetic fibre is the primary reinforcement. Choosing a BarChip design eliminated the rebar cage and its inherent labour and reduced production cycle times by nearly 50%. This resulted in a reduction in overall segment cost of approximately 40% (see over page).

Sustainability Benefits

BarChip positively impacts nearly all pillars of sustainable infrastructure, including economic, social, environmental and people. To start, BarChip makes it faster, easier and safer on-site, positively impacting the experience of workers.

BarChip reduces deliveries to site, reduces noise of steel works and shortens construction time. All of these have a positive social impact on those close to construction. More tangibly, BarChip can greatly reduce the carbon footprint and material consumption in the supply chain. Modelling from available EPD's shows the impact BarChip had on the Santoña Laredo project.

	Carbon (kgCO2e)	Percentage Reduction
BarChip Hybrid Solution	161,990	76 %
Steel Only Solution	700,836	
	Fresh Water Consumption (m ³)	Percentage Reduction
BarChip Hybrid Solution	636	78 %
Steel Only Solution	2,896	
	Non-Renewable Energy (MJ)	Percentage Reduction
BarChip Hybrid Solution	2,978,279	62 %
Steel Only Solution	7,847,689	



Original Reinforcement Design



BarChip Fibre Reinforced Design



Easily Demoulded and Transported

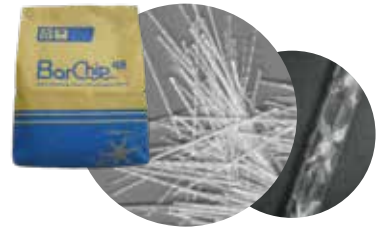


No Issues from Stacking and Storage

Modelling is based on data provided in published EPD's.

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40% Cost Reduction With BarChip Synthetic Fibre

The below table is supplied by the contractor of the Santoña Laredo Water Tunnel and shows that an overall saving of approximately 40% was achieved with a BarChip synthetic fibre reinforcement system.

Number of Rings in Project	Segment / Ring	m³ of Concrete / Ring	Segmentation
1,218	6	3.534	5 + 1
1) EPC's BarChip Fibre Reinforced Segments			
	Unit Cost / m³	m³ / Ring	Cost / Ring
C45/55 with EPC's Synthetic Fibre Reinforcement System	€ 115	3.534	€ 406.41
Rebar: Bursting ladders	€ 1.1 / kg	16 kg / m³	€ 62.20
	Man-hours / Ring	Cost / Hour	
Labour to place bursting ladders	0.25	€ 25	€ 6.25
	Percentage	Segments for Repair	
% of segments requiring major repairs	0.5%	36.54	
	Man-Hours / Segment	Cost / Hour	
Labour for repair	3	€ 25	€ 13.5
Cost of craneage in/out repair areas	1	€ 25	€ 4.5
Administration/QC costs	1	€ 50	€ 9
	Cost / Segment	Total Cost	
Cost of repair materials	€ 4.17	€ 152.25	€ 0.75
Total Cost/Ring			€ 502.61
2) Rebar Cage Reinforced Segments			
	Unit Cost / m³	m³ / Ring	Cost / Ring
C45/55 Concrete with 95 kg/m³ Steel Bar Reinforcement	€ 156	3.534	€ 551.3
	Man-Hours / Ring	Cost / Hour	
Labour for fabrication	3	€ 25	€ 75
Administration/QC Costs	0.5	€ 50	€ 25
Jigs / Spacers	0.5	€ 25	€ 12.5
Welding / tie wire	0.25	€ 25	€ 6.25
	Man-hours / Ring	Cost / Hour	
Labour to place cages	0.5	€ 25	€ 12.5
Cost of craneage	0.5	€ 25	€ 12.5
QC costs (checking cover)	0.5	€ 50	€ 25
	Percentage	Segments For Repair	
% of segments requiring major repairs	2 %	146.16	
	Man-hours / Segment	Cost / Hour	
Labour for repair	3	€ 25	€ 54
Cost of craneage in/out repair areas	1	€ 25	€ 18
Administration / QC Costs	1	€ 50	€ 36
	Cost / Segment	Total Cost	
Cost of repair materials	€ 4.17	€ 609	€ 3
Total Cost / Ring			€ 831.05

Published Papers

[Solving the Challenges of the Santoña-Laredo General Interceptor Tunnel, World Tunnelling Conference 2017.](#)

Cost comparison data supplied by Santoña Laredo construction contractor. Cost of labour and installation of the rebar cage are based on time estimations.

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The Synthetic Fibre Experts

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