LE SFIDE DELLA INDUSTRIALIZZAZIONE NELLA COSTRUZIONE E MANUTENZIONE DI OPERE SOTTERRANEE

Pietro Pisa Laboratory

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HIGH VERTICAL LOADING CAPACITY FRAME

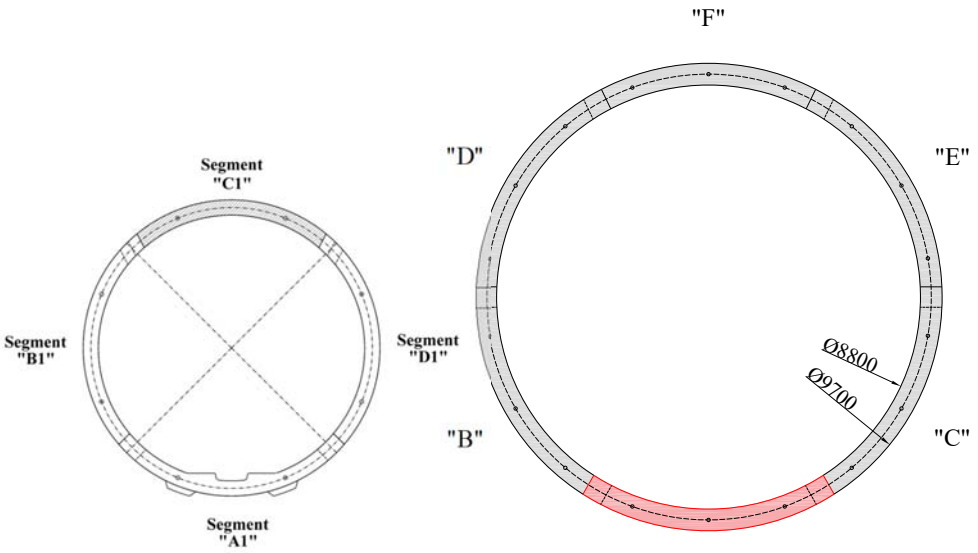
High vertical loading capacity frame

FEATURES OF THE REACTING FRAME

- **Self-equilibrated system**
- concrete beam 1x1x5 m + 6 steel frames
- maximum trust capacity: **16 MN**
- **different loading configurations**
- maximum sample height: **2 m**

SEGMENT TESTED

- **Internal diameter from 3.5 m up to 8.8 m**

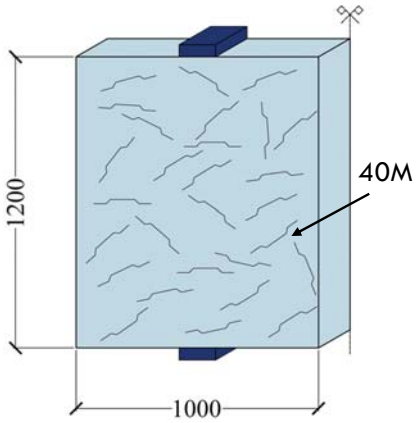


High vertical loading capacity frame

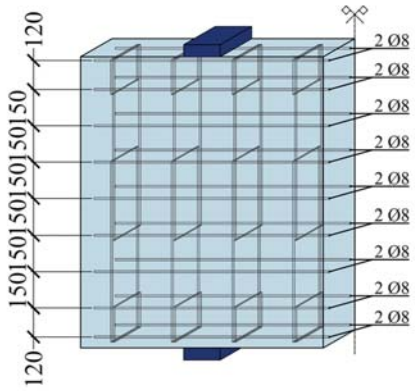
High vertical loading capacity frame



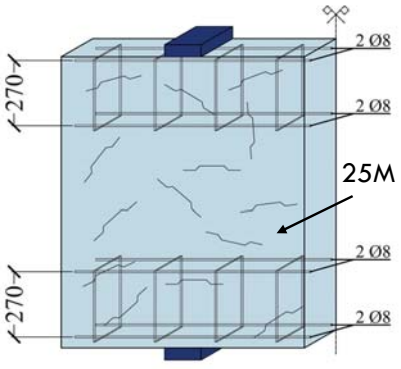

High vertical loading capacity frame: joint research UniBs-RUB



SFRC-40M



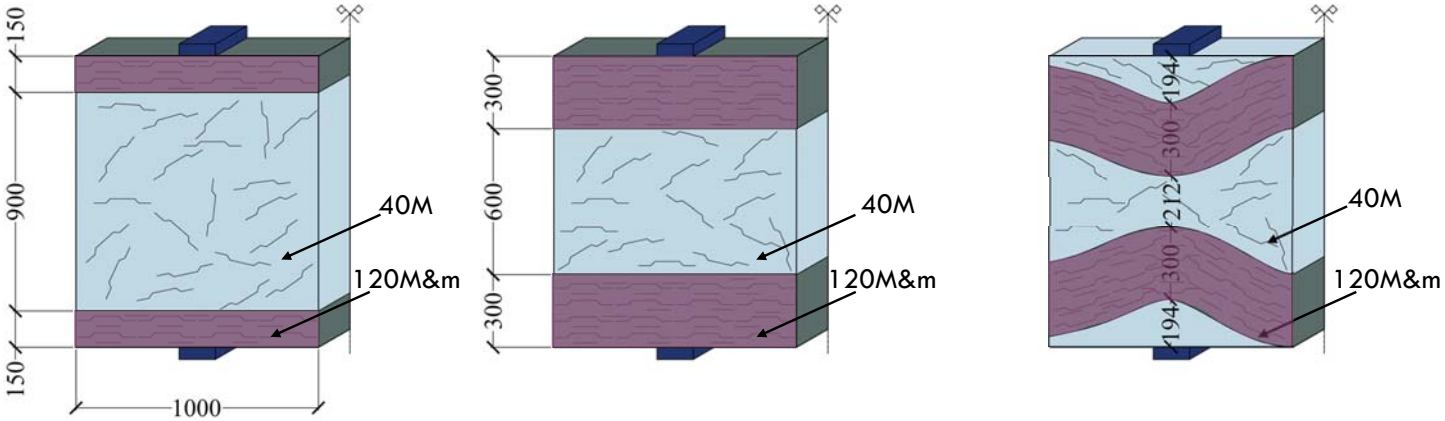
RC



Hy-25M

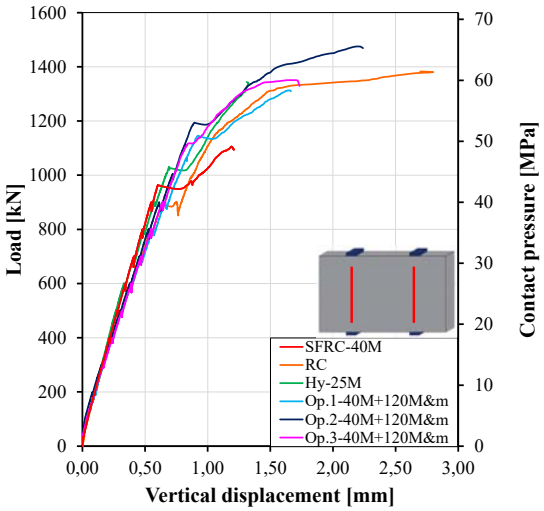
Filippo Medeghini, Ivan Trabucchi, Giulia Brentana, Giuseppe Tiberti, Giovanni A. Plizzari, Peter Mark

High vertical loading capacity frame: joint research UniBs-RUB



Op.1-40M+120M&m | Op.2-40M+120M&m | Op.3-40M+120M&m

High vertical loading capacity frame: joint research UniBs-RUB



ID	f_{cm} [MPa]	P_{max} [kN]	σ_{max} [MPa]	σ_{max}/f_{cm} [-]
SFRC-40M	50,2	1105,7	49,1	0,98
RC	43,9	1382,9	61,5	1,40
Hy-25M	48,4	1344,7	59,8	1,23
Op.1-40M+120M&m	44,7	1312,7	58,3	1,31
Op.2-40M+120M&m	47,6	1475,0	65,6	1,38
Op.3-40M+120M&m	47,0	1351,1	60,0	1,28

SFRC-40M | RC | Op.3-40M+120M&m

1500 kN LOADING FRAME

1500 kN loading frame

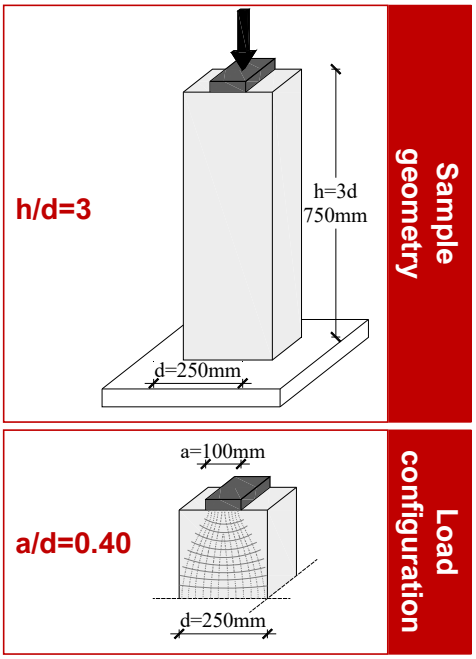
1500 kN loading frame

Experimental campaign:

- prismatic samples
- line load configuration
- reinforcement solutions:
  - fibres only
  - rebars only
- two casting directions

Fibre types:

	60/65	30/80
Material	steel	steel
Shape	double hooked end	hooked end
Diameter [mm]	0.90	0.38
Length [mm]	60	30
Aspect ratio [-]	65	80
Dosage [kg/m^3]	25-40-60	25-40-60

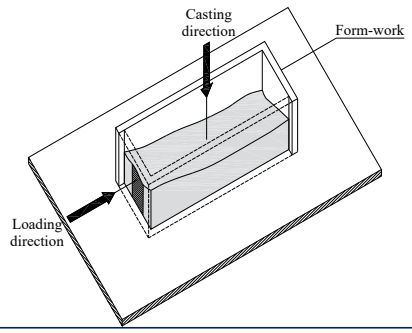


1500 kN loading frame

Horizontal casting

Casting direction perpendicular to loading direction

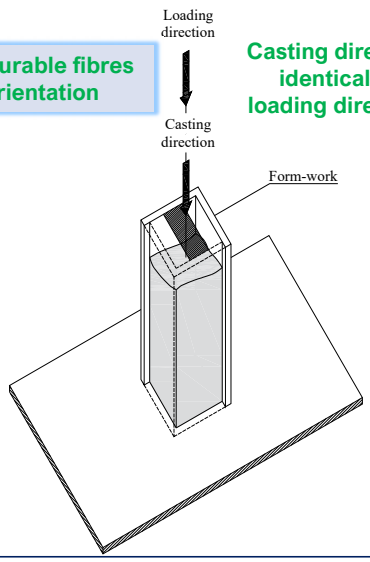
Unfavourable fibres orientation



Vertical casting

Favourable fibres orientation

Casting direction identical to loading direction

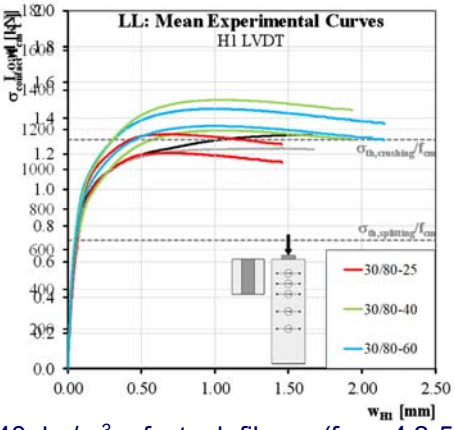


1500 kN loading frame

ID	N° of samples	Fibre type	Fibre dosage [kg/m³]	Steel reinfo.	Base concrete	Casting direction
60/65-25	3	60/65	25	-	SFRC25	Vertical
60/65-40	3	60/65	40	-	SFRC40	Vertical
60/65-40H	3	60/65	40	-	SFRC40	Horizontal
60/65-60	3	60/65	60	-	SFRC60	Vertical
30/80-25	3	30/80	25	-	SFRC25	Vertical
30/80-40	3	30/80	40	-	SFRC40	Vertical
30/80-40H	3	30/80	40	-	SFRC40	Horizontal
30/80-60	3	30/80	60	-	SFRC60	Vertical
RC-0.6	3	-	-	Φ8/65	PC	Vertical
RC-1.0	3	-	-	Φ8/40	PC	Vertical

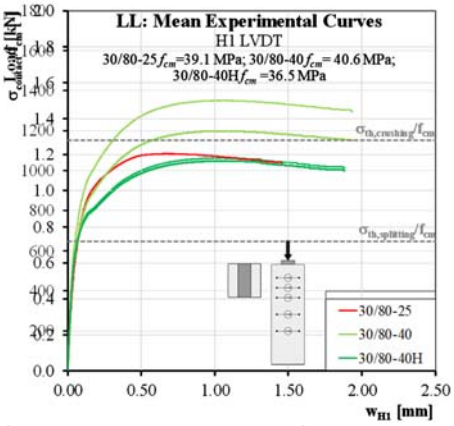
rebars

1500 kN loading frame



40 kg/m³ of steel fibres (f_{R1m}=4.2-5.5 MPa) **change the failure mode from splitting to crushing**

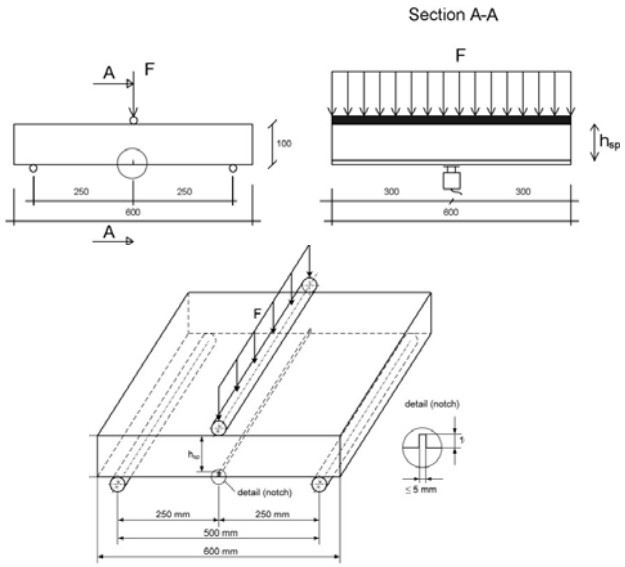
60 kg/m³ of steel fibres (f_{R1m}=6.7-6.5 MPa) guaranteeing a **stiffer response than RC solution**



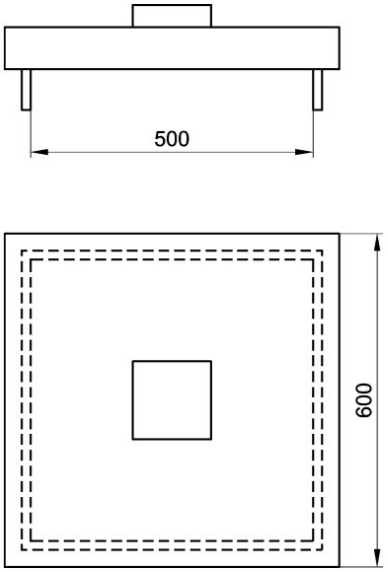
Casting direction influences the maximum load and the failure mechanism, thus the post-cracking behaviour of specimens is affected by casting direction

Mechanical characterization of Fiber Reinforced Sprayed Concrete

Tests according EN14488-3 – Method B



Tests according EN14488-5



Latest publications on international journals

I. Trabucchi, G. Tiberti and G.A. Plizzari (2022). **"A model for predicting the splitting bearing capacity of Fiber Reinforced Concrete elements under partially loaded areas"**. Structural Concrete. https://doi.org/10.1002/suco.202200010.

I. Trabucchi, G. Tiberti, A. Conforti, F. Medeghini and G.A. Plizzari (2021). **"Experimental study on Steel Fiber Reinforced Concrete and Reinforced Concrete elements under concentrated loads"**. Construction and Building Materials. https://doi.org/10.1016/j.conbuildmat.2021.124834.

I. Trabucchi, G. Tiberti and G.A. Plizzari (2021). **"A parametric numerical study on the behavior of large precast tunnel segments during TBM thrust phase"**. Engineering Structures. https://doi.org/10.1016/j.engstruct.2021.112253.

I. Trabucchi, M. Smarslik, G. Tiberti, D.N. Petraroia, G.A. Plizzari and P. Mark (2021). **"A hybrid solution proposal for precast tunnel segments"**. Structural Concrete. https://doi.org/10.1002/suco.202000629.

A. Conforti, I. Trabucchi, G. Tiberti, G. A. Plizzari, A. Caratelli, A. Meda (2019). **"Precast tunnel segments for metro tunnel lining: A hybrid reinforcement solution using macro-synthetic fibers"**. Engineering Structures. https://doi.org/10.1016/j.engstruct.2019.10

… … …

Latest publications on international conferences

G. Tiberti, I. Trabucchi, A. Mudadu and G.A. Plizzari (2024). **"Evaluation of fiber distribution and orientation of a SFRC tunnel segment"**. In BEFIB2024 XI International Symposium On Fiber Reinforced Concrete. Dresden, Germany.

F. Medeghini, I. Trabucchi, G. Tiberti, G.A. Plizzari and P. Mark (2024). **"Optimized Fiber Reinforced Concrete structural elements with oriented fibers to resist high concentrated loads"**. In BEFIB2024 XI International Symposium On Fiber Reinforced Concrete. Dresden, Germany.

G. Tiberti, I. Trabucchi, A. Mudadu, A. Morbi and G.A. Plizzari (2024). **"Precast tunnel segments made by Steel Fiber Reinforced Concrete with fast setting and hardening process"**. In: Atti Italian Concrete Conference 2024. Firenze, Italy.

M. Z. Gezahegn, G. Tiberti, I. Trabucchi, G. A. Plizzari (2024). I. Trabucchi, G. Tiberti and G. Plizzari (2023). **"Post-cracking performance criteria for fibre-reinforced sprayed concrete in permanent tunnel linings"**. In: 9th International Symposium on Sprayed Concrete. Sandefjord, Norway.

M. Z. Gezahegn, G. Tiberti, I. Trabucchi, G. A. Plizzari (2024). **"Fibre-reinforced sprayed concrete for use in permanent tunnel lining application"**. In: 15th fib PhD Symposium 2024. Budapest, Hungary.

… … …

Latest publications on international conferences

I. Trabucchi, G. Tiberti and G. Plizzari (2023). **"An analytical proposal to calculate splitting bearing capacity of FRC elements under partially loaded area"**. In: 3rd Italy YMG Symposium on Concrete and Concrete Structures. Torino, Italy.

I. Trabucchi, G. Tiberti, G. Plizzari, R. Ruttigliano, A. Anania, M. Laffranchi, G. Sechi, M. Tanzini and D. Merlini (2022). **"High-speed railway line Brescia-Verona: full-scale tests of precast tunnel segments for reproducing the TBM thrust phase"**. In: Atti Italian Concrete Conference 2022. Naples, Italy.

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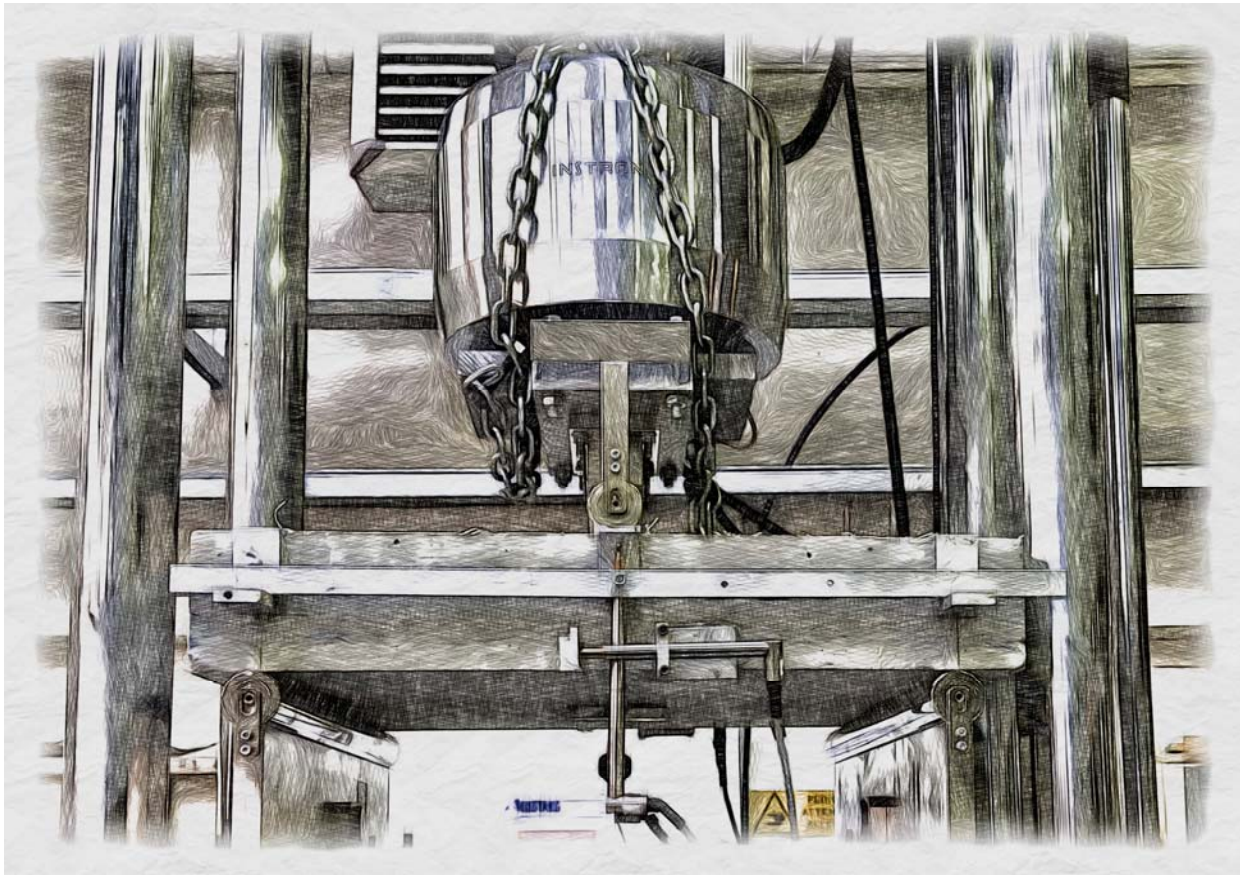

Thank you!
…questions?