



ACI – *fib* – RILEM Joint Workshop

**Fibre Reinforced Concrete:**

**from Design to Structural Applications**

**Desenzano, Italy, June 27<sup>th</sup> - 30<sup>th</sup>, 2018**



**Workshop booklet - Final Program**





**Organized by:**



UNIVERSITY  
OF BRESCIA



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DICATAM - Department of Civil, Environmental, Architectural Engineering and  
Mathematics

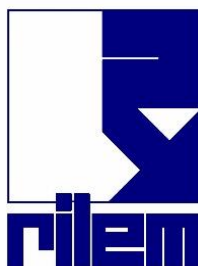
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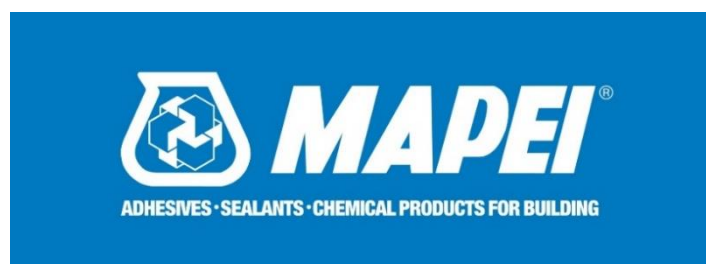
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## PREFACE

The first international FRC workshop supported by RILEM and ACI was held in Bergamo (Italy) in 2004. At that time, lack of specific building codes and standards was identified as the main inhibitor to the application of this technology in engineering practice. The workshop aim was placed on identification of applications, guidelines, and research needs in order for this advanced technology to be transferred to professional practice.

The second international FRC workshop, held in Montreal (Canada) in 2014, was the first ACI-fib joint technical event. Many of the objectives identified in 2004 had been achieved by various groups of researchers who shared a common interest in extending the application of FRC materials into the realm of structural engineering and design. The aim of the workshop was to provide the State-of-the-Art on the recent progress that had been made in term of specifications and actual applications for building and bridge projects in Europe and North-America.

The rapid development of codes, the introduction of new materials and the growing interest of the construction industry suggest presenting this forum at closer intervals. In this context the third international FRC workshop is held in Desenzano (Italy), four years after Montreal. In this first ACI-fib-RILEM joint technical event, the maturity gained through the recent technological developments and large-scale applications will be used to show the acceptability of the concrete design using various fiber compositions. The growing interests of civil infrastructure owners in ultrahigh-performance fibre-reinforced concrete (UHPFR or UHPC?) and synthetic fibres in structural applications bring new challenges in terms of concrete technology and design recommendations. In such a short period of time we have witnessed the proliferation of the use of fibers as structural reinforcement in various applications such as industrial slabs, elevated slabs, precast tunnel lining sections, foundations, as well bridge decks. We are now moving towards addressing many durability based design requirements by the use of fibers, as well as the general serviceability based design. In that perspective, the aim of FRC2018 workshop is to provide the State-of-the-Art on the recent progress in term of specifications development, actual applications, and to expose users and researchers to tomorrow's challenges in the design and construction of a wide variety of structural applications.

We appreciate the enormous support we have received from all three sponsoring organisations and look forward to paving the path for future collaborations in various areas of common interest so that the developmental work and implementation of new specifications and design procedures can be expedited internationally.

June, 2018

Bruno Massicotte

Fausto Minelli

Barzin Mobasher

Giovanni Plizzari



## 1. SYMPOSIUM VENUE

The conference will take place at Acquaviva del Garda Hotel (Viale Francesco Agello, 84) in Desenzano del Garda; Brescia, Italy.

The Hotel Acquaviva del Garda overlooks the shores of the lake. Its large park, swimming pools and private beach provide unforgettable moments of relaxation and full enjoyment of the beauty of the place. The interior of the rooms reflect the love for design and art, in a pleasing contrast between modern furniture and collection pieces. The wellness area is large, as is the offer of treatments and every room is designed for psychophysical wellness. The restaurant, furnished with a marvellous terrace overlooking the lake, offers a healthy cuisine that interprets the local flavours and aromas. The hotel is fully equipped for MICE and, thanks to its large, dedicated spaces, the location is ideal for meeting and company conferences.



### Internet

Complimentary Wireless Internet access.

**WiFi Connection:** Hotel Acquaviva

**Password:** acquaviva2015



## 2. COMMITTEES AND LOCAL ORGANISERS

### Conference Chairman

Bruno Massicotte (*Polytechnique Montreal, Canada*)

Fausto Minelli (*University of Brescia, Italy*)

Barzin Mobasher (*Arizona State University, USA*)

Giovanni Plizzari (*University of Brescia, Italy*)

### Local Organising Committee

**Fausto Minelli**

**Giovanni Plizzari**

**Fabiola Iavarone**

**Ivan Trabucchi**

Antonio Conforti

Luca Facconi

Sara Lucchini

Giovanni Metelli

Antonio Mudadu

Mónica Yolanda Oña Vera

Anthony Paderno

Marco Preti

Adriano Reggia

Giuseppe Tiberti

### International Advisory Board

L György Balázs

Arnon Bentur

Andrzej Brandt

Horst Falkner

Hirozo Mihashi

Sidney Mindess

Antoine Naaman

Keitetsu Rokugo

Surendra P. Shah

Frank Vecchio

Joost Walraven

## Scientific Committee

Antonio Aguado	Karin Lundgren
Maria Antonietta Aiello	Peter Mark
Mohammad AiHamaydeh	Enzo Martinelli
Nemkumar Banthia	Viktor Mechtcherine
Joaquim Barros	Alberto Meda
Andrea Belleri	Günter Meschke
Stefan Bernard	Aurelio Muttoni
Nicola Buratti	Benoit Parmentier
Giuseppe Campione	Gustavo Parra Montesinos
Jean Philippe Charron	Sergio Pialarissi
Matteo Colombo	Dario Redaelli
Valeria Corinaldesi	Jacques Resplendino
Albert De La Fuente	Zila Rinaldi
Frank Dehn	Pierre Rossi
Marco Di Prisco	Pedro Serna
Alessandro Fantilli	Luca Sorelli
Liberato Ferrara	Giuseppe Tiberti
Stephen Foster	Romildo Dias Toledo Filho
Ravindra Gettu	G.P.A.G. van Zijl
Juan Navarro Gregori	Lucie Vandewalle
Steffen Grünewald	Cristina Zanotti
Terje Kanstad	Raul Zerbino
Wolfgang Kusterle	Li Zongjin
Christopher Leung	

### 3. CONFERENCE AND SOCIAL PROGRAMME AT A GLANCE

WEDNESDAY JUNE 27 <sup>th</sup>			
18:30 – 21:00	Registration		
19:30 – 21:00	Ice-breaking party: Hotel Acquaviva del Garda (1 <sup>st</sup> floor terrace)		
THURSDAY JUNE 28 <sup>th</sup>			
7:30 – 17:00	REGISTRATION		
8:30 – 9:00	Welcome speech from the Chancellor of the University of Brescia <i>Maurizio Tira</i>  From Montreal 2014 to Desenzano 2018 <i>Barzin Mobasher</i>		
9:00 – 10:30	PLENARY SESSION 01 <i>Chairmen: Giovanni Plizzari, Fausto Minelli</i>		
10:30 – 11:00	Coffee break		
11:00 – 12:40	<b>Parallel Session A1:</b> Mechanical characterisation <i>Chairmen:</i> <i>Pierre Rossi,</i> <i>Gonzalo Ruiz</i>	<b>Parallel Session B1:</b> Durability <i>Chairpersons:</i> <i>Pedro Serna,</i> <i>Karin Lundgren</i>	<b>Parallel Session C1:</b> Bridges/Elevated slabs <i>Chairmen:</i> <i>Jean-Philippe Charron,</i> <i>Luca Facconi</i>
12:40 – 14:00	Lunch		
14:00 – 15:40	<b>Parallel Session A2:</b> Mechanical characterisation <i>Chairmen:</i> <i>Viktor Mechtcherine,</i> <i>Alessandro Fantilli</i>	<b>Parallel Session B2:</b> Shear <i>Chairmen:</i> <i>Bruno Massicotte,</i> <i>Antonio Conforti</i>	<b>Parallel Session C2:</b> Elevated Slabs <i>Chairmen:</i> <i>Horst Falkner,</i> <i>Matteo Colombo</i>
15:40 – 16:10	Coffee break		
16:10 – 17:50	<b>Parallel Session A3:</b> Mechanical characterisation <i>Chairpersons:</i> <i>Joaquim Barros,</i> <i>Valeria Corinaldesi</i>	<b>Parallel Session B3:</b> Seismic/Special loading conditions <i>Chairpersons:</i> <i>Karin Lundgren,</i> <i>Juan Navarro Gregori</i>	<b>Parallel Session C3:</b> Structural rehabilitation <i>Chairmen:</i> <i>Albert de la Fuente,</i> <i>Adriano Reggia</i>
18:30 – 19:30	SOCIAL PROGRAMME: Wine Tasting Experience by Cà dei Frati Winery		

FRIDAY JUNE 29 <sup>th</sup>			
8:30 – 17:00	<b>REGISTRATION</b>		
9:00 – 10:30	<b>PLENARY SESSION 02</b> <i>Chairmen: Fausto Minelli, Giovanni Plizzari</i>		
10:30 – 11:00	Coffee break		
11:00 – 12:40	<b>Parallel Session A4:</b> Precast elements <i>Chairmen:</i> <i>Marco di Prisco,</i> <i>Ian Gilbert</i>	<b>Parallel Session B4:</b> Seismic/special loading conditions <i>Chairmen:</i> <i>György Balázs,</i> <i>Stefan Bernard</i>	<b>Parallel Session C4:</b> Tunnel linings <i>Chairmen:</i> <i>Alberto Meda,</i> <i>Rolf Breitenbücher</i>
12:40 – 13:50	Lunch		
13:50 – 14:00	Workshop Group Picture		
14:00 – 15:20	<b>Parallel Session A5:</b> High Performance FRC <i>Chairmen:</i> <i>Pietro Lura,</i> <i>Luca Sorelli</i>	<b>Parallel Session B5:</b> Service conditions <i>Chairmen:</i> <i>Liberato Ferrara,</i> <i>Jaime Carlos Galvez Ruiz</i>	<b>Parallel Session C5:</b> Tunnel linings <i>Chairmen:</i> <i>Peter Mark,</i> <i>Giuseppe Tiberti</i>
15:20 – 15:50	Coffee break		
15:50 – 16:50	<b>Parallel Session A6:</b> High Performance FRC <i>Chairmen:</i> <i>Barzin Mobasher,</i> <i>Dario Redaelli</i>	<b>Parallel Session B6:</b> Service conditions <i>Chairmen:</i> <i>Gustavo Parra Montesinos,</i> <i>David Conciatori</i>	<b>Parallel Session C6:</b> Structural applications <i>Chairmen:</i> <i>Jakob Šušteršič,</i> <i>G. P. A. G. van Zijl</i>
17:00 – 18:00	<b>Perspectives and future developments in FRC structural applications</b>		
18:00 – 18:15	<b>CLOSING SESSION</b>		
20:00 – 23:00	<b>GALA DINNER: Hotel Restaurant L'Aquila d'Oro; Desenzano del Garda</b>		

SATURDAY JUNE 30 <sup>th</sup>	
9:30 – 12:30	<b>SOCIAL PROGRAMME: Boat tour on Lake Garda</b>

#### 4. SESSION PROGRAMME

##### WEDNESDAY JUNE 27<sup>th</sup>

<b>18:30 – 21:00</b>	<b>REGISTRATION</b>
<b>19:30 – 21:00</b>	<b>Ice-breaking party: Hotel Acquaviva del Garda</b>

##### THURSDAY JUNE 28<sup>th</sup>

<b>7:30 – 17:00</b>	<b>REGISTRATION</b>
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<b>8:30 – 9:00</b>	<b>WELCOME SPEECH FROM THE CHANCELLOR OF THE UNIVERSITY OF BRESCIA</b> <i>Maurizio Tira</i>  <b>FROM MONTREAL 2014 TO DESENZANO 2018</b> <i>Barzin Mobasher</i>	<b>Room Acquaviva</b>
<b>9:00 – 10:30</b>	<b>PLENARY SESSION 01</b> <b>Chairmen: Giovanni Plizzari – Fausto Minelli</b>	
9:00 – 9:30	Twenty years experience on FRC structural precast elements: a gym for national and international standards <i>Marco di Prisco</i>	
9:30 – 10:00	Fiber-Reinforced Concrete - From Fresh Properties to Structural Design: New Tools, Guides, and Reports from ACI Technical Committee 544 <i>Liberato Ferrara</i>	
10:00 – 10:30	High performance fibre reinforced concrete for structural applications <i>Bruno Massicotte</i>	

<b>10:30 - 11:00</b>	<b>Coffee break</b>
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<b>11:00 – 12:40</b>	<b>PARALLEL SESSION A1</b> <b>MECHANICAL CHARACTERISATION</b> <b>Chairmen: Pierre Rossi - Gonzalo Ruiz</b>	<b>Room Acquaviva</b>
<b>Time</b>	<b>Title and Authors</b>	<b>Proceed. pg.</b>
11:00 – 11:20	Influence of the beam size on the residual strength of fibre-reinforced concrete <i>E. Galeote, A. Blanco, S. H. P. Cavalaro, A. de la Fuente</i>	28
11:20 – 11:40	Comparison of different methods of inverse analysis to assess the tensile law of UHPFRC from four points bending tests <i>D. Bouchard, L. Sorelli, D. Conciatori, S. Dobrusky</i>	20

11:40 – 12:00	A new multi-scale hybrid fiber reinforced cement-based composites <i>L. Li, C. Mingli</i>	22
12:00 – 12:20	A sectional approach for the bending creep of FRC based on uniaxial tension creep tests <i>R. Vrijdaghs, M. di Prisco, L. Vandewalle</i>	24
12:20 – 12:40	Optimized quality control procedure with the Barcelona test and the inductive method for FRC <i>E. Galeote, A. Blanco, S. H. P. Cavalaro, A. de la Fuente</i>	26

<b>11:00 - 12:40</b>	<b>PARALLEL SESSION B1 DURABILITY Chairpersons: Pedro Serna - Karin Lundgren</b>	<b>Room Sirmione</b>
<b>Time</b>	<b>Title and Authors</b>	<b>Proceed. pg.</b>
11:00 – 11:20	Influence of chloride corrosion on the surface aspect of steel fibre reinforced cementitious composites <i>M. M. Vieira, S. H. P. Cavalaro, A. Aguado</i>	50
11:20 – 11:40	The effect of fibres on corrosion in RC elements <i>C. G. Berrocal, K. Lundgren, I. Löfgren</i>	52
11:40 – 12:00	Self-monitoring of cracking development of fiber reinforced conductive concrete subjected to bending <i>Y. Ding, G. Liu, Z. Du</i>	58
12:00 – 12:20	Influence of the Post-Cracking Residual Strength Variability on the Partial Safety Factor <i>A. de la Fuente, S. H. P. Cavalaro, J. M. Bairán</i>	54
12:20 – 12:40	Comparability of bond tests for repair and retrofit of concrete structures with Fiber Reinforced Concrete <i>C. Zanotti, N. Randl, P. Setayesh Gar, B. Kabiri Far, M. Steiner</i>	56

<b>11:00 - 12:40</b>	<b>PARALLEL SESSION C1 BRIDGES/ELEVATED SLABS Chairmen: Jean-Philippe Charron – Luca Facconi</b>	<b>Room Catullo</b>
<b>Time</b>	<b>Title and Authors</b>	<b>Proceed. pg.</b>
11:00 – 11:20	Hybrid Fiber Reinforced Concrete for the Application of Bridge Deck <i>M. Khan, M. Cao, M. Ali</i>	60
11:20 – 11:40	Performance under fatigue loading of field-cast UHPFRC joints in positive moment regions between precast bridge deck panels <i>B. Marleau, B. Massicotte, J. P. Charron</i>	62
11:40 – 12:00	Design of precast prestressed SFRC T-girders for accelerated sustainable bridge construction <i>B. Massicotte, N. Cordoni</i>	64
12:00 – 12:20	SF+RC modelling using DIANA FEA <i>A. Van Den Bos, S. Dhanmeher, Y. Dai</i>	66
12:20 – 12:40	Steel Fibre Only Reinforced Concrete in Suspended Slabs: Design From Academic to Practical Methods <i>X. Destrée</i>	68

<b>12:40 - 14:00</b>	<b>Lunch</b>	
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<b>14:00 - 15:40</b>	<b>PARALLEL SESSION A2 MECHANICAL CHARACTERISATION Chairmen: Viktor Mechtcherine - Alessandro Fantilli</b>	<b>Room Acquaviva</b>
<b>Time</b>	<b>Title and Authors</b>	<b>Proceed. pg.</b>
14:00 – 14:20	Round-Robin Test on Various Test-Methods for Flexural Behavior of Steel Fiber Reinforced Sprayed Concretes <i>S. Plückelmann, R. Breitenbücher</i>	18
14:20 – 14:40	Mechanical properties of self-compacting concrete reinforced with hybrid mixes of hooked steel fibers of variable lengths <i>M. Pajak</i>	30
14:40 – 15:00	Influence of test methodology on the applicability of test results of fibre reinforced concrete for design <i>P. Juhasz, P. Schaul, R. Winterberg</i>	32
15:00 – 15:20	Parameters affecting the properties of plain and fiber reinforced Self-Consolidating concrete <i>A. Javadian, A. Mahdavi, O. Benamrane, M. Majeed, H. Aoude</i>	34
15:20 – 15:40	Numerical Validation of a Simplified Inverse Analysis Method to Characterise the Tensile Behaviour of UHPFRC <i>E. J. Mezquida-Alcaraz, J. Navarro-Gregori, J. Á. López Martínez, P. Serna Ros</i>	36

<b>14:00 - 15:40</b>	<b>PARALLEL SESSION B2 SHEAR Chairmen: Bruno Massicotte – Antonio Conforti</b>	<b>Room Sirmione</b>
<b>Time</b>	<b>Title and Authors</b>	<b>Proceed. pg.</b>
14:00 – 14:20	Experimental study of shear transfer in polypropylene fibre-reinforced concrete using pre-cracked push-off specimens <i>F. Ortiz Navas, L. Scaroni, J. Navarro-Gregori, P. Serna Ros</i>	82
14:20 – 14:40	Shear crack behaviour and shear deformation of polypropylene fibre-reinforced concrete slender beams <i>F. Ortiz Navas, J. Navarro-Gregori, P. Serna Ros, G. L. Herdocia</i>	84
14:40 – 15:00	Enhancements in Fracture Behavior and Shear capacity in Hybrid Steel and Macro-Polypropylene Fiber reinforced concrete <i>G. Sahith, R. K. Chiranjeevi, K. V. L. Subramaniam</i>	86
15:00 – 15:20	Experimental investigation of shear-critical prestressed steel fibre reinforced concrete beams <i>M. De Smedt, K. De Wilder, D. Anastasopoulos, E. Reynders, G. De Roeck, L. Vandewalle</i>	88
15:20 – 15:40	Fibres as shear reinforcement in RC beams: an overview on assessment of material properties and design approaches <i>J. Barros, S. J. Foster</i>	90



<b>14:00 - 15:40</b>	<b>PARALLEL SESSION C2 ELEVATED SLABS Chairmen: Horst Falkner - Matteo Colombo</b>	<b>Room Catullo</b>
<b>Time</b>	<b>Title and Authors</b>	<b>Proceed. pg.</b>
14:00 – 14:20	Effect of reinforcement configuration on the ductility requirements of real-scale slabs <i>E. Galeote, A. Blanco, A. de la Fuente</i>	70
14:20 – 14:40	A new method for designing FRC elevated slabs according to Model Code 2010 <i>L. Facconi, F. Minelli, G. Plizzari</i>	72
14:40 – 15:00	Experimental and numerical comparative analysis of a SFRC slab on piles <i>L. Dlouhý, R. Remy</i>	74
15:00 – 15:20	FRC Hybrid slabs: reliability of Model Code approaches <i>A. Pourzarabi, M. Colombo, P. Martinelli, M. di Prisco</i>	76
15:20 – 15:40	Optimization of partially prefabricated HyFRC slabs <i>G. Zani, M. Colombo, C. Failla, M. di Prisco</i>	78

<b>15:40 – 16:10</b>	<b>Coffee break</b>
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<b>16:10 - 17:50</b>	<b>PARALLEL SESSION A3 MECHANICAL CHARACTERISATION Chairpersons: Joaquim Barros - Valeria Corinaldesi</b>	<b>Room Acquaviva</b>
<b>Time</b>	<b>Title and Authors</b>	<b>Proceed. pg.</b>
16:10 – 16:30	Optimization of fibre combination using latest generation of steel and poly-olefin fibres <i>M. G. Alberti, J. C. Gálvez, A. Enfedaque, A. Cortez</i>	38
16:30 – 16:50	An application oriented state-of-art and research-need perspective on self-healing fibre-reinforced cementitious composites <i>L. Ferrara, E. Cuenca Asensio, F. Lo Monte, D. Snoeck, N. De Belie</i>	40
16:50 – 17:10	Early-age behaviour of High Performance Fiber Reinforced Concretes <i>V. Corinaldesi, J. Donnini, G. Merlonetti</i>	42
17:10 – 17:30	Experimental and numerical analysis of fiber reinforced concrete beams in real scale with steel bars reinforcement <i>M. Ripani, P. Folino, H. Xargay, N. Rocca</i>	44
17:30 – 17:50	An experimental investigation on the post-cracking behaviour of Recycled Steel Fibre Reinforced Concrete <i>C. Frazão, J. Barros, J. A. Bogas, K. Pilakoutas</i>	46

<b>16:10 - 17:30</b>	<b>PARALLEL SESSION B3 SEISMIC/SPECIAL LOADING CONDITIONS Chairpersons: Karin Lundgren – Juan Navarro Gregori</b>	<b>Room Sirmione</b>
<b>Time</b>	<b>Title and Authors</b>	<b>Proceed. pg.</b>
16:10 – 16:30	Performance of Ductile FRCC under Cyclic Loads and Non-Linear FE Simulation <i>A. Georgiou, S. Pantazopoulou</i>	94
16:30 – 16:50	Effect of synthetic fibers on the quasi-static and blast behaviour of reinforced concrete beams <i>H. Aoude, Y. Li, R. Bastami, S. Castonguay, C. Guertin-Normoyle, F. M. Ibrahim</i>	96
16:50 – 17:10	Strain-Based Fatigue Failure Criterion for Steel-Fiber Reinforced Concrete <i>E. Poveda, G. Ruiz, H Cifuentes, R. C. Yu, X. Zhang</i>	98
17:10 – 17:30	Cyclic Damage on PVA Microfibre Embedded in Cementitious Matrix in Alternating Tension-Compression Regime <i>M. Ranjbarian, V. Mechtcherine</i>	100

<b>16:10 - 17:30</b>	<b>PARALLEL SESSION C3 STRUCTURAL REHABILITATION Chairmen: Albert de la Fuente – Adriano Reggia</b>	<b>Room Catullo</b>
<b>Time</b>	<b>Title and Authors</b>	<b>Proceed. pg.</b>
16:10 – 16:30	The behaviour of concrete columns confined by UHP-FRCC jacketing <i>A. Fantilli, T. Nishiwaki, V. Lisi, M. Longo</i>	112
16:30 – 16:50	Retrofitting a full-scale two-story hollow clay block masonry building by Steel Fiber Reinforced Mortar coating <i>S. Lucchini, L. Facconi, F. Minelli, G. Plizzari</i>	114
16:50 – 17:10	Working Life Extension of RC Bridge Pier Through UHPFRC Jacketing <i>A. Reggia, A. Morbi, G. Plizzari</i>	116
17:10 – 17:30	Improved ductility of SHCC retrofitted unreinforced load bearing masonry seismic resistance <i>D. J. A. de Jager, G. P. A. G. van Zijl</i>	118

<b>18:30 – 19:30</b>	<b>SOCIAL PROGRAMME: Wine Tasting Experience by Cà dei Frati Winery</b>
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FRIDAY JUNE 29<sup>th</sup>

## 8:30 – 17:00 REGISTRATION

9:00 – 10:30	PLENARY SESSION 02 Chairmen: Fausto Minelli – Giovanni Plizzari
9:00 – 9:30	Material characterization and in-situ control of FRC <i>Albert de la Fuente</i>
9:30 – 10:00	Recent developments in FRC tunnel linings <i>Alberto Meda</i>
10:00 – 10:30	Steel Fiber Reinforced Concrete For Structures Subjected To Severe Actions <i>Gustavo Parra Montesinos</i>

## 10:30 - 11:00 Coffee break

11:00 - 12:40	PARALLEL SESSION A4 PRECAST ELEMENTS Chairmen: Marco di Prisco – Ian Gilbert	Room Acquaviva
Time	Title and Authors	Proceed. pg.
11:00 – 11:20	New Concretes for Precast Panels in Uruguay <i>G. Rodriguez de Sensale, I. Rodriguez Viacava, R. Rolfi, M. E. Fernández</i>	122
11:20 – 11:40	Opportunities for synthetic fibre reinforcement in concrete tramlines <i>K. P Juhasz, P. Schaul</i>	124
11:40 – 12:00	Optimized reinforcement and performance of precast elements using polypropylene macro fibers <i>À. Calvo Costa, J. M. Vaquero, C. C. Corominas; A. M. Ramírez</i>	126
12:00 – 12:20	Closed loop control in crushing test for fibre reinforced concrete pipes <i>R. Monte, A. de la Fuente Antequera, A. D. de Figueiredo</i>	128
12:20 – 12:40	RC Beams with Steel Fibres - Towards Better Determination of their Minimum Conventional Reinforcement Ratio <i>A. N. Dancygier, Y. S. Karinski</i>	130

11:00 - 12:40	PARALLEL SESSION B4 SEISMIC/SPECIAL LOADING CONDITIONS Chairmen: György Balázs – Stefan Bernard	Room Sirmione
Time	Title and Authors	Proceed. pg.
11:00 – 11:20	Seismic Performance of Fibre Reinforced Concrete in the Absence of Bars <i>E. S. Bernard</i>	102
11:20 – 11:40	Finite Element Analyses of Seismic Response of a 22-story RC Wall Building subjected to Drying Shrinkage Cracking and Application of SCRPPC <i>K. Kitazawa, Y. Sato, K. Naganuma, Y. Kaneko</i>	104
11:40 – 12:00	Flexural fatigue performance of plastic fiber and steel microfiber in reinforced concrete	110

	<i>D. Martinello Carlesso, A. de la Fuente Antequera, S. H. P. Cavalaro, W. L. Repette</i>	
12:00 – 12:20	Residual crack width in RC and R/FRC ties subjected to repeated loads <i>A. P. Fantilli, F. Tondolo</i>	106
12:20 – 12:40	A method for strengthening and thermal-insulating cavity walls with Fiber Reinforced Mortar: the case of Groningen <i>F. Iavarone, S. Lucchini, L. Facconi, A. Conforti, S. Sacrato, G. Plizzari</i>	108

<b>11:00 - 12:20</b>	<b>PARALLEL SESSION C4 TUNNEL LININGS Chairmen: Alberto Meda - Rolf Breitenbücher</b>	<b>Room Catullo</b>
<b>Time</b>	<b>Title and Authors</b>	<b>Proceed. pg.</b>
11:00 – 11:20	Santoña–Laredo General Interceptor Collector – Challenges and Solutions <i>R. Winterberg, R. J. Cámara, D. S. Abad</i>	134
11:20 – 11:40	Segmental Lining Design using Macro Synthetic Fibre Reinforcement <i>R. Winterberg, L. M. Rodríguez, R. J. Cámara, D. S. Abad</i>	136
11:40 – 12:00	An experimental study on the use of polypropylene fibers in precast segments for hydraulic and metro tunnel lining <i>A. Conforti, I. Trabucchi, G. Tiberti, G. Plizzari, A. Caratelli, A. Meda, S. Moro, M. Hunger</i>	138
12:00 – 12:20	Design of SFRC Precast Tunnel Segments Supported by NLFEA <i>R. Pukl</i>	140

<b>12:40 – 13:50</b>	<b>Lunch</b>
<b>13:50 – 14:00</b>	<b>Workshop Group Picture</b>

<b>14:00 - 15:20</b>	<b>PARALLEL SESSION A5 HIGH PERFORMANCE FRC Chairmen: Pietro Lura – Luca Sorelli</b>	<b>Room Acquaviva</b>
<b>Time</b>	<b>Title and Authors</b>	<b>Proceed. pg.</b>
14:00 – 14:20	Structural behavior of prestressed Ultra-High Performance Fibre-Reinforced Concrete beams with and without openings: comparison between experimental results and finite element modelling techniques <i>D. Redaelli, J. Y. Nseir</i>	152
14:20 – 14:40	Use of a Probabilistic Explicit Cracking Model for Analyzing the mechanical behaviour of an Ultra-High Performance Fibre Reinforced Concrete (UHP-FRC) Beam Subjected to Shear Loading <i>P. Rossi, D. Daviau-Desnoyers, J.-L. Tailhan</i>	154
14:40 – 15:00	UHPRC Precast slabs and field-cast joints of the Isabey-Darnley pedestrian bridge <i>J. P. Charron, C. Desmetre, B. E. Cantin</i>	156
15:00 – 15:20	Fiber effect on shear behavior of UHPC beams <i>N. Randl, T. Mészöly</i>	158

<b>14:00 - 15:20</b>	<b>PARALLEL SESSION B5 SERVICE CONDITIONS Chairmen: Liberato Ferrara - Jaime Carlos Galvez Ruiz</b>	<b>Room Sirmione</b>
<b>Time</b>	<b>Title and Authors</b>	<b>Proceed. pg.</b>
14:00 – 14:20	Evaluation of Effective Moment of Inertia for Calculation of Short-Term Deflections of Steel Fiber Reinforced Concrete Flexural Members <i>L. B. Fargier-Gabaldon, M. Al-Tameemi, G. J. Parra-Montesinos</i>	168
14:20 – 14:40	Reduction of Flexural Crack Widths Using Synthetic Fibres in Reinforced Concrete <i>E. S. Bernard</i>	170
14:40 – 15:00	Serviceability Limit State Design of SFRC Members <i>A. Amin, R. I. Gilbert</i>	172
15:00 – 15:20	Effect of fiber dosage and matrix compressive strength on MSFRC performance <i>C. Del Prete, A. Tilocca, N. Buratti, C. Mazzotti</i>	174

<b>14:00 - 15:20</b>	<b>PARALLEL SESSION C5 TUNNEL LININGS Chairmen: Peter Mark - Giuseppe Tiberti</b>	<b>Room Catullo</b>
<b>Time</b>	<b>Title and Authors</b>	<b>Proceed. pg.</b>
14:00 – 14:20	Closed-form Solutions for Interaction Diagrams of Hybrid Fiber-Reinforced Tunnel Segments <i>Y. Yao, M. Bakhshi, V. Nasri, B. Mobasher</i>	142
14:20 – 14:40	Steel and Polypropylene Fiber Reinforced Concrete for Secondary Tunnel Lining <i>J. Šušteršič, M. Lutman, A. Likar, M. Huis, A. Zajc</i>	144
14:40 – 15:00	Experimental Behaviour of Precast Tunnel Segments in Steel Fiber Reinforcement with GFRP Rebars <i>A. Meda, Z. Rinaldi, S. Spagnuolo, B. De Rivaz, N. Giamundo</i>	146
15:00 – 15:20	Structural behavior of precast tunnel segments with macro-synthetic fibers during TBM operations: a numerical study <i>I. Trabucchi, A. Conforti, G. Tiberti, G. Plizzari, R Winterberg</i>	148

<b>15:20 - 15:50</b>	<b>Coffee break</b>
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<b>15:50 - 16:50</b>	<b>PARALLEL SESSION A6 HIGH PERFORMANCE FRC Chairmen: Barzin Mobasher - Dario Redaelli</b>	<b>Room Acquaviva</b>
<b>Time</b>	<b>Title and Authors</b>	<b>Proceed. pg.</b>
15:50 – 16:10	Practical considerations on the application of the recent SIA 2052 guidelines on testing of Ultra-high-performance fiber-reinforced concrete <i>R. Loser, J. Justs, P. Lura</i>	160
16:10 – 16:30	Effect of Fibers on the Flexural Behaviour of Beams Built with High-Strength Concrete and High-Strength Reinforcement <i>R. Bastami, Y. Li, O. Algassem, H. Aoude</i>	162

16:30 – 16:50	Mechanical characterization of fiber reinforced floor screeds: Influence of glass fibers on shrinkage and cracking mechanisms <i>F. Chelha, S. Y. Alam, A. Z. Bendimerad, Ahmed Loukili</i>	164
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<b>15:50 - 16:50</b>	<b>PARALLEL SESSION B6 SERVICE CONDITIONS Chairmen: Gustavo Parra Montesinos - David Conciatori</b>	<b>Room Sirmione</b>
<b>Time</b>	<b>Title and Authors</b>	<b>Proceed. pg.</b>
15:50 – 16:10	Predictions of the Micro-crack Openings for Ultra High Performance Fiber Reinforced Concrete <i>V. Turgeon-Malette, L. Sorelli, D. Conciatori, V. Durand, J. Réthoré</i>	176
16:10 – 16:30	Macrosynthetic fibers for end region crack control <i>G. Diaz-Acosta, G. R. Consolazio, H. R. Hamilton</i>	178
16:30 – 16:50	Investigation of fiber effect on the geometrical property of crack and water permeability of cracked concrete <i>Y. Ding, D. Li, W. Zeng</i>	180

<b>15:50 - 16:50</b>	<b>PARALLEL SESSION C6 STRUCTURAL APPLICATIONS Chairmen: Jakob Šušteršič - G. P. A. G. van Zijl</b>	<b>Room Catullo</b>
<b>Time</b>	<b>Title and Authors</b>	<b>Proceed. pg.</b>
15:50 – 16:10	Experimental Investigation of Hybrid Concrete Elements with Varying Fiber Reinforcement under Concentrated Load <i>S. Plückelmann, R. Breitenbücher</i>	184
16:10 – 16:30	A holistic calculation and design tool for structural SFRC members <i>K. Look, P. Mark</i>	186
16:30 – 16:50	FRCcalc - Software for design of fiber reinforced concrete elements according to MC2010 recommendations <i>T. Valente, J. Barros, L. Lourenço</i>	188

<b>17:00 – 18:00</b>	<b>Perspectives and future developments in FRC structural applications</b>
<b>18:00 – 18:15</b>	<b>CLOSING SESSION</b>

<b>20:00 – 23:00</b>	<b>SOCIAL DINNER: Hotel Restaurant L'Aquila d'Oro</b>
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<b>SATURDAY JUNE 30<sup>th</sup></b>	
9:30 – 12:30	<b>SOCIAL PROGRAMME: Boat tour on Lake Garda</b>

## 5. INSTRUCTIONS FOR ORAL PRESENTATIONS

- The time for oral presentation is maximum 15-16 minutes plus 4-5 minutes of discussion time. Authors are kindly invited to not exceed the time allowed for their presentation.
- There is no template for Authors' presentation.
- Presentations should be uploaded in the computers available in the Session Room well in advance before the presentation (during the coffee breaks). Speakers are kindly requested to bring their file on a pen drive and to save all presentation files in one folder. Presentation files should be named as follows "session number-lastname.extension" (i.e: A1-Rossi.ppt). Ppt, pptx or pdf files are mostly desirable. Technical assistance will be available before and after the sessions.
- Authors are kindly invited to come to their Session Room well in advance before the presentation and to contact the reference person in the room who will make sure the presentation is ready. Technical assistance will be available during the sessions and during the opening times of the registration desk.
- Only fonts that are included in the basic installation of MS-Windows will be available. Use of other fonts not included in Windows can cause wrong layout/style of your presentation.
- Please, do not use MAC file format, if possible. Authors than edited their presentation in a MAC are kindly invited to provide also a pdf version, which is general does not have any projection problem.



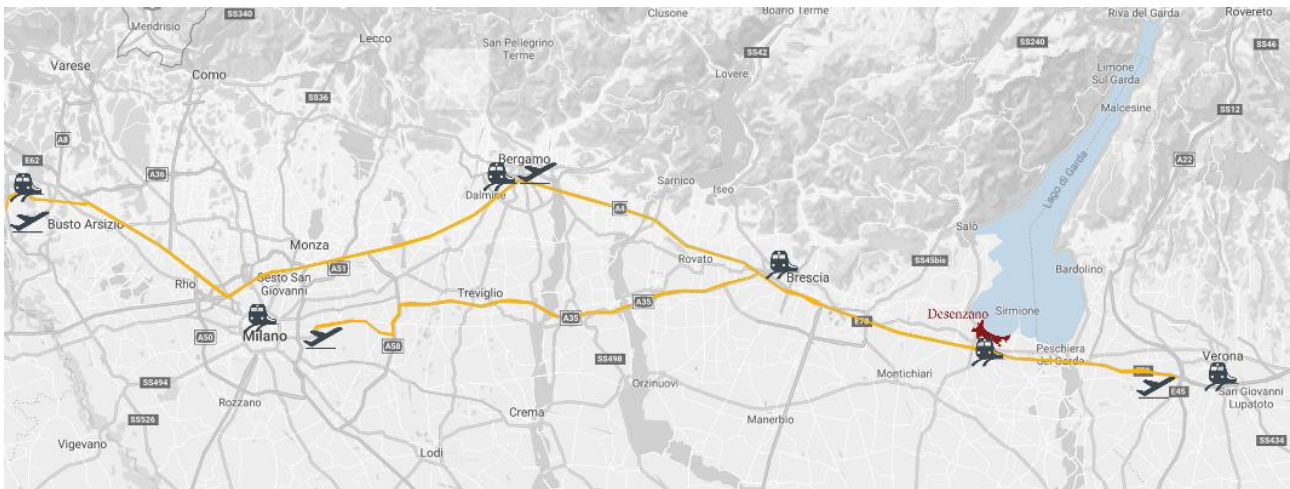
## 6. GENERAL INFORMATION

### How to reach Desenzano del Garda

#### By plane

Verona Airport "Valerio Catullo" (VRN) offers connections with major Italian and important European cities. The airport is 40 km from Desenzano del Garda and is connected to Verona's train station by a shuttle service. At 80 km from Desenzano you will find Milan Orio al Serio (BGY) international airport. It is Italy's first low-cost airport with many flights for Italian and European destinations.

Another option would be to access the two airports in Milan and continue by train to Brescia: Malpensa (MXP, 170 km from Desenzano) is the main airport and also has intercontinental flights, while the Linate (LIN, 80 km from Desenzano) airport serves domestic flights and some European links. Both airports are connected to the train stations by an airport coach service.



#### By Train

Desenzano is located on the Turin-Milan-Verona-Venice line, with frequent trains both ways.

The station is located at 4,5 km from Aquaviva del Garda Hotel.

For times please consult the Trenitalia website (<http://www.trenitalia.com/tcom-en/>) or Trainline website (<https://www.trainline.eu/>).

#### By Car

From Turin or Milan take highway A4 Torino Venezia up to the exit at Desenzano.

From Venice or Verona take highway A4 towards Milan up to the exit at Desenzano.

## Registration

### How to Register

The Registration to the Workshop is mandatory for attending Sessions and the Workshop events (Welcome Party, Lunches, Coffee Breaks, Banquet Dinner...). Registration is also mandatory to have the accepted papers included in the published Workshop Proceedings.

#### Please follow the instructions herein described:

1. For registering to the Workshop, **please download and fill in the attached registration form** (<https://frc2018.unibs.it/files/FRC2018Registrationform.pdf>) with your data and, in addition, anything you might mention to the organizer (food intolerances, special needs...).
2. Each Registrant is allowed to specify **up to 3 papers** (if authored by him): the first is included in the registration fee, the additional paper(s) are charged 300€ each. If so, please specify this, in the registration form;
3. After having completed the registration procedure, **you must proceed with the online procedure for the payment, that can be made either via bank transfer or Paypal.**
4. Participants who prefer to pay by Bank Wire Transfer are required to send their payment at their earliest convenience as it takes some time to get processed.
5. Please provide, in the wire transfer, **the reference indicated in the "ORDER CODE" during the payment procedure.**

Failure to pay the required amount by June 15th might result in the exclusion of the paper(s) from the Workshop Proceedings.

#### **LINK FOR PAYMENT:** <https://www.csmt.it/en/e-shop-eventi-corsi.asp?tipo=1>

- 1- Please write each name of the participants in the "Shipping Address" field
- 2- Select the applicable type of registration and proceed with the instructions

### FRC2018 Registration Fees

Category	Before May 22 2018	After May 22 2018
Regular	€ 450.00	€ 550.00
Student	€ 300.00	€ 300.00
One-day registration	€ 300.00	€ 300.00
Additional paper	€ 300.00	€ 300.00
Additional Banquet Dinner	€ 80.00	€ 80.00

## **FRC2018 Registration Includes**

- Attendance to the Workshop Sessions
- Workshop gadget, bag and material
- Free access to the Proceeding Volume
- All Workshop Lunches
- All Coffee Breaks
- Welcome Reception
- Banquet Dinner
- Wine tasting Experience
- Lake tour (only with good weather conditions)

**Note that student registration and one-day registration do not include the banquet dinner**

## **Notes (read carefully):**

- For each Accepted Paper, one author must register, pay the registration fee, and personally present the paper in the Workshop (see above exceptions for additional papers).
- Students (undergraduate, graduate and Ph.D.) who will attend the Workshop can register and pay the student registration fee. Please send (together with registration form and proof of payment) a scanned copy (pdf file) of your certification as a student at [frc2018@unibs.it](mailto:frc2018@unibs.it). Students will be asked to present the original copy of their certification at the registration desk.
- Once the registration payment is done, NO REFUND is available.

## **Temperature**

In June the temperature is about 25-33°C and generally sunny.

## **Electricity**



Electricity in Italy is 220 volts, 16 Ampere, 50 cycles alternating current (AC). Italian sockets are designed to accept round prongs.

## **Currency**

The official currency is Euro.

## **Language**

All oral presentations will be in English. No simultaneous translation will be provided.

## **Badges**

Each participant will receive a name badge upon registration. All participants are kindly requested to wear it during all symposium activities and social events.

Each participant will receive four coffee break, two lunch vouchers, one Gala Dinner voucher, one voucher for the Wine Tasting Experience and another for the lake boat tour, if requested.

All vouchers have to be delivered at the entrance of the restaurant/bar lounge/winery/boat entrance.

All social events are offered by our sponsors.

## **Social program**

### **Thursday 28<sup>th</sup> June 2018 - Wine Tasting Experience by Cà dei Frati Winery**

Cà dei Frati Winery was established in 1939 in Lugana di Sirmione. It produces excellent wines from the enological tradition of Lombardy. The vineyards are cultivated in Lugana (Sirmione) and in the countryside nearby. The most famous wines are "Lugana" and "Brolettino". The grapes of every vineyard are vinified separately in order to gain a clearer vision of the expressions of our "terroir". The processes take place with the utmost respect for the raw material through an innovative technique refined over the years that enables producers to obtain full-bodied wines with great longevity.

You can enjoy this experience and discover different typical wines offered by this very famous winery company at 18:30.



### **Friday 29<sup>th</sup> June 2018 - Gala dinner**

The Gala Dinner will take place on the Garda Lake in the Aquila d'Oro (Desenzano del Garda – BS) at 20:00. After the gala dinner, buses will take the participants back to their hotels.





### **Saturday 30<sup>th</sup> June 2018 – Half day lake tour**

Lake Garda offers breathtaking sights and marvelous views to anyone who wishes to see it from a different, less traditional perspective. With a boat trips you can enjoy the most beautiful places on the lake.

The program foresees: departure from *Desenzano* at 9.30; the harbour is in front of the Mayer Hotel. Initially the ferry will make a tour around the beautiful peninsula of Sirmione; then the boat will arrive near the *Isola del Garda* where, from the lake, the extraordinary Venetian neo-Gothic style villa can be admired. Once arrived in *Salò*, there will be a stop of 1.5 hours. *Salò* was founded by the Romans. It became a famous and important place in the 1943 during the second World War, when Mussolini established the "Repubblica di Salò" to revive the Fascist regime helped by the German soldiers. Return to *Desenzano* around 12.30.

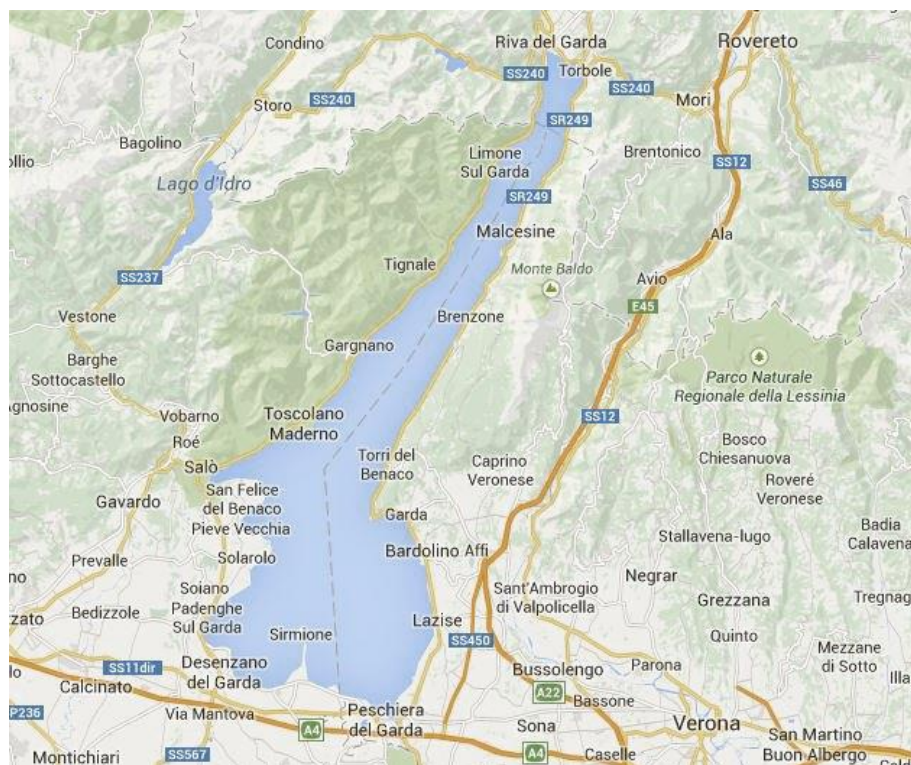


## 7. TOURISTIC INFORMATION

### About Lake Garda

The beautiful lakeside towns around Lake Garda (Lago di Garda) have charmed foreign visitors for centuries. Even for the ancient Romans, the area was a luxury summer destination; in Sirmione and Desenzano you can visit ruins and mosaics that evidence their presence.

Lake Garda, with its 25 picturesque villages, all bordered by the Gardesana state road and reachable with highway, is rich in historical monuments, castles and fortresses, so it offers a general view on its incomparable history. That is the reason why famous writers and painters choose Lake Garda as their favorite holiday destination: here they are able to find the inspiration they needed to give birth to their art.



Lake Garda's water reaches a large number of beautiful small towns and comprises three Italian provinces. The first one is Verona, with its towns: Peschiera del Garda, Castelnovo del Garda, Lazise, Bardolino, Gardà, Torri del Benaco, Brenzone and Malcesine. The second one is Brescia with the towns of Lonato, Sirmione, Desenzano del Garda, Padenghe del Garda, Moniga del Garda, San Felice del Benaco, Manerba del Garda, Salò, Toscolano-Maderno, Gardone Riviera, Gargnano, Tignale, Tremosine and Limone sul Garda. Finally, the province of Trento with Riva del Garda and Nago-Torbole.

A daily ferryboat service connects all these places, so that they become easily reachable by water way as well.

Lake Garda's climate is mild all year long, with its warm summer months (from the end of April to the beginning of October) and its winter months characterized by rare rainy days. This climate is ideal for the cultivation



of local products such as olives, lemons and grapes. Moreover, the lake's production of wines and oils are worldwide known and very much appreciated by locals and by visitors.

## Desenzano



### General information

Desenzano is a smallish town on the southern shore of Lake Garda in the north of Italy. The current population is about 25,000 people. The town is in the region of “Lombardia” and makes a convenient base for travelers using public transport, as it is part of the Italy's rail network Trenitalia. Desenzano is in the province of Brescia and very close to its capital town called with the analogous name of Brescia. Desenzano presents a particularly rich artistic, historical and archaeological heritage, starting from the Roman era. In the Middle Ages it was the matter of several fights between Brescia and Verona. Afterwards, in the 15th century the Venetians took control of Desenzano and turned it into a thriving commercial area. The core of the city develops around Malvezzi Square and the Ancient Harbor, with the XVI century pal-aces by Todeschini, a famous architect from Brescia. One may love to explore the waterfront and adjacent shopping streets, and the beautiful narrow street of Via Castello which will take you to the town's small fortress, the Castello. The fortress is a special place for the locals and visitors, one can visit the place and its courtyard all year long and enjoy some public events such as concerts during the summer period.

From the southern side of the Lake, one can enjoy breathtaking views, specially remarkable in clear days of both winter and summer seasons. One can reach the Lake's resorts and Sirmione itself, by boat.

In the last years, Desenzano has also become the Garda locality best known for its vitality and entertainment opportunities, above all its nightlife, thanks to the numerous varieties of restaurants, bars, discobars and discotheques.

## Sites to visit

### Villa Romana



Desenzano's Roman villa (IV century) is a historical site worth visiting: the ruins, mosaics and a small museum can all be admired. Desenzano has an archaeological museum too (limited afternoon opening hours) with pre-historic and Bronze Age exhibitions from the town and surrounding area. Both the villa and the archaeological museum are closed on Mondays.

*Ticket price: 4.00 €*

*Opening hours: Tuesday to Sunday from 8:30 to 19:30*

### Castello di Desenzano



The Castle, which was probably built on a Roman castrum to defend the barbarian invasion, is dominant over the city. It was re-built on the XI century and then strengthened in the XV century, when it comprised 120 houses and a church dedicated to S. Ambrogio. By the end of 1943 the Castle was turned into barracks. Of the



original construction remains only the wall, the four towers and the entrance tower with the ruin of a wood draw-bridge. The wall's restoration allows the visitors to walk by and climb up to the main entrance, from which one can enjoy one of the most beautiful views of Lake Garda.

*Ticket price: 3.00 €*

*Opening hours: Tuesday to Sunday from 9:30 to 13:00 and 16:30 to 19.30*

#### The “Porto Vecchio” and “Palazzo Todeschini”



The small harbor (called “Porto Vecchio”), from which documents testifying its construction back in 1274 were found, was further used to serve the flourishing grain market at the time of the Venetian Republic. On the ancient dock overlooking the arches of Palazzo Todeschini, a building dating from 1580, designed by the architect Giulio Todeschini as a municipal house can be found. In 1806 the construction of the quay and the lighthouse in Nordic style began, which still characterizes the panorama of the lake.

#### San Martino Tower



The tower raises on the highest hill in San Martino. It was built with the aim of remembering King Vittorio Emanuele II and those who fought for the Italian independence and union throughout the campaigns between 1848 and 1870. The tower, a monument that can be admired for its majesty from the outside and for its artistic qualities in the inside, is located in a broad garden and it is expression of the patriotic sense of the Italian population, as it was built thanks to a national collection. Its construction began in 1880 and it was inaugurated on 15 October 1893, at the presence of King Umberto I, Queen Margherita, ministers, members of the Parliament and a large crowd coming from all the Italian provinces. At its base there's a tapered cylinder, surrounded by battlements and measuring 22,8 meters in diameter and 19,8 meters in height. Over this tapered cylinder we can see the tower's main building, which is cylindrical in shape and has a diameter of 13 meters at the bottom and 11,4 meters up top. The tower turns wider at its top underneath the battlements as the diameter of the terrace reaches 13,9 meters. The path leading from the hall room until the upper platform is enriched by bronze statues and precious frescos which recall facts and key figures from the Italian Risorgimento (Resurgence) period. The Tower has an internal formation of 490 meters, 64 meters high and in the middle of its upper platform, which is defended by battlements and walls, are located a flagpole and a large light which at night shines with the Italian flag colors.

From the top of the monument the beautiful panoramas of the underlying lowlands can be admired. Close to the bottom of the tower one can see "Villa Contracagna", formerly Counts Tricagni's property, which, on the day of the battle, was the target of seven assaults by the Sardinian Army fighting the Austrian troops.

Behind San Martino Tower one can find the museum that has a collection of heirlooms, documents and memories from the battle of June 24th, 1859, as well as significant records of other events related to the history of the Italian Risorgimento.

*Ticket price: 5.00 €*

*Opening hours: Tuesday to Saturday from 9:00 to 00:30 and 14.30 to 19:00*

## **Desenzano del Garda transport**

Desenzano's little railway station is located on the top of a hill looking to-wards the city center. It's an easy ten-minute walk downhill. To reach the historical center, just leave the railway station, cross the road and direct downhill and continue straight.

The nearest airports to Desenzano are Brescia and Verona Airport. From either airport you can get a bus to the city center- Brescia or Verona - and from there you can travel by bus or train to Desenzano.

Rail services crossing northern Italy stop at Desenzano, going from Venice towards Turin. Venice is a two-hour journey away but note that there are several different categories of train on the route, with different ticket prices.

There are also bus services to small towns nearby and other sites. A bus to Verona stops at a station located opposite to the railway station, there are al-so various excursions to Venice and many other destinations nearby - please pick up some details at the tourist information office.

## **Desenzano del Garda contacts**

### Info Points Desenzano

Address: Via Porto Vecchio, 34 25015 Desenzano

Tel: +39 030 3748726

e-mail address: iat.desenzano@tiscali.it

### Taxi Desenzano

Tel: +39 030 9141527

## Sirmione



### General information

Sirmione is one of the most popular holiday destinations among the villages located in the shores of Lake Garda. The town is in the province of Brescia and has population of approximately 8'500 people. The small historical center is located on the tip of a long peninsula protruding from the southern shore of the lake.

Sirmione is popular by its thermal springs, in fact, it was a spa destination since Roman times. One can visit these and other impressive Roman ruins at the end of the headland, which along with the Castle are the two main touristic sites worth visiting.

On a clear day one may enjoy beautiful views of the lake and the surrounding mountains from the north.

### Sites to visit

#### Villa Romana





The ruined Roman villa - Villa Romana - out at the end of the headland is large and impressive. The poet Catullus had a family home in the Sirmione area, so historically this site has been associated with him, and known as the Grotte di Catullo (“caves of Catullus”). However, the villa is of a slightly later date and of a scale and grandeur suggesting a very important and rich owner. The ruins are in a lovely setting surrounded by the lake, with lizards scuttling through olive groves. Visitors can walk through the ruined walls and admire archaeological finds in the small museum.

*Ticket price: 6.00 €*

*Opening hours: Tuesday to Saturday from 8:30 to 16:30 and on Sunday 9.30 to 18.30*

### Rocca Scaligera



The town is dominated by a thirteenth-century castle, the “Rocca Scaligera”, defended by a channel toured by swans and ducks. The castle – which is actually a fortress - is fully open to the public. The interior is not much more than an empty shell, but visitors can explore the ramparts, admire the views over Lake Garda and climb the tower.

*Ticket price: 5.00 €*

*Opening hours: Tuesday to Saturday from 8:30 to 19:30 and on Sunday 9:15 to 17:45*



### Aquaria Thermal SPA



Due to the precious Salsobromiodic Sulphurous water that flows spontaneously from the deep of the lake, the Terme di Sirmione are the vanguard for treating respiratory diseases, rheumatic conditions and motor rehabilitation. This thermal water feeds the "Virgilio" and "Catullo" facilities and the brand-new Aquaria Spa Wellness Centre.

The Aquaria Centre is an oasis of wellness immersed in a large park, a place to enjoy moments of intense pleasure all year round, during day or evening, alternating the sensorial experiences from the thermal water, the steam and heat, the pampering of personalized treatments.

*Ticket price (Aquaria): 43.00 € (5 hours)*

*Opening hours (Aquaria): Sunday to Wednesday from 9:00 to 22:00, Thursday from 11:00 to 24:00, Friday and Saturday 9:00 to 24:00*

### **Sirmione transport**

Sirmione is connected to Lake Garda's other destinations by ferries which depart from the city center's dock. The town is on a bus route between Brescia and Verona, and it is easy reachable from both towns. The nearest rail-way stations are in the nearby lakeshore towns of Peschiera and Desenzano del Garda. You can catch the bus or a ferry from either of these towns to Sirmione.

Sirmione has a signposted exit from the National Highway which connects Milan with Venice. If you are staying in the historical center, you will only be allowed to drive into the pedestrianized zone (ZTL) with confirmation of your hotel booking.

## **Sirmione contacts**

### Info Points Sirmione

Address: Viale Marconi, 2 25019 Sirmione

Tel: +39 030 916114

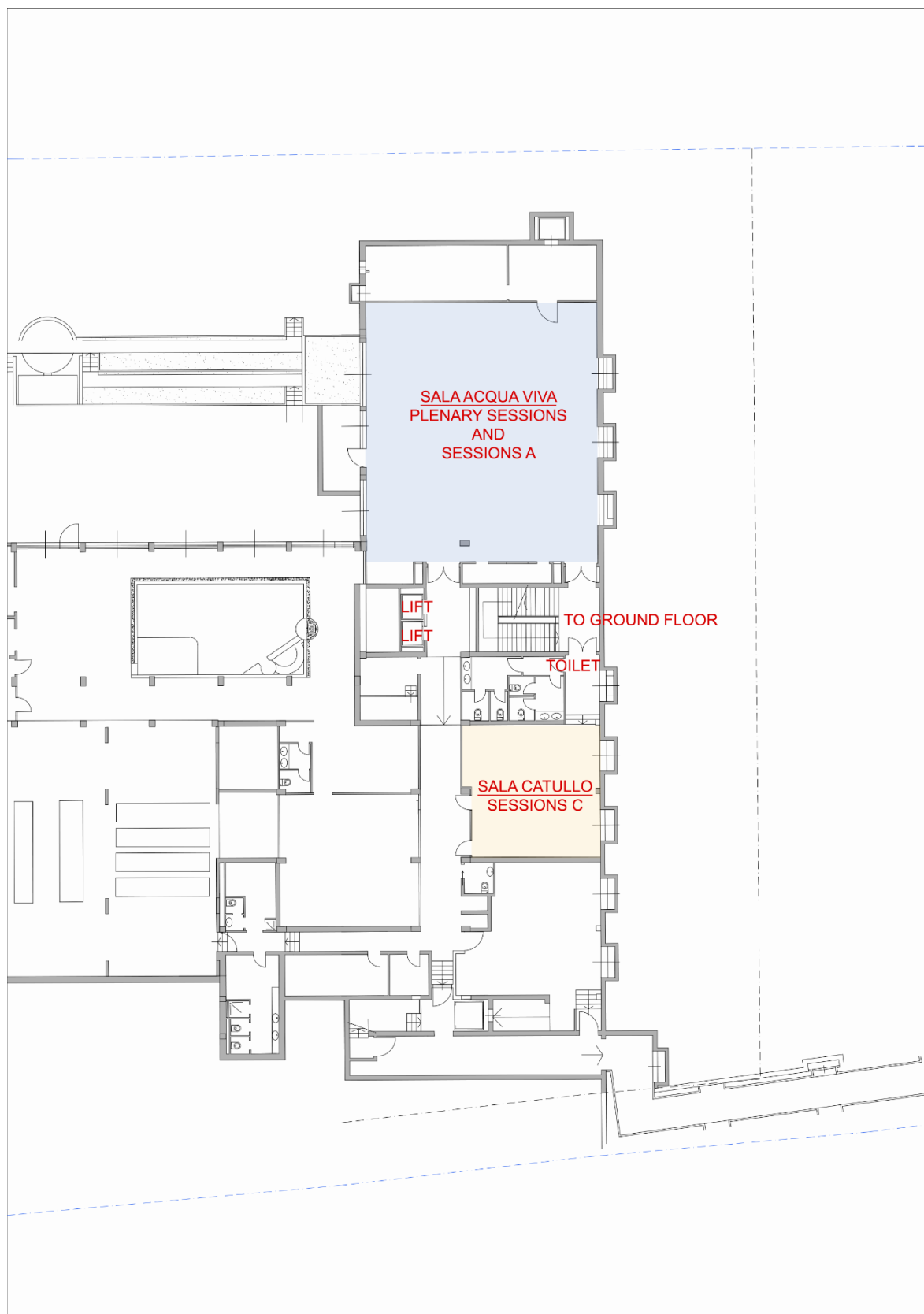
e-mail address: [iat.sirmione@tiscali.it](mailto:iat.sirmione@tiscali.it)

### Taxi Sirmione

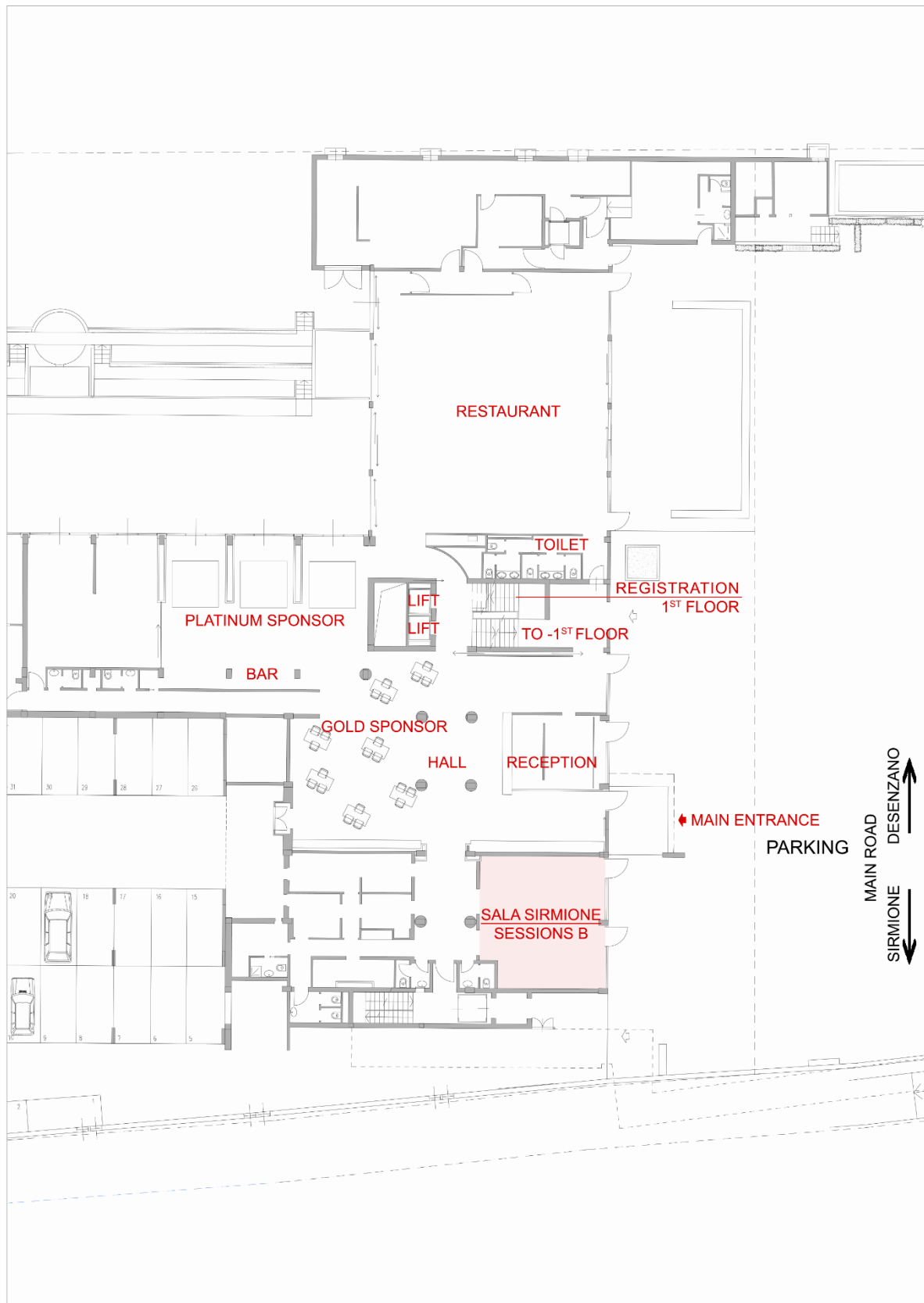
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## 8. CONFERENCE CENTER

### BASEMENT FLOOR



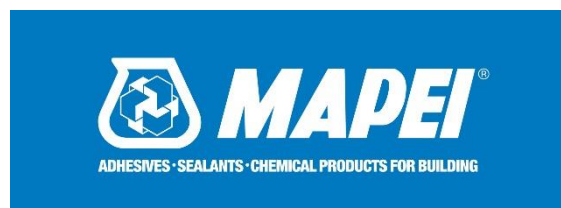
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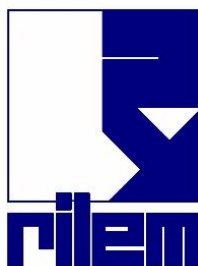
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