

International Summer School on **HISTORIC MASONRY STRUCTURES**

6th Edition

25 August – 8 September 2024

Segovia, Spain

Supporting institutions: Università del Sannio-Benevento, Università di Salerno, Università Roma Tre, Universidad Politecnica de Madrid, Municipality of Segovia, KEIKO non-profit Association



historicmasonrystructures@gmail.com – www.himass.org

Topics

Structural Analysis of Historic Masonry Structures
Historic Masonry Case Studies
Limit Analysis and Heyman's Theory
Graphic Statics of Arches, Vaults, Domes
Membrane Equilibrium Analysis for Vaults
Numerical Methods for Masonry Assessment
Seismic Response and Assessment of Masonry Structures

Teachers

Maurizio Angelillo
Gianmarco de Felice
Santiago Huerta
Alessio Bortot
Alessandro Dell'Endice
Paula Fuentes
Rosa Ana Guerra
Antonino Iannuzzo
Pietro Meriggi
Andrea Montanino
Fabian Bernal Orozco Barrera
Vittorio Paris
Philippe Block (online)
John Ochsendorf (online)

Activities

Theoretical lectures
Field work (case studies in the city of Segovia)
Guided tours
Building workshop
Guest Lectures

Venue & Accommodation

Casa de Espiritualidad - Diócesis de Segovia

Programme

This International Summer School aims to provide the fundamental theoretical and applied tools to analyse Historic Masonry Structures combining engineering, architecture, restoration and history of construction. The Summer School on Historic Masonry Structures is designed to gather researchers and scholars from the different fields of structural masonry, construction history and restoration to share their experiences on the history, design rules, construction methods and assessment tools of historic masonry structures. At the end of the programme the results of the field-work campaign will be presented by the students.

Course work

Course days will be focused on a general theme and are planned to include morning and afternoon sessions. Several days will end with a keynote lecture dealing with specific problems from the practical or theoretical work of one of the teachers or PhD students.

The morning sessions are devoted to introductory lectures delivered by experts in ancient masonry structures. Each lecture will last for about an hour, allowing enough time for questions and discussion. The afternoon sessions will be mostly be dedicated to workshops, some of which will be exploratory and allow the students to question and develop their understanding. Others will have seminar character, with groups of students giving presentations about selected case studies in the range of the day's main theme.

Field work

Four historic structures in the city of Segovia will be analysed by groups of students. First, they will document the actual state using traditional drawing techniques as well as a variety of more advanced instruments. The information collected will be then used to build the structural model and assess their safety, detect possible damage and propose suitable repairs. This work will be complemented by documentary sources to support the understanding of the structural behaviour of vaults, arches and domes.

Venue & Accommodation

“La Casa de Espiritualidad San Frutos” is located in the area of the complex of buildings of the old Jesuitic Seminar. The Seminario Conciliar de Segovia is an architectural complex located in the city of Segovia. It was built in the late sixteenth century to house the college of the Society of Jesus, installed in the city since 1559. After the Society was expelled by royal order, in the 18th century the bishop of the diocese, Alonso Marcos de Llanes Argüelles, founded the seminary in its facilities, under the name of Seminario Conciliar de San Frutos y San Ildefonso (Conciliar Seminary of San Frutos and San Ildefonso). In 1959 its structure was profoundly altered, and a huge building was added to the complex to expand the seminary's services. (The Casa de Espiritualidad belongs to this extension.) In the year 2000, the so-called historic part of the complex, which includes the church of the Company, and the areas of the old college around the cloister, was declared an Asset of Cultural Interest.

Meals

Everyday breakfast (8:30-9:15 a.m.), lunch (13:00-14:00 a.m.) and dinner (19:30-20:30) will be served in the canteen of the *Casa*. Meals are included in the participation fee.

The City

The city of Segovia is well known for its historic buildings including three main landmarks: its midtown Roman aqueduct, its cathedral (one of the last ones to be built in Europe following a Gothic style), and the medieval castle. The city center was declared of World Heritage by UNESCO in 1985.

Segovia is located on the plains of Old Castile, near Valladolid and the Spanish capital, Madrid. It is one of nine provinces that make up the autonomous region of Castile and León. Burgos and Valladolid lie to the north, Ávila to the west, Madrid to the south, and Soria to the east. The altitude of the province varies from 750 metres (2,461 feet) in the extreme northwest to a maximum of 2,430 m (7,972 ft) at Peñalara peak in the Sierra de Guadarrama. The town lies on the main route of the Camino de Santiago de Madrid.

The Alcazar



The Alcazar of Segovia, the royal palace built on a stone peninsula between the rivers Eresma and Clamores, is documented for the first time in 1122, although it may have existed earlier. It was one of the favored residences of the kings of Castile, built in the transition from Romanesque architecture to Gothic and Mudéjar. The building is structured around two courtyards and has two towers, and a keep. It was a favorite residence of Alfonso X the Wise and Henry IV, and Isabella the Catholic was crowned Queen of Castile in Segovia's Plaza Mayor. Devastated by a fire in 1862, it was later rebuilt. It now houses the General Militar de Segovia archive and museum of the Royal School of Artillery, managed by the Board of the Alcazar.

The Cathedral



The Segovia Cathedral, the last Gothic cathedral built in Spain. It is considered a masterpiece of Basque-Castilian Gothic architecture and is known as "The Lady of Cathedrals." Juan Gil de Hontañón, Rodrigo Gil de Hontañón, and other masters of Spanish architecture worked on the construction. It was consecrated in 1768 and is 105 meters long, 50 metres wide and 33 m high in the nave, has 18 chapels and has three doors: El Perdón, San Frutos and San Geroteo.

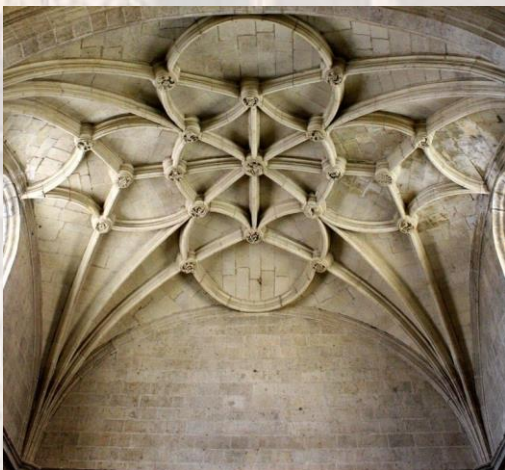
The Roman Aqueduct of Segovia

The Aqueduct of Segovia dates from the late 1st or early 2nd century AD. It is still used to deliver drinking water to the City. The aqueduct of Segovia is – because of its long span, architectural beauty, uncharacteristic slenderness, and dramatic presence in the center of a dense urban fabric – the most impressive Roman structure in Spain, and one of the most famous among the numerous aqueducts built by the Romans throughout their vast Empire. It consists of about 25,000 granite blocks held together without any mortar, and spans 818 meters with more than 170 arches, the highest being 29 meters high.



Old Sacristy of the cathedral of Segovia

The old sacristy of Segovia Cathedral was built by Rodrigo Gil de Hontañón, the cathedral architect, in 1562. It is a large space made up of two bays covered by surbased cross vaults: that is, instead of having semicircular cross arches, these are basket arches. The vault has a profusion of ribs and liernes. The vaults have a span of 12 m, and the thickness of the ribs between the ribs is only 12-14 cm. The old sacristy is an extraordinary example of late Spanish Gothic vaulted construction. Moreover, the results of calculations and measurements can be compared with the structural rules published by Rodrigo Gil in his treatise written around 1550. Today, this space gives way to the chapel of the Santísimo, with an extraordinary baroque dome.



Church of San Andrés

The church of San Andrés in Segovia was built in the 12th century. It has three naves and a chevet with two apses. It also has a beautiful brick tower. The naves are covered with wooden trusses. In the 17th century, as part of the trend to make the interior of churches Baroque, a series of thin tile vaults were built to hide the wooden framework. These vaults were later decorated with rich plaster decorations. It is of great interest to study the thick-walled Romanesque construction and compare it with the two-leaf tile vault, which is less than 10 cm thick. The exatrados of the vaults is accessible and both types of construction can be seen. The church is located within the city walls, halfway between the Alcázar and the cathedral.



Church of San Miguel

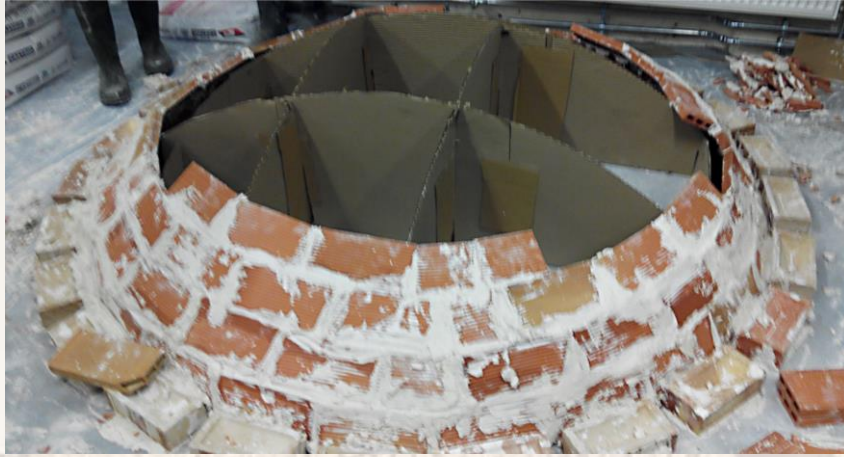
It is a stone church with a large Gothic nave of considerable height, a wide transept and chapels on the sides. The façade stands on an atrium, with a high tower and the Romanesque doorway that was transferred from the original Church. It was built by Rodrigo Gil de Hontanon at the end of the 15th Century. The main nave and the main vault in the transept are covered by precious and refined ribbed vaults. The vaults show some minor cracks.



Tile vault construction workshop

We will build together with the students a vaulted structure. The workshop will consist in preparation (scaffolding, formwork, etc.), plaster mixing, preparation of lime mortar, cutting bricks, laying bricks. We will then assess its bearing capacity under static loading conditions.

The tile vault workshop is sponsored by the School of Architecture & Design of IE University (Segovia)



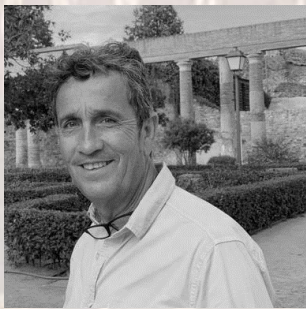
Tile vault construction workshop

Alejandra Albuerne IE University (Spain)



Dr. Alejandra Albuerne is a structural engineer with more than twenty years of international experience across industry and academia. Her career has included work in Asia and Europe as structural engineer and heritage specialist within organisations such as Arup and Architecture Sans Frontieres. In 2017 she joined UCL as Assistant Professor of Sustainable Heritage at the Bartlett Faculty of the Built Environment. Since 2022, Albuerne is Assistant Professor at IE University's School of Architecture and Design, where she is Coordinator of Building Structures. Albuerne obtained her Master of Engineering degree from the University of Cambridge in 2003 and her DPhil in Archaeology and Engineering Science from the University of Oxford in 2016. She has a background in traditional building structures, heritage management and international development. Her research focuses on the role of cultural heritage in the safety and development of communities. Examples of ongoing research include the seismic performance evaluation of earthen constructions in the 2023 Morocco earthquake and the development of fire-structure interaction models for historic structures.

Carlos Martín



Vault builder and master plasterer, he has been involved in the construction and restoration of more than 300 vaults to date. He is the founder of Bóvedas Hispanas, a company specializing in the construction and restoration of vaults, working on numerous projects, including some of the most important in Spain in the last 30 years. He is a Professor of vault workshops at a national and international level and the author of several publications on plaster and vaulted structures.

Outstanding works. Vaulted vault in the Chapel of the Seminary of the Santos Niños Justo y Pastor de Alcalá de Henares (Madrid); Structural vaults of the Aljibe of the castle of Jadraque (Guadalajara) and in the cellar of the Valdemonjas de Quintanilla (Valladolid); Gothic vaults in stone in the Monastery of Pelayos de la Presa (Madrid); Vaults and domes in the Colegio San Basilio Magno de Alcalá de Henares (Madrid), in the Convent of San Juan de la Penitencia de Alcalá de Henares (Madrid), in the sacristy of Loeches (Madrid) and in the Chapel of San Felipe de Novelda (Alicante). He has participated as a builder in the Venice Architecture Biennale of 2016, executing a contemporary vaulted ceiling in collaboration with MIT (Prof. John Ochsendorf), with the design of Sir Norman Foster.

Esther Redondo



Architect, graduated from the School of Architecture, Polytechnic University of Madrid. Working as a structural designer and consultant since 1999, as co-founder of the GV408 Studio, since 2001 she teaches structural design at the School of Architecture of the European University of Madrid, where she has been in charge of several subjects in the area of structures, as well as joint subjects in the area of technology. She also worked as a visiting professor at ETSAM (Madrid), EaT (Toledo), Universidad Rey Juan Carlos (Madrid) and Universidad de Ambato (Ecuador). PhD in 2013 -"Tile vaulting in Sapin in the 19th Century: The transformation of a constructive system"-, her current field of research is the history of construction and structures. In this context, she has written numerous publications and participated in the organization of related congresses in Madrid (2013), Segovia (2015) and Soria (2019).

Maurizio Angelillo

University of Salerno (Italy)

Maurizio Angelillo is professor of Statics and Strength of Materials at the School of Engineering and Architecture of the "Università degli Studi di Salerno". Architect and structural expert with multi-disciplinary research interests including masonry mechanics, and Biomechanics, trained in Architecture at the University of Naples and in Mechanics at the University of Minnesota, Minneapolis, he and his group are actively working on the kinematics and on the equilibrium of masonry buildings. Angelillo, who is the Editor and the co-author of the CISM books "Mechanics of Masonry Structures" and "Discrete Computational Mechanics of Masonry Structures", works on unilateral models for masonry since the early 80s, being the author of more than 50 papers on the application of these models to real masonry structures and masonry elements such as arches, domes, vaults and spiral stairs.



Gianmarco de Felice

Roma Tre University (Italy)

Gianmarco de Felice is professor of structural engineering at the Department of Engineering of Roma Tre University. He is coordinator of the PhD school in Civil Engineering at Roma Tre University, chairman of the RILEM Technical Committee TC-250 CSM "Composites for Sustainable strengthening of Masonry" and member of the drafting Committee of the Charter of Rome on the Resilience of Art Cities to Natural Catastrophes. He has been the scientific coordinator for the design of engineering projects on heritage conservation and structural rehabilitation, such as the restoration of the Farnese Palace in Ischia di Castro and that of the Abbey of San Clemente in Casauria supported by the World Monuments Fund and awarded by the Domus International Prize for Restoration and Conservation.



Santiago Huerta

Universidad Politecnica de Madrid (Spain)

Santiago Huerta is a professor of Structural Design at Escuela Técnica Superior de Arquitectura de Madrid (ETSAM). President of the Spanish Construction History Society (SEDHC). Work as consultant for Historical Constructions Analysis (Cathedrals of Mallorca; Santiago de Compostela; Lonja de Mallorca; San Juan de los Reyes, etc.). Director of publications of the Juan de Herrera Institute. Author of more than 80 publications: books (editor), articles and papers, mainly on historic masonry structures and Construction History. Prize for the 'Dissemination of Architecture' related to the Exhibition and Catalog Guastavino Co. the Reinvention of the Vault (COAM), 2003. Telford Gold Medal of the British Civil Engineers Association London, 2011.



John Ochsendorf

Massachusetts Institute of Technology (USA)

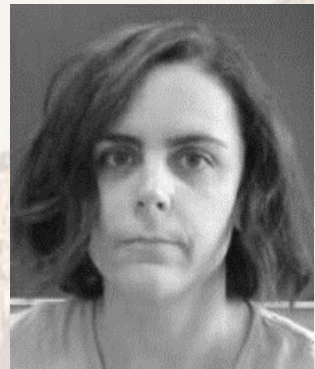
John Ochsendorf is a structural engineer with multi-disciplinary research interests including the history of construction, masonry mechanics, and sustainable design. Trained in structural mechanics at Cornell, Princeton, and the University of Cambridge, he conducts research on the structural safety of historic monuments, and the design of more sustainable infrastructure. His group is actively researching the dynamics of masonry buildings, the safety of cracked masonry vaults and domes, displacement loading of structures and the design of more sustainable infrastructure. Ochsendorf is the author of "Guastavino Vaulting: The Art of Structural Tile" and several dozen journal papers in structural mechanics. He has been awarded a Rome Prize from the American Academy in Rome and a MacArthur Fellowship from the John D. and Catherine T. MacArthur Foundation.





Alessio Bortot
University of Trieste (Italy)

Alessio Bortot, is an Architect and a “Doctor Europaeus” since 2016 in Architecture, City and Design, with a specialization in Representation. He has been professor for the course of “Descriptive geometry”, “Advanced technologies for representation” and “Digital 3D modelling” at the IUAV University of Venezia, at the faculty of Engineering of the University of Padova, at the IED of Venice and at the École National Supérieure des Travaux Publics in Yaoundé (Camerun). He has been research fellow working on topics about History of representation and advanced technologies for Architecture. He has lectured in conferences in academic institutions in Italy and abroad, and participated to national (PRIN 2010-2011) and international research. He is Associate Professor at the Department of Engineering and Architecture in the University of Trieste since 2021.



Paula Fuentes Gonzales
University of Alcalá (Spain)

Paula Fuentes Gonzales is an Architect by the Polytechnic University of Madrid and has a Master in Building Structures. In 2013 she finished her PhD Dissertation: “Crossed-arch vaults between 10th and 16th centuries. Geometry, construction and structural behaviour.” From October 2016 to April 2019 she was research associate in the BTU Cottbus-Senftenberg and member of the DFG Research Training Group 1913 “Cultural and Technological Significance of Historic Buildings”, where she developed the post-doc research project. Her research interests are focused on history of construction, masonry structures and surveying and drawing of architectural heritage. From 2019 to 2021 she was post-doctoral researcher at the Vrije Universiteit Brussels, funded by a Marie Skłodowska-Curie Individual Fellowship under the supervision of Prof. Wouters. Since 2021 she is professor at the Department of Architecture at University of Alcalá.



Rosa Ana Guerra
Escola Técnica Superior Santiago de Compostela (Spain)

Rosa Ana Guerra is PhD Architect and Master in Architectural Restoration. Professor of Engineering Graphics at the Escola Técnica Superior de Enxeñaría in Santiago de Compostela. Researcher in masonry structures, focused on the use of the state-of-the-art techniques for metric survey of architectural heritage. Member of the Spanish Construction History Society, and an active participant in national and international congresses on Construction History. She is the founder, together with Paula Fuentes, of the metric survey and analysis report of architectural heritage association villard3d.



Antonino Iannuzzo
Università degli Studi del Sannio (Italy)

Antonino Iannuzzo is a structural engineer. He completed his Ph.D. in 2017 with a dissertation on “A new rigid block model for masonry structures”. Antonino’s research during his Ph.D. work focused on models for the static, kinematic and dynamic analysis of masonry elements and structures modelled as continua composed of Normal Rigid No-Tension material. During the academic year 2017-18 he worked as a post-doctoral researcher on “large scale assessment of ordinary masonry buildings under seismic actions” at the P.LIN.I.V.S. Study Centre for Hydrogeological, Volcanic and Seismic Engineering, whose scientific coordinator is Prof. Giulio Zuccaro, and joined the Block Research Group at ETH Zurich as a post-doctoral researcher, for three years: 2018-21. He is currently a Tenured Lecturer at UniSannio and an Honorary Fellow at Swinburne University Melbourne.



Philippe Block
ETH Zurich (Switzerland)

Philippe Block is Professor at the Institute of Technology in Architecture at ETH Zurich, where he co-directs the Block Research Group (BRG) together with Dr. Tom Van Mele. He is director of the Swiss National Centre of Competence in Research (NCCR) in Digital Fabrication, and founding partner of Ochsendorf DeJong & Block (ODB Engineering). Block studied architecture and structural engineering at the VUB, Belgium, and at MIT, USA, where he earned his PhD in 2009. Research at the BRG focuses on computational form finding, optimisation and construction of curved surface structures, specialising in unreinforced masonry vaults and concrete shells. Within the NCCR, BRG researchers develop innovative structurally informed bespoke prefabrication strategies and novel construction paradigms employing digital fabrication. With the BRG and ODB Engineering, Block applies his research into practice on the structural assessment of historic monuments in unreinforced masonry and the design and engineering of novel shell structures.



Matthew DeJong
Berkeley University of California (USA)

Matthew DeJong is a Professor in Structural Engineering, Mechanics and Materials at University of California, Berkeley. He was a university lecturer in Structural Engineering and a Fellow and Director of Studies in Engineering at St Catharine's College. He was a Fulbright Scholar at the Technical University of Delft and completed his PhD at the Massachusetts Institute of Technology. He holds an undergraduate degree in Civil Engineering from the University of California, Davis, and worked as a structural design engineer in California. His research interests lie broadly in the field of structural engineering, but are primarily focused in the areas of earthquake and masonry structures.



Aguinaldo Fraddosio
Polytechnic University of Bari (Italy)

Aguinaldo Fraddosio, Ph.D., is a structural engineer and associate professor of "Scienza delle Costruzioni" at the Department of Architecture Construction and Design (ArCoD) of the Polytechnic University of Bari.

His research activity, developed within an established network of Italian and international scholars, is focused on fundamental and applicative issues of solids, structural, and experimental mechanics. His research interests in historic masonry constructions concern advanced applications of the lower bound theorem of limit analysis for corbelled structures, arches, vaults, and domes; dynamics of curved masonry constructions; advanced strengthening techniques; damage characterization. He is the principal investigator in research projects on existing and historical structures, seismic metamaterials, and non-linear ultrasonic techniques for damage characterization.



José Lemos
National Laboratory for Civil Engineering (LNEC) (Portugal)

Dr José Lemos is a Principal Researcher at the National Laboratory for Civil Engineering (LNEC) in Lisbon, Portugal. He holds a Civil Engineering degree from the University of Porto and a PhD in Rock Mechanics from the University of Minnesota, Minneapolis. He has been involved in the development of the discrete element codes UDEC and 3DEC. His research interests include dam foundations in rock, seismic analysis of masonry structures and discrete element modelling.

Nicola Nodargi

University of Rome Tor Vergata (Italy)

Nicola A. Nodargi is an Assistant Professor at the Department of Civil Engineering and Computer Science of the University of Rome Tor Vergata, Italy. He received his M.Sc. degree in Civil Engineering and his M.Sc. degree in Mathematics from the same university, where he earned his Ph.D. in Civil Engineering in 2016. His Ph.D. thesis was selected as a finalist for the 2016 ECCOMAS Best Ph.D. Thesis award and was recognized with the 2016 GIMC Best Ph.D. Thesis award and the 2017 ECCOMAS Best Ph.D. Presentation award. As a Postdoctoral researcher, he was a visiting scholar at the Technical University of Braunschweig, Germany. His research activity, framed in the field of computational mechanics, focuses on the development of computational strategies for the analysis of structures exhibiting material and geometric nonlinearities, with a particular interest in the static and dynamic response of historical masonry constructions.

Lia Romano

Sapienza University of Rome (Italy)

Lia Romano, Architect, PhD in Architectural Heritage and Landscape: History and Restoration (2018), is currently Assistant Professor in Architectural Restoration (RTDa) at the Department of Architecture, University of Naples Federico II. She was a Post-Doctoral Researcher in the same department from 2020 to 2023 and Visiting Researcher in 2017 at the Ecole Nationale Supérieure d'Architecture de Paris La Villette and in 2019 at the Université Paris 1 Panthéon-Sorbonne (Institute d'histoire moderne et contemporaine), supported by the ATLAS mobility program funded by the Fondazione Luigi Einaudi of Turin and the Fondation Maison des sciences de l'homme in Paris.

Since 2014, Lia Romano has been actively engaged in research and teaching activities on the knowledge and restoration of architectural and archaeological heritage. Her research interests include historical construction techniques, the circulation and transmission of construction knowledge in Italy and Europe and the implementation of conservation strategies for cultural heritage at risk.

Valentina Russo

University of Naples Federico II (Italy)

Valentina Russo is Full Professor of Restoration in the Department of Architecture at the University of Naples Federico II. She was the Vice-President of the Italian Society for the Restoration of Architecture (SIRA) and a member of its Board of Directors. At the University of Naples Federico II, she directs the School of Specialization in Architectural and Landscape Heritage and the 3rd level Master's degree in Restoration and Design for Archaeology. Since 2014 she has directed the "Architettura e Restauro" series (Nardini editore, Florence). She coordinated research projects on competitive calls and is the main author of more than 150 papers and books dedicated to the theoretical, to the historical-critical and to the technical-planning aspects of architectural and landscape restoration.

Her research interests are largely focused on the themes of the History of Construction and on the building site through the centuries, also investigated in relation to the repercussions on contemporary restoration and damage prevention projects.



Marialuigia Sangirardi

University of Oxford (UK)

Marilù is Lecturer in Structural Failure and Mechanics of Materials at Trinity College and PDRA at the Department of Engineering Science of the University of Oxford, where she is working on the development of new advanced in situ testing methods for historic masonry. Before, she was Research Associate at Università Roma Tre and, previously, at Sapienza Università di Roma, where she worked on several research topics under the over-arching scope of the structural preservation of cultural heritage. She has been involved in many national and international projects regarding experimental characterization of materials, real scale shaking-table testing and numerical modelling of rubblestone masonry structures and low impact seismic retrofitting design, soil-structure interaction and tunnelling induced damage on masonry buildings, risk assessment and damage related to low-magnitude earthquakes correlated to gas extraction.



Vittorio Paris

University of Bergamo (Italy)

Vittorio Paris is Lecturer at the Department of Engineering and Applied Science at the University of Bergamo. He received his PhD in 2020 under the supervision of Professor Attilio Pizzigoni. Vittorio's research focuses on masonry self-balanced shells and their equilibrium during the construction, through which he aims to pave a way towards sustainable construction that is inspired by historical techniques. Under this aim, he has conducted extensive research on the unique and long lost masonry technique: the herringbone technique and the cross-herringbone masonry pattern to construct domes.

He is also part of the Form Finding Lab at Princeton University since 2018. Here, he works with Prof. Sigrid Adriaenssens towards applying self-balancing techniques to a range of shells varying in form, scale and materials, and further in collaboration with new-age technologies of robotic construction.



Fabian Bernal Orozco Barrera

National Autonomous University of Mexico (Mexico)

Fabian is an architect who specializes in masonry vaults and domes, using static thrust line techniques to assess the safety in ancient masonry buildings. He studied in the National Autonomous University of Mexico (UNAM) through a master's degree in Restoration with the thesis "Methodological proposal for the conservation of Vaults and Domes in view of earthquakes". He did a research stay at the Polytechnic University of Madrid under the Supervision of Professor Santiago Huerta.

Currently he is a Lecturer at the Faculty of Architecture in UNAM, collaborating as an Independent researcher. He has worked as an active consultant on the assessment of Masonry Structures in Mexico for private and public entities since 2020. He has also worked on survey, restoration and retrofitting of masonry buildings.



Andrea Montanino

Università di Napoli Federico II (Italy)

Andrea Montanino is Lecturer at the University of Naples "Federico II". He obtained his PhD in Computational Mechanics and Advanced Materials from the University of Pavia in 2015. His thesis was awarded as the Best PhD thesis in Computational Mechanics of Fluids by the Italian Group of Computational Mechanics. Since then, his research has focused on different applications of computational mechanics, including fluid-dynamics, biomechanics and computational methods for masonry structures. From 2015 to 2018 he joined as a Post-Doctoral Researcher, the Research Group of Anna Pandolfi at the "Politecnico di Milano" working on various projects on the Biomechanics of the Eye. He is coauthor of about 35 publications on peer-reviewed international journals.





Pietro Meriggi
Roma Tre University (Italy)

Pietro Meriggi is an Assistant Professor and member of the Structures Research Group at the Department of Civil Engineering, Computer Science and Aeronautical Technologies of Roma Tre University. He got his PhD in Civil Engineering in 2021 at Roma Tre University. His scientific interests and expertise include laboratory and field testing of both traditional and innovative materials and of full-scale masonry structural members (subject to static and dynamic loads), analytical and numerical modelling of masonry structures, and surveying, monitoring, modelling of existing structures and infrastructures through digital photogrammetry/aerophotogrammetry. In 2020 he was visiting PhD Student at Navier Laboratory – IFSTTAR in Paris, where he started studying possible strengthening solutions for 3D printed digital concrete structures. Since 2017 he is teaching assistant for the course of Earthquake Engineering, and since 2022 lecturer of the course of Sustainable Structural Design and Retrofitting, at Roma Tre University.



Alessandro Dell'Endice
ETH Zurich (Switzerland)

Alessandro is a chartered building engineer and architect with a strong interest in structural design, masonry structures and digital fabrication.. In 2016, he earned a Master of Advanced Studies (MAS) in Architecture and Digital Fabrication at ETH Zurich, led by the Gramazio Kohler Research Group. In 2016, he joined the Block Research Group (BRG), where in 2018, he started a PhD focusing on developing computational tools for the structural assessment and design of unreinforced masonry structures using the Discrete Element Method, investigating the role of geometrical imperfections on their structural behaviour. Between 2021 and 2023, Alessandro took part as a structural designer in the realisation of Striatum, an unreinforced masonry 3D-concrete-printed pedestrian bridge built in Venice, during the Biennial Exhibition 2021, and Phoenix. After defending his PhD in June 2022, Alessandro currently works at the BRG as a Senior Researcher.



Amal Gerges
University of Cagliari (Italy)

Amal Gerges, graduated with an MSc in Civil engineering in 2020, and then worked on several rehabilitation projects and on the construction of reinforced concrete structures. She will defend his PhD in July 2024 at University of Cagliari. The focus of her research is on the stability of masonry structures under static and dynamic loads. She completed a study period abroad at Escuela Técnica Superior de Arquitectura de Madrid (ETSAM), where, under the supervision of Prof. Santiago Huerta, investigated limit-analysis-based methods to predict the behavior of masonry structures. She is also currently involved in a research study, in collaboration with Prof. Juan Carlos Vielma of the Pontificia Universidad Católica de Valparaíso (Chile), devoted to the improvement of the linear and non-linear dynamic analyses of new and existing buildings according to the Lebanese seismic code.



Paolo Borin
University of Brescia (Italy)

Paolo Borin is a Tenure-track Assistant Professor at DICATAM – University of Brescia. He got his PhD at the Università IUAV (Venice), with a thesis which explores the science and stereotomy of Guarino Guarini through digital and computational modeling techniques. He graduated in Architectural Engineering from University of Padua in 2011 with honors. From 2011 he has been exploring theory and practice of BIM and applying it to enhance the building process, particularly for existing buildings. His interests in research involve history of representation methods, application of advanced geometry for AEC industry (e.g., vaulting systems in heritage buildings, architectural façade systems, etc.), open format for BIM management, description of historic transformation with BIM.

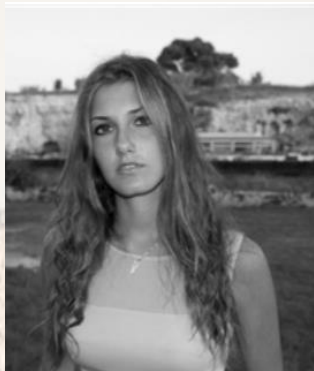
Martina Buzzetti
Politecnico di Milano

Martina Buzzetti is a PhD student in the Department of Architecture, Built Environment, and Construction Engineering at Politecnico di Milano, Italy. She earned her BSc in Civil Engineering in 2020 and her MSc in Earthquake Engineering in 2022, specializing in the seismic assessment and retrofitting of historical masonry buildings. Her master's thesis focused on this area, and she continued this research in her PhD, particularly on the seismic response of historical masonry buildings to earthquake sequences. Her work aims to develop numerical models to prevent damage and collapse from repeated seismic shocks, improving the safety and resilience of heritage structures in earthquake-prone regions like Italy. She also has experience as a teaching assistant for the Structures and Seismic Design Criteria course in the master's program.



Natalia Pingaro
Politecnico di Milano

Natalia Pingaro is a PhD student at the Department of Architecture, Built Environment, and Construction Engineering. Her interest in architecture and the restoration of historical buildings began during her undergraduate studies at the Politecnico di Milano School of Architecture, where she completed a BSc thesis on the seismic vulnerability of historical masonry towers. To gain deeper insight into structural problems of historical buildings, she pursued an MSc in Building Engineering, focusing on historical masonry arches through advanced numerical models. Her PhD thesis involves computational models with experimental validation of historic masonry curved structures, considering retrofitting interventions. She has experience as a teaching assistant in structural mechanics and structural analysis courses and is a co-author of five papers published in peer-reviewed international journals.



SUNDAY 25 AUGUST

Time	Location	Course/Event
14.30 - 19.30 h	Hall of the Casa de E.	Informal get together
19.30 - 20.30 h	Dinner	

DAY 1 | MONDAY 26 AUGUST

Time	Course/Event	Lecturers
8.30 - 9.15 h	Breakfast	
9.30 h	Course Opening	
9.30 - 10.00 h	Historic masonry architecture: geometry and equilibrium	S. Huerta
10.00 - 10.30 h	New tools for masonry reviving the old approach	M. Angelillo
10.30 - 11.00 h	Historic masonry structures facing earthquakes	G. de Felice
11.00 - 11.30 h	Coffee Break	
11.30 - 13.00 h	Introduction to Field Work Presentation of the case studies	A. Gerges F. Rodriguez
13.00 - 14.00 h	Lunch	
15.00 - 16.30 h	Lecture The Theory of Survey 1	A. Bortot, P. Fuentes, R. Guerra
16.30 - 17.00 h	Coffee Break	
17.00 - 18.15 h	Field work Visit to case studies.	All teachers and tutors
18.15 - 19.30 h	Basic Theory Material masonry. Heyman's principles of limit analysis	S. Huerta
19.30 - 20.30 h	Dinner	
20.30 - 22.00 h	Field work Group work on case studies	

DAY 2 | TUESDAY 27 AUGUST

Time	Course/Event	Lecturers
8.30 – 9.15 h	Breakfast	
9.30 – 11.00 h	Lecture (online) The art of Masonry Construction Basic Theory Equilibrium and thrust lines. Arches. Cracks. Collapse of arches.	S. Huerta J. Ochsendorf
11.00 – 11.30 h	Coffee Break	
11.30 – 13.00 h	Basic Theory Limit analysis, safety. Buttresses. Case Study: The Church of Guimarei.	S. Huerta
13.00 – 14.00 h	Lunch	
15.00 – 16.30 h	Lecture The Theory of Survey 2	A. Bortot, P.Fuentes, R. Guerra
16.30 – 17.00 h	Coffee Break	
17.00 – 19.30 h	Field work Visit to case studies.	Teachers and Tutors
19.30 – 20.30 h	Dinner	
20.30 – 22.00 h	Field work Group work on case studies	

DAY 3 | WEDNESDAY 28 AUGUST

Time	Course/Event	Lecturers
8.30 – 9.15 h	Breakfast	
9.30 – 11.00 h	Basic Theory The Gothic Structure. Flying buttresses and cross vaults. Case Study: The stability of the Cathedral of Palma de Mallorca	S. Huerta
11.00 – 11.30 h	Coffee Break	
11.30 – 13.00 h	Basic Theory Towers & Spires. Rose windows. Flat vaults. Case Studies: The Towers of the Obradoiro (Cathedral of Santiago de Compostela), Flat vaults of the Convent of Lluçmajor	S. Huerta
13.00 – 14.00 h	Lunch	
15.00 – 16.30 h	Lecture Digital Drawing	A. Bortot, P. Fuentes, R. Guerra
16.30 – 17.00 h	Coffee Break	
17.00 – 18.15 h	Case StudieS: Mexico	F. Orozco
18.15 – 19.30 h	Case Studies: Tuscania	M. Meriggi
19.30 – 20.30 h	Dinner	
20.30 – 22.00 h	Field work Group work on case studies	

DAY 4 | THURSDAY 29 AUGUST

Time	Course/Event	Lecturers
8.30 – 9.15 h	Breakfast	
9.30 – 11.00 h	Advanced Theory Heyman's No Tension continua. Limit Analysis and energy The Safe Theorem and TNA	M. Angelillo A. Iannuzzo
11.00 – 11.30 h	Coffee Break	
11.30 – 13.00 h	Advanced Theory Vaults and domes. The membrane Equilibrium Analysis (MEA) Applications	M. Angelillo A. Montanino
13.00 – 14.00 h	Lunch	
15.00 – 16.30 h	Invited Lecture	J. Lemos
16.30 – 17.00 h	Coffee Break	
17.00 – 18.15 h	Field Work Group work on digital restitution and drawing	Teachers and Tutors
18.15 – 19.30 h	Lecture: TBA	V. Paris
19.30 – 20.30 h	Dinner	
20.30 – 22.00 h	Invited Lecture	N. Nodargi

DAY5 | FRIDAY 30 AUGUST

Time	Course/Event	Lecturers
7,30 9.00 h	Breakfast	
9.30 – 11.00 h	Advanced Theory Rigid Blocks for masonry. Numerical approximations: PRD, CDF	M. Angelillo A. Iannuzzo
11.00 – 11.30 h	Coffee Break	
11.30 – 13.00 h	Advanced Theory	M. Angelillo A. Montanino
13.00 – 14.00 h	Lunch	
15.00 – 16.30 h	Invited Lecture	J. Lemos
16.30 – 17.00 h	Coffee Break	
17.00 – 19.30 h	Lecture-BRG	A. Dell'Endice
19.30 – 20.30 h	Lecture-BRG	A. Dell'Endice
21.00 – 22.00 h	Lecture Tile Vaulting	E. Redondo C. Martin

DAY 6 | SATURDAY 31 AUGUST

Time	Course/Event	Lecturers
8.30 – 9.15 h	Breakfast	
9.00 – 10.30 h	Bus to the visit sites	
10.30 – 13.00 h	Visit Segovia Historical surroundings	Teachers and Tutors
13.00 – 14.30 h	Picnic lunch	
14.30 – 17.30 h	Visit Segovia Historical surroundings	Teachers and Tutors
17.30 – 19.00 h	Bus to Casa de Espiritualidad	
19.30 – 20.30 h	Dinner	

DAY 7 | SUNDAY 1 SEPTEMBER

Time	Course/Event	
7,30 – 9.00 h	Breakfast	
9.00 – 19.30 h	Free Day: Picnic Lunch	
19.30 – 20.30 h	Dinner	

DAY 8 | MONDAY 2 SEPTEMBER

Time	Course/Event	Lecturers
8.30 – 9.15 h	Breakfast	
9.30 – 11.00 h	Advanced Theory	A. Iannuzzo A. Gerges
11.00 – 11.30 h	Coffee Break	
11.30 – 13.00 h	Advanced Theory Seismic assessment	G. de Felice M. Sangirardi
13.00 – 14.00 h	Lunch	
15.00 – 16.30 h	Field Work Group work on structural Analysis	Teachers and Tutors
16.30 – 17.00 h	Coffee Break	
17.00 – 18.15 h	Field Work Group work on structural analysis	Teachers and Tutors
18.15 – 19.30 h	Invited Lecture TBA	P. Block
19.30 – 20.30 h	Dinner	
20.30 – 22.00 h	Field work Group work on case studies	

DAY 9 | TUESDAY 3 SEPTEMBER

Time	Course/Event	Lecturers
8.30 – 9.15 h	Breakfast	
9.30 – 11.00 h	Advanced Theory Seismic assessment and retrofiting	G. de Felice M. Sangirardi
11.00 – 11.30 h	Coffee Break	
11.30 – 13.00 h	Field Work Group work on Structural Analysis	Teachers and Tutors
13.00 – 14.00 h	Lunch	
15.00 – 16.30 h	Field Work Group work on Structural Analysis	Teachers and Tutors
16.30 – 17.00 h	Coffee Break	
17.00 – 18.15 h	Field Work Group work on Structural Analysis	Teachers and Tutors
18.15 – 19.30 h	Invited Lecture TBA	V. Russo
19.30 – 20.30 h	Dinner	
20.30 – 22.00 h	Field work Group work on case studies	

DAY 10 | WEDNESDAY 4 SEPTEMBER

Time	Course/Event	Lecturers
8.30 – 9.15 h	Breakfast	
9.30 – 11.00 h	Advanced Theory Seismic assessment and retrofitting	G. de Felice
11.00 – 11.30 h	Coffee Break	
11.30 – 13.00 h	Field Work Group work on Structural Analysis	Teachers and Tutors
13.00 – 14.00 h	Lunch	
15.00 – 16.30 h	Field Work Group work on Structural Analysis	Teachers and Tutors
16.30 – 17.00 h	Coffee Break	
17.00 – 18.15 h	Field Work Group work on Structural Analysis	Teachers and Tutors
18.15 – 19.30 h	Invited Lecture TBA	L. Romano
19.30 – 20.30 h	Dinner	
20.30 – 22.00 h	Field work Group work on case studies	

DAY 11 | THURSDAY 5 SEPTEMBER

Time	Course/Event	Lecturers
8.30 – 9.15 h	Breakfast	
9.30 – 11.00 h	Field Work Group work on Structural Analysis	Teachers and Tutors
11.00 – 11.30 h	Coffee Break	
11.30 – 13.00 h	Field Work Group work on Structural Analysis	Teachers and Tutors
13.00 – 14.00 h	Lunch	
15.00 – 16.30 h	Field Work Group work on Structural Analysis	Teachers and Tutors
16.30 – 17.00 h	Coffee Break	
17.00 – 18.15 h	Field Work Group work on Structural Analysis	Teachers and Tutors
18.15 – 19.30 h	Invited Lecture TBA	M. DeJong
19.30 – 20.30 h	Dinner	
20.30 – 22.00 h	Invited Lecture TBA	A. Fraddosio

DAY 12 | FRIDAY 6 SEPTEMBER

Time	Course/Event	Lecturers
8.30 – 9.15 h	Breakfast	
9.30 – 11.00 h	Field Work Group work on Structural Analysis	Teachers and Tutors
11.00 – 11.30 h	Coffee Break	
11.30 – 13.00 h	Field Work Group work on Structural Analysis	Teachers and Tutors
13.00 – 14.00 h	Lunch	
15.00 – 16.30 h	Field Work Group work on Structural Analysis	Teachers and Tutors
16.30 – 17.00 h	Coffee Break	
17.00 – 18.15 h	Field Work Group work on Structural Analysis	Teachers and Tutors
18.15 – 19.30 h	Invited Lecture TBA	A. Albuerne
19.30 – 20.30 h	Dinner	
20.30 – 22.00 h	Field work Group work on case studies	

DAY 13 | SATURDAY 7 SEPTEMBER

Time	Course/Event	Lecturers
8.30 – 9.15 h	Breakfast	
9.30 – 11.00 h	Field Work Group work on Structural Analysis	Teachers and Tutors
11.00 – 11.30 h	Coffee Break	
11.30 – 13.00 h	Field Work Group work on Structural Analysis	Teachers and Tutors
13.00 – 14.00 h	Lunch	
15.00 – 16.30 h	Students' Final Presentations	
16.30 – 17.00 h	Coffee Break	
17.00 – 18.15 h	Students' Final Presentations	
18.15 – 19.30 h	Panel Discussion	
20.00 – 23.00 h	Social Dinner	

DAY 14 | SUNDAY 8 SEPTEMBER

Time	Course/Event	Lecturers
8.30 – 9.15 h	Breakfast	
9.15 – 13.00 h	Farewell and Departures	

Special Issue

The results of the field works performed during past editions of the Summer School were published on the online magazine Structural, which dedicates a yearly special issue to the structural analysis of historical construction and the scientific outcomes of the work carried out by the groups of students during this intense two-weeks experience.

A special issue dedicated to this Edition of the School is also planned.

More information at:

<http://www.structuralweb.it/cms/it1-magazine-building-engineering-structural-design-.asp>



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