

Fulvio Tonon, Ph.D., P.E.

1. Personal details

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2. Education

- (1)1998-(6)2000 Ph.D. in Civil Engineering, University of Colorado at Boulder. Thesis title: “*Three-dimensional modeling of underground excavations and estimation of boundary conditions in rock with fabric*”. Advisor Prof. B. Amadei. Graduate Committee: Profs. B. Amadei, S. Sture, R. Pak, D.M. Frangopol, K.J. Willam, W. Savage.
- (10)1989-(10)1995 Degree in Civil Engineering (Laurea), University of Padua (Italy), maximum marks of 110/110 and first-class honors; awarded an honorable mention for the academic study career. Degree thesis title: “*Multiobjective optimization of uncertain structures: a fuzzy set approach with application to the design of tunnel lining in hard rock*.” Prepared at the Department of Structural Mechanics (Istituto di Scienza e Tecnica delle Costruzioni), College of Engineering, University of Padua, under the guidance of Prof. A. Bernardini, A. Mammino and Prof. G. Ricceri.
- (9)1984-(6)1989 Maturità Classica (Classical High School), Liceo Ginnasio A. Canova, Treviso, Italy.

3. **Languages:** Italian (native), English (fluent spoken and written)

4. Registration

Licensed Professional Engineer in Texas, license number 101441, since 2008. Registered Professional Engineer in Italy (Treviso Charter, No. 1793 from 1996 to 2013; Trento Charter N. 3806 from 2013 to present).

5. Pilot Licenses

Licensed UAS (Unmanned Aerial System) Pilot in the United States (FAA Certificate Number 3930704) and Italy (ENAC Certificate No. I.APRA.004029, Ratings: VL/Ap = Very Light (<4kg MTOM) Aeroplane, L/Mc= Light (<25 kg MTOM Multicopter)). Passed theory examination for PPL-H (Private Pilot License-Helicopter), ENAC (Italian Civil Aviation Authority).

6. Professional experience

- 1996-present: Professional Engineer. Areas of expertise: geotechnical, tunnel, structural, and bridge engineering. A complete list of projects is given in Section 11.
- 2000-2002 Senior Tunnel Engineer, Parsons Transportation Group Inc., 1133 15th St. NW, Suite 800, Washington DC 20005-2701. Supervisor Mr. M. Irshad. Areas of expertise: geotechnical, tunnel, structural, and bridge engineering. A complete list of projects is given in Section 11.
- 1998-2000: Full-time Research Assistant at the University of Colorado at Boulder. Areas of concentrations: Green's functions for 3D anisotropic media and their incorporation into a BEM formulation, effect of rock mass anisotropy on tunnels, estimation of boundary conditions for rock masses with fabric. Developed collaborations with faculty in different areas and overseas scholars. Organized three seminars with foreign scholars.
- (1)1996-(6)1996 Contract researcher for CNR (Italian National Science Foundation). Further researched on non-probabilistic models of uncertainty as applied to Civil Engineering, under the guidance of Prof. A. Bernardini, University of Padua. Further developed collaboration with Prof. I. Elishakoff (Florida Atlantic University), previously started by Prof. A. Bernardini.

7. Current and previous academic experience

- July 2017 - Present Associate Professor of Geotechnical Engineering, University of Udine, Dept. of Engineering and Architecture
- Feb. 2014 - Present Habilitation to Associate Professor in Geotechnical Engineering (Area 08/B1) in Italy.
- March 2015-June 2019 Adjunct Professor, Dept. of Civil, Environmental, and Architectural Engineering, University of Colorado at Boulder.
- Summer 2012-Spring 2015 Director, On-line Certificate in Tunneling, University of Texas, Austin.
- Fall 2005-Summer 2012 Assistant Professor of Geotechnical Engineering, Department of Civil, Architectural and Environmental Engineering, University of Texas, Austin.
- Spring 2002 – Summer 2005 Assistant Professor of Geological Engineering, Department of Geology and Geophysics, University of Utah.

8. Experience profile

Dr. Fulvio Tonon earned his Laurea in civil engineering from the University of Padova, Italy, in 1995, and his Ph.D. in civil engineering from the University of Colorado at Boulder, USA, in 2000. He has more than 22 years of professional experience working on projects in the Americas, Europe and Africa. Design experience includes: cut-and-cover and bored tunnels in rock, soft ground and mixed face conditions, with or without the use of Tunnel Boring Machines; foundations and special foundations; rock and soil slope stabilizations; precast concrete and steel-concrete composite bridges; hydraulic infrastructures for dams, purification plants and rivers; renovations of ancient masonry buildings; and reinforced concrete buildings. Fulvio Tonon is Member and Principal Engineer of Tonon USA: Engineering, Measurements and Testing, LLC, and

Laboratorio Rocce e Ricerca Tonon, s.r.l.. In these firms, he carries out quality rock testing, provides photogrammetric modeling of tunnels and slopes, and consults in the field of civil engineering. He was a faculty member in the Department of Civil, Architectural and Environmental Engineering at the University of Texas at Austin, and previously he served in the faculty of Geological Engineering at the University of Utah. He spent two years as a senior tunnel engineer with Parsons, and has been a consultant since 1995. He directed the International Tunneling Consortium, which encouraged academic research in response to industrial needs, from the fall 2007 to the summer 2013. He developed and directed the On-line Certificate in Tunneling, which provided working knowledge on tunneling for busy professionals from 2010 to 2019 first at the University of Texas at Austin, and then at the University of Colorado Boulder; the program was endorsed by the International Tunneling Association (ITA). In 2006, Dr. Tonon won the Award for Applied Rock Mechanics from the American Rock Mechanics Association for his paper entitled: "Stresses in anisotropic rock masses: an engineering perspective building on geological knowledge." His research emphasizes rock mechanics and engineering, underground excavations and uncertainty modeling with generalized theories of probability. He has published two books on tunneling, one book on uncertainty bounds in civil engineering, 6 papers in peer-reviewed journals and 48 papers in conference proceedings. In 2014 he obtained his habilitation as an Associate Professor in Italy in the area of Geotechnical Engineering and has been Associate Professor of Geotechnical Engineering at the University of Udine since 2017. He is a licensed UAS (Unmanned Aerial System) Pilot in the United States (FAA) and Italy (ENAC).

9. Professional memberships and Committees

Associate member of the American Society of Civil Engineers (ASCE), and of the International Association of Bridge Management and Safety (IABMAS). Member of the following institutions: Underground Construction Association (UCA), Italian Tunneling Society (SIG); International Tunneling Association (ITA), American Rock Mechanics Association (ARMA), and International Society of Rock Mechanics (ISRM).

Member of the following committees:

- International Society of Rock Mechanics (ISRM); Maintenance and Repair of Underground Structures in Rock Masses committee (president: L. Ribeiro e Sousa); 2004-2007.
- International Society of Rock Mechanics (ISRM); Rock Fracture Characterization Committee (president: J. Harrison); 2009-present.
- International Tunneling Association (ITA); Committee on Education and Training (chair R. Ghaller); 2008-present. Member of the Executive Board.
- International Tunneling Association (ITA); Working Group 2, Research (animator E. Chiriottia); 2002-present.
- National Academy of Sciences: Underground Geoengineering for Sustainable Development Committee; (chair Paul H. Gilbert) 2010-2012.
- American Association of State Highway and Transportation Officials (AASHTO) Scan Team 09-05, Best Practices for Roadway Tunnel Design, Construction, Maintenance, Inspection, and Operations (K. Thompson, AASHTO Co-Chair, J. Rohena, FHWA Co-Chair).
- American Society of Civil Engineers (ASCE); Geo-Institute Rock Mechanics committee; 2000-present. **Chair:** 2009-2014.
- American Society of Civil Engineers (ASCE); Geo-Institute Risk Assessment and Management committee (coordinator K.-K. Phoon); 2004-present.
- Transportation Research Board (TRB); Committee AFS20, Soils and Rock Instrumentation (chair Thomas C. Sheahan); 2003-2006.
- TRB Committee AFF60, Tunnels and Underground Structures (chair C. Felice); 2005-present. Chair of the Research Subcommittee.
- TRB Committee AFP30, Soils and Rock Properties (chair Silas Nichols); 2003-present.

10. Prizes and scholarships

American Rock Mechanics Association (ARMA): 2006 Award for Applied Rock Mechanics for the paper entitled: Stresses in anisotropic rock masses: an engineering perspective building on geological knowledge. *Int. J. Rock Mech. Min. Sci.*, 40 (2003), 1099–1120.

Awarded the Thesis Prize by the Italian Tunneling Society, Third Edition, for the best thesis on Underground Excavations defended in Italy in the years 1994-95-96.

Awarded scholarships for graduate studies by the following institutions: University of Padua, Italy; University of Pisa, Italy; Fondazione Gini (twice), Padua, Italy; CNR (Italian National Science Foundation); Rotary Foundation (ambassadorial scholarship).

11. Professional projects

11.1 Photogrammetry applications

11.1.1 Underground excavations

1. Inspection of the water tunnel Pian Palù-Cogolo: 1.65-1.9 m diameter, 850 m length, in the presence of high CO₂ concentrations. 3D model of the tunnel lining intrados textured with high resolution photographs and its use for: lining crack identification and change detection (elongation, formation, and enlargement), concrete spalling identification and change detection (formation, enlargement, and deepening), lining strain-stress pattern based on 3D crack survey, and lining displacement. 3D model georeferenced to 1 mm accuracy. Client: Hydro Dolomiti Energia SRL, Trento, Italy.
2. Monitoring of the by-pass tunnel in the Helms Pumped Project (Courtright Reservoir, CA) owned by Pacific Gas and Electric (PG&E), San Francisco, CA. Establish and repeat control, and 3D model of the excavation intrados textured with high resolution photographs; overall accuracy (control + 3D model) = 1 mm. Change detection: intrados displacements, lining moisture conditions, and crack elongation, formation, and enlargement. Monitoring is repeated every 3-6 months. Client: URS and then AECOM, Oakland, CA.
3. Tassullo underground chambers for limestone quarrying and underground storage of Non-Valley apples (Mollaro, TN, Italy). 3D models of the underground excavations textured with high resolution photographs and their use for: detailed fracture mapping and analysis, rock mass classifications, continuous 3D rock mass model along the entire excavation length, 3D geometry and profile check. Client: Tassullo Materiali S.p.A., Tassullo, TN, Italy.
4. Cowee rail tunnel (NC). 3D models of the voids created by rock falls at the two ends of the concrete lining. Client: Shannon and Wilson Inc., Jacksonville, FL.
5. Malus exploratory tunnel for the Brenner Base Tunnel through the Periadriatic Fault (Austria-Italy). 3D model of the entire excavation heading (face, walls and crown) textured with high resolution photographs and its use for: detailed fracture mapping, continuous 3D rock mass model along the entire tunnel length, point wise shotcrete thickness calculation, profile check, and final lining concrete volume calculations. Client: demonstration to Brenner Base Tunnel SE, Bolzano, Italy.
6. Inspection of the Liberty roadway tunnel (Pittsburg, PA). 3D model of the tunnel lining intrados textured with high resolution photographs and its use for: lining crack identification and change detection (elongation, formation, and enlargement), concrete spalling identification and change detection (formation, enlargement, and deepening), lining strain-stress pattern based on 3D crack survey, and lining displacement. Client: demonstration to Pennsylvania Department of Transportation, PA.
7. Inspection of the Eisenhower-Johnson highway tunnel along I-70 (CO). 3D models of the air-duct lining intrados and of the roadway tiled revetment, both textured with high resolution photographs

and their use for: lining and tile panel displacement identification, identification of the displacements of the air-duct dividing wall (hung from ceiling), lining and tile panel crack identification and change detection (elongation, formation, and enlargement), concrete spalling identification and change detection (formation, enlargement, and deepening), and lining strain-stress patterns based on 3D crack survey. Client: demonstration to Colorado Department of Transportation, CO.

8. Inspection of the Chesapeake Bay immersed highway tunnel (VA). Demonstration of: 3D models of the air-duct lining intrados and of the roadway tiled revetment, both textured with high resolution photographs and their use for: lining and tile panel displacement identification, lining and tile panel crack identification and change detection (elongation, formation, and enlargement), concrete spalling identification and change detection (formation, enlargement, and deepening), lining strain-stress patterns based on 3D crack survey, and entire tunnel survey of displacements induced by loss of ballast or ballast overloading. Client: demonstration to Chesapeake Bay Bridge-Tunnel, Cape Charles, VA.

11.1.2 Slopes

1. Rock mass characterization of Barruecopardo open pit mine (Salamanca, Spain) owned by Saloro; tungsten extraction. Total width of rock faces: about 600 m. 3D model textured with high resolution photos, fracture mapping (about 2,500 fractures). Client: Golder Associates Global Ibérica S.L.U..
2. Survey of a rock face behind former "Italcementi Plant" in Trento, TN, Italy. The rock face, located in an urban area, was about 90 m high and 300 m long. Topographic control, 3D model textured with high resolution photos. This information was then used in a rockfall analysis and in the design of the rockfall mitigation system. Global accuracy of 3 cm obtained from ground stations located 0.2-1.3 km from the rock face. Client: Patrimonio del Trentino SRL, Trento, Italy.
3. Aerial survey of four ignimbrite (porphyry) quarries in Fornace, TN, Italy. Coverage area = 170 ha (420 ac), elevation difference 350 m (1150 ft): topographic control, 20 million faces 3D model textured with high resolution photos, 2.5 cm resolution orthophoto, contour map; 1 cm horizontal accuracy, 1.8 cm vertical accuracy. February 2017, 2018, 2019; calculation of excavation volumes in each of the 10 lots. Client: Comune di Fornace (Fornace Municipality), TN, Italy.
4. Rock mass characterization of Mount Brione in Arco, TN, Italy. The rock face was about 270 m high and 2,600 m wide. Topographic control, 3D model textured with high resolution photos, fracture mapping (over 6,000 fractures), determination of the dimensions of the rock blocks on the slope and identification of unstable blocks. This information was then used in a rockfall analysis and in the design of the rockfall mitigation system. Global accuracy of 3 cm obtained from ground stations located 1-1.3 km from the rock faces. Client: Comune di Arco (Arco Municipality), TN, Italy.
5. Rock mass characterization of Rocchetta and Cima SAT rock faces in Riva del Garda, TN, Italy. Each rock face was about 500 m high and 270 m wide. Topographic control, 3D model texture with high resolution photos, fracture mapping, determination of the dimensions of the rock blocks on the slope and identification of unstable blocks. This information was then used in a rockfall analysis for the areas to be developed some 800 m below the toe of the rock faces. Global accuracy of 3 cm obtained from ground stations located 1.8-2.6 km from the rock faces. Client: GeoExperts International SRL, Trento, Italy.
6. Monitoring of the Hanging-Lake rock slope along I-70 (CO). Developed entire monitoring scheme and photo acquisition technique for the 500 m high, 1,800 m wide vertical to sub-vertical rock slope in order to achieve 2.5 cm (1 inch) accuracy over the entire slope. The slope is located in a very narrow canyon and it has a very irregular shape (concavities and convexities), which prevent imaging from the ground. 3D model of the slope textured with high resolution photographs and its use to determine slope displacements. Monitoring is repeated every 3-6 months. Client: Colorado Department of Transportation, CO.
7. Monitoring of the De Beque rock slide along I-70 (CO). Established control and developed entire monitoring scheme for the 500 m high, 600 m wide rock slope in order to achieve 1 cm (0.4 inch)

accuracy over the entire slope. 3D model of the slope textured with high resolution photographs and its use to determine slope displacements. Client: Colorado Department of Transportation, CO.

11.2 Design and analysis of tunnels and underground excavations

1. Review of the Mechanized Excavation Study for the water tunnel (7.3 m, 24 ft, diam. and 2.7 km, 1.7 mile, long) included in the Central Bayside System Improvement Project, San Francisco Public Utilities Commission, Contract CS-169, Task 12.04, San Francisco, CA. Client: Stantec Consulting Services Inc., Walnut Creek, CA.
2. Flat jack *in situ* stress measurements in the by-pass tunnel at the Helms Pumped Project (Courtright Reservoir, CA) owned by Pacific Gas and Electric (PG&E), San Francisco, CA. Procured specialized firm to carry out the specified measurements, managed the measurements at the site, and reviewed the measurement report. Client: AECOM, Oakland, CA.
3. Part of the Review Panel for the Director's CD-3A Review of the Long-Baseline Neutrino Facility (LBNF), Conventional Facilities, Underground Excavations. Review of the Preliminary Design for the Detector's facilities 1,500 m (4850 ft) below surface at Sanford Underground Research Facility (formerly Homestake Gold Mine) in Lead, South Dakota, USA. Facilities include 4 caverns (27.4-m or 90-ft high, 20-m or 65-ft wide, 154-m 505-ft long), central utility cavern (11.5-m or 38ft high, 19.5-m or 64 ft wide and 190-m or 624-ft long), 1,200 m (3,871 ft) of new and enlarged access drifts and 953 m (3,125 ft) of mucking ramps. Client: Fermi National Accelerator Laboratory, Batavia, IL.
4. Part of the Expert Review Panel for the 8-km long Scarborough Subway Extension (SSE) Project by the Toronto Transit Commission (TTC), Toronto, Canada. Glacial deposits: overconsolidated silts, sands and clays below the water table. Evaluation of the current design solutions (including 14.1-m, 46-ft single bore with stacked tracks), proposal of alternative solution (10-m single bore with two parallel tracks), risk register. Client: Toronto Transit Commission, Toronto, ON, Canada.
5. Black and Veatch Review Panel for the 10.8 km-long Jollyville Water Tunnel, Austin, TX. Soft limestone of the Glen Rose formation. Client: Black and Veatch Inc., Austin, TX.
6. Geotechnical and structural analysis and design for a 300-m long drainage tunnel for slope stabilization. Claystone and shale at different degrees of weathering. Lucera, Foggia, Italy. ♦
7. Analysis and design of the rehabilitation of the two-lane Comelico tunnel along a 350-m long tectonic contact between limestone and flysch. Belluno, Italy. ♦
8. Proposal for a new highway in northern Africa: 3 tunnels (3,350+8,200+1,670 = 13,220 m) and four bridges (300+300+350+380 = 1,330 m). Geological and geotechnical proposal for tunnels and bridge foundations, and proposal of construction methods for tunnels. ♦
9. Analysis and shop drawing design for the two-lane Listolade tunnel, Belluno, Italy. Cross-section: 110 m²; length: 100 m in colluvial detritus + 1,375 m in limestone and 135 m in siltstone. ♦
10. Review of Parsons Water & Infrastructure project for evaluating the repair and replacement alternatives for the T-19 tunnel and the Forebay in granite, part of the Southern California Edison Kern River Number 1 hydroelectric project. Bakersfield, California, USA.
11. Geotechnical and structural analysis and design of five new twin tunnels (each 110 m² in cross-section) in fractured limestone and mudstone for the highway Salerno-Reggio Calabria, Italy, contract DG-32. Tunnels: Ospedaletto (length 600 m), Cillarese (length 1000 m), Cerreta (length 750 m), Colloredo (length 150 m), Campotenese 2 (400 m). Special features: intersections and interference between the old and the new tunnels, presence of a high water head in mudstone (Cerreta tunnel), and presence of a valuable monastery over Colloredo tunnel. ♦
12. Geotechnical and structural analysis and design of two new twin tunnels (each 110 m² in cross-section) in fractured flysch and limestone for the highway Salerno-Reggio Calabria, Italy, contract DG-8. Tunnels: Sardina II (length 300 m), Costa del Monte (length 600 m). Special features: intersections and interference between the old and the new tunnels, soft shale and shallow cover

under inhabited area for Sardina tunnel. Preparation of the geotechnical interpretation and baseline reports for the two tunnels. ♦

13. State Road 77 from Muccia to Colfiorito, Ancona, Italy. Preliminary design and value engineering of 10 km of tunnels for the four alignment alternatives. Geotechnical and structural analysis and final design of the thirteen tunnels for the selected alignment: Brogliano (868 m), Casali (460 m), Faeto (790 m), Castelletto, (970 m), Unnamed (175 m), Serravalle (395 m), Bavareto (750 m), Gelagna (975 m), Massa (550 m), Costafiore (1960 m), Muccia II (590 m), Muccia I (340 m), La Rocchetta (980 m), total 9,803 m. Rock masses: limestone, shale, mudstone, marl. ♦
14. Geotechnical and structural analysis and design for a large underground tuff quarry of Etruscan age (50-200 m in span, 20-30 m in height, 20 m deep) to be transformed into a conference center. Tarquinia, Viterbo, Italy. ♦
15. Geotechnical and structural analysis and design of the diversion tunnels for two earth dams in northern Africa. Internal diameter: 5.5 m; length: 300 m; rock mass: chalk-limestone. ♦
16. Post-Tender design of the Seattle Light Rail Link subway project, WA, USA. Geotechnical and structural analysis and design of the EPB-excavated running tunnel (10 m in internal diameter, 7.5 km in length), 3 mined stations (17 m wide, 14 m high, 120 m long) and shafts (internal diameter from 16 to 36 m) in soft ground under the water table. Special features: deepest subway in the USA (80 m), passage of Portage Bay. ♣
17. La Guardia Airport “N” line extension tunnel feasibility study (New York, NY, USA); 3 km of tunnels and 3 stations in soft ground (glacial sand, varved silt and clay, glacial till, organic silts and clays) under the water table. Development of new, deep profile to avoid organic soil or running sands, and development of construction methods for three deep mined stations, recommendations for the most appropriate tunnel boring machine. Development and spreadsheet implementation of methodologies for ranking different design alternatives. ♣
18. Water intrusion study for the Medical Center crossover cavern (15 m wide, 12 m high, 24 m overburden) on the Subway Red Line, Washington Metropolitan Area Transit Authority (Bethesda, VA, USA). Assessment of the existing condition and development of a monitoring program for the rock reinforcement and cavern lining. Recommendations for the mitigation of the water intrusion problem. ♣
19. Second Avenue Subway Project, New York, NY, USA. Member of the proposal team. Geotechnical and structural study of several design alternatives; study of different tunneling methods and construction methods for the stations. Soft ground, hard rock, and mixed-face conditions. Preparation of man-hour estimates and construction cost estimates. ♣
20. RTD light-rail extension, Denver, CO, USA. Independent check and final design of: outfall tunnel lining and EPBM construction method (diameter 4.5 m, length 400 m through sandstone, sand/gravel, and clay under the water table), transition structure, junction structure, drop shaft, and bridge underpinnings. ♣

11.3 Foundations and special structural and earth works

1. Drillability and excavatability characterization of the chert (flint) layer in the Upper Copenhagen Limestone formation encountered between 9.5 and 11.5 m depth during the construction of the slurry walls for the Sønders Boulevard Subway Station in the Cityringen Project, Copenhagen, Denmark. The rock was extremely abrasive and hard, and it caused significant damage and bit consumption to the hydromill excavation equipment as well as significant construction delays. The laboratory tests for the characterization were decided and carried out by Prof. Tonon at his laboratory (Laboratorio Rocce e Ricerca Tonon, SRL, Trento, Italy). Client: Trevi S.p.A., Cesena, Italy.
2. Design and analysis of a combined sheet-pile wall and micropile retaining system for the construction of new retaining walls in proximity of ancient and delicate masonry buildings in Giudecca Canal, Venice, Italy. Design and analysis of the final retaining wall on micropiles. ♦

3. Analysis and design of 12-m deep tied-back slurry walls and micropile tremie concrete walls for a new building adjacent to 200-year-old stone-masonry buildings in Cortina D'Ampezzo (Belluno, Italy). ♦
4. Geotechnical and structural design of the foundations for a cable-stayed bridge on the Adda river, Italy (span 400 m). ♦
5. Geotechnical and structural, reliability-based design of micropile foundations for a factory in Costa Rica in very loose chaotic soil in seismic zone. ♦
6. Analysis and design of an embankment for a rock trap ditch subjected to impacting rock blocks, in Trento, Italy. ♦
7. Analysis of shallow foundations for a series of high electric towers in Italy. ♦
8. Geomechanical analysis and design of a landfill for municipal waste in seismic zone (Val Organa); construction phases, short term and long term behavior. Cavaso del Tomba, Treviso, Italy. ♦
9. Design and analysis of abutment pile foundations for the new Woodrow-Wilson Bridge between Maryland and Virginia, USA. ♣

11.4 Rock and soil slope stabilizations

1. Analysis and design of a 6- to 7-m high rock cut in limestone and of its stabilization. The cut was adjacent to an ancient 3-story high masonry house, with distance to the house foundation varying from 20 cm to 3 m. Nago, Trento, Italy. ♦
2. Safety assessment of the current condition, and analysis and design of the stabilization system for a sub-vertical 50-m high rock slope in Condino, Trento, Italy. ♦
3. Slope stability analysis of river levees for the Po river. Rovigo, Italy. ♦
4. Slope stability analysis for the slope under Bridge 4284 on the Appalachian Corridor H, Section 16, West Virginia, USA. Soft clay overlaying shale deposit. Recommendations for the mitigation of the slope instability threatening the pier foundations. ♣

11.5 Hydraulic infrastructures

1. Structural design and analysis of special reinforced concrete structures (tanks, process basins, etc.) for the purification plant in Asti, Italy. ♦
2. Analysis of the current state, failure causes and technical design documentation relative to the rehabilitation and reconstruction of two earth dams in northern Africa; crest length 500 m, crest height 30 m. Analysis and design of diversion tunnels, grouting and toe galleries, intake towers, and outlet works in seismic zone. ♦
3. Analysis of a dock for the Port of Ancona, Italy, composed of tied-back sheet-pile walls. ♦
4. *In situ* stress measurement program at the Seminole dam (Wyoming, USA), owned by the US Bureau of Reclamation. The dam was suffering from alkali-aggregate reactions. Recommendations for the stress analyses to be conducted. Study carried out together with Prof. B. Amadei, University of Colorado at Boulder, USA.

11.6 Bridges

1. Final structural design and shop drawings of a precast, prestressed concrete simply-supported bridge 27-m in span over the Roncajette river, Padova, Italy. Girders, deck, abutments and foundations. ♦
2. Final structural design and CAD shop drawings of a steel-concrete composite viaduct 20-m in width, for the highway Milan-Serravalle (Milan, Italy); tree span (43-74-43 m) continuous bridge: superstructure, abutments, piers and foundations. ♦
3. Analysis of piers and micropile foundations of a prestressed reinforced concrete bridge in seismic zone, close to Pescopagano, Italy. ♦

11.7 Reinforced concrete buildings

Structural design for Ex-Giacetti building, 3 storeys + underground basement. Vicenza, Italy. ♦

11.8 Structural restorations

1. Structural restoration analysis and design of a XV century masonry building called “Mulini Vecchi” in Bassano del Grappa (Vicenza, Italy). ♦
2. Assessment of the current conditions and redesign of the restoration measures for an XVIII century 50-m high masonry bell tower in Bessica di Loria (Vicenza, Italy). ♦

11.9 Expert Witnesses for Court or Dispute Board Use

1. Expert witness for ANAS (Italian National Road and Transportation Agency) relative to a spring intersected by Agnese tunnel in Trento, Italy. Hydrological and hydrogeological study. ♦
2. Expert witness for Central Texas Regional Mobility Authority (CTRMA) in a dispute with Contractor CH2M-Hill pertaining to the difficulties encountered by the contractor in microtunneling through Edwards Limestone in Austin, TX, USA. The microtunneling work was used to install drains for the MoPac (Loop 1) Improvement Project: express lanes between Cesar Chavez and Parmer Lane to manage congestion and improve reliability. The expert witness was instrumental in winning the \$54 million claim in front of the Dispute Board.

Note: the symbol ♦ indicates a project carried out as a consultant for SIGES (Treviso, Italy); the symbol ♣ indicates a project carried out as a Senior Tunnel Engineer with Parsons Transportation Group (Washington, DC, USA).

12. Publications

12.1 Books

12.1.1 Co-authored

- 1) A. Mammino and F. Tonon, (1997); *Opere strutturali per l'ingegneria Territoriale (Structural Works in Geotechnical Engineering Applications), Vol.1 , Tome 2*. Alinea Editrice, Firenze, XLVI + 1431 pages. **Contents:** Introduction; 1. Fundamentals of Fuzzy Set, Random Set and Evidence Theory; 2. Structural Optimization of Uncertain Structures; 3. Geology Applied to Tunneling; 4. Design Parameters for Tunnel Design; 5. Convergence-Confinement Method; 6. Tunnel Lining Optimization; 7. Structurally Controlled Stability of Tunnels; 8. Structural Analysis of Tunnel Linings. (In Italian). ISBN: 9788881251575.
- 2) A. Mammino and F. Tonon, (1997); *Opere strutturali per l'ingegneria Territoriale (Structural Works in Geotechnical Engineering Applications), Vol.1 , Tomo 3*. Alinea Editrice, Firenze, XLVI + 1065 pages. *Vol.1 , Tome 3*. **Contents:** 9. Tunnels close to a Mountainside; 10. Cut and Cover Tunneling; 11. Concrete Diaphragm Walls; 12. Slope Stability; 13. Special Reinforced Concrete Structures for Hydraulic Networks Nodes; 14. Weirs. (In Italian). ISBN: 88-8125-157-4.
- 3) Bernardini, A. and Tonon, F. (2010). *Bounding Uncertainty in Civil Engineering – Theoretical Background*. Springer, 350 pages. ISBN: 978-3-642-11189-1.
- 4) K. Thompson, J. Rohena, A.K. Bardow, B.B. Brecto, B. Khaleghi, L. Ruzzi, M.G. Salamon, F. Tonon, M.L. Ralls, *Best Practices For Roadway Tunnel Design, Construction, Maintenance, Inspection, And Operations*, NCHRP Project 20-68A, Scan 09-05. NCHRP, 186 pages.
- 5) Committee on Underground Engineering for Sustainable Development (2013). *Underground Engineering for Sustainable Urban Development*. The National Academies Press, Washington, D.C.. ISBN: 978-0-309-27824-9.

12.1.2 Co-edited

- 1) F. Tonon and J.T. Kottenstette (eds.), (2007); Proc. of the workshop “Laser and photogrammetric methods for rock face characterization”, Golden, CO, June 17-18, 2006. American Rock Mechanics Association (ARMA).

- 2) F. Tonon, W. Wu, X. Liu (eds.), (2010); “Deep and Underground Excavations” ASCE Geotechnical Special Publication 206, Proceedings of the session “Deep excavations & retaining structures, New frontiers in urban geotechnology, Tunneling and underground constructions” at GeoShanghai 2010. American Society of Civil Engineers (ASCE). ISBN: 978-0-7844-1107-0.

12.2 Book chapters

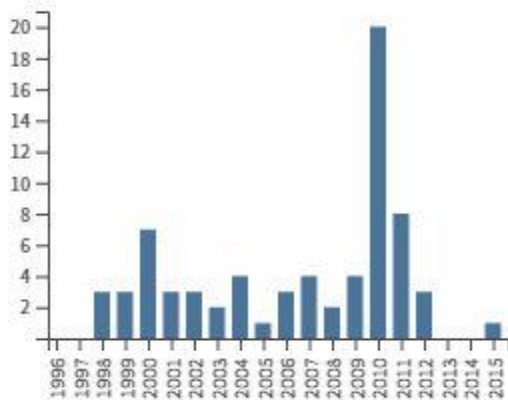
- 1) F. Tonon, A. Mammìno, F. Pagliacci and P. Borghi, Final lining ahead of a tunnel face by means of the Pretunnel system: equipment, case histories, and design procedures. *MIR 2000 – Mechanized Tunneling*, 275-309 (G. Barla ed.). Patron, Bologna, 2000.
- 2) A. Bernardini and F. Tonon, Bounding Uncertainty in Civil Engineering: Theoretical Background and Applications. *Nondeterministic Mechanics (CISM International Centre for Mechanical Sciences, Courses and Lectures, Vol. 539)*, 227-259 (I. Elishakoff and C. Soize eds.). Springer, 2013. ISBN: 978-3709113059.

12.3 Papers

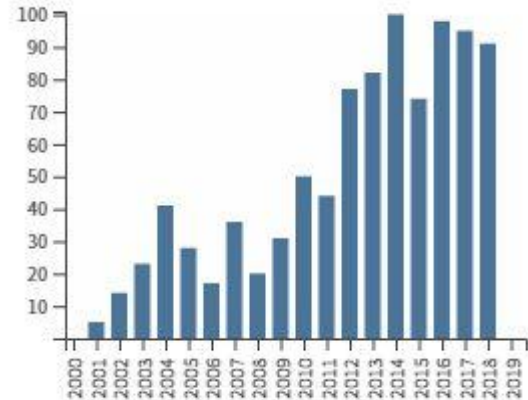
12.3.1 Refereed journals

Scopus statistics: Current h-index = 21; Citing Articles *without* self-citations: 1409 (updated April 10, 2019). ISI Web-of-Science statistics: Current h-index = 17; Citing Articles *without* self-citations: 871; Average Citations per Item: 12.65 (updated 11/11/2018).

Published Items in Each Year



Citations in Each Year



- 1) F. Tonon and A. Bernardini, A Random Set approach to the optimization of uncertain structures. *Computers and Structures* 68 (1998) 583-600.
- 2) F. Tonon and A. Bernardini, Multiobjective optimization of uncertain structures through Fuzzy Set and Random Set theory. *Computer-Aided Civil and Infrastructure Engineering* 14 (1999), 119-140.
- 3) a) F. Tonon, Generalization of Mauldon’s and Goodman’s vector analysis of keyblock rotations. *ASCE’s Journal of Geotechnical and Geoenvironmental Engineering* 124(10) (1998), 913-922. DOI: 10.1061/(ASCE)1090-0241(1998)124:10(913).
 b) F. Tonon, Closure on the discussion of the paper “Generalization of Mauldon’s and Goodman’s vector analysis of keyblock rotations”. *ASCE’s Journal of Geotechnical and Geoenvironmental Engineering*, 126(1) (2000), 99.
- 4) F. Tonon, A. Bernardini and I. Elishakoff, Concept of Random Sets as applied to the design of structures and analysis of expert opinions for aircraft crash. *Chaos, Solitons and Fractals* 10 (1999), 1855-1868.

- 5) F. Tonon, A. Bernardini and A. Mammino, Multiobjective optimization under uncertainty applied to tunnel lining design: a new approach through Fuzzy Set Theory. *Gallerie e Grandi Opere Sotterranee*, 56 (1999), 26-34.
- 6) E. Pan and F. Tonon, Three-dimensional Green's functions in anisotropic piezoelectric solids. *Int. J. of Solids and Structures*, 37 (2000), 943-958.
- 7) A. Mammino, F. Tonon and F. Zen, Un metodo generale di verifica statica per torri campanarie snelle. *Costruire in Laterizio*, 78 (2000), 62-69. (Title: A general method for the analysis of slender masonry bell towers).
- 8) F. Tonon, E. Pan and B. Amadei, Green's functions and boundary element formulation in general anisotropic elastic solids. *Computers & Structures*, 79(5) (2001), 469-482.
- 9) F. Tonon, A. Bernardini and A. Mammino, Determination of parameters range in Rock Engineering by means of Random Set Theory. *Reliability Engineering & System Safety*, 70(3) (2000), 241-261.
- 10) F. Tonon, A. Bernardini and A. Mammino, Reliability analysis of rock mass response by means of Random Set Theory. *Reliability Engineering & System Safety*, 70(3) (2000), 263-282.
- 11) F. Tonon, A. Bernardini and I. Elishakoff, Hybrid analysis of uncertainty: Probability, fuzziness and convexity. *Chaos, Solitons and Fractals*, 12(8) (2001), 1403-1414.
- 12) F. Tonon, B. Amadei and E. Pan, Bayesian estimation of boundary conditions with application to deep tunneling. *Geotechnical and Geological Engineering*, 19 (2001), 43-67.
- 13) F. Tonon, B. Amadei, E. Pan and D.M. Frangopol, Bayesian estimation of rock mass boundary conditions with applications to the AECL Underground Research Laboratory, Canada. *Int. J. Rock Mech. Min. Sci.*, 38(7) (2001), 995-1027.
- 14) F. Tonon and B. Amadei, Effect of elastic anisotropy on tunnel wall displacements behind a tunnel face. *Rock Mechanics and Rock Engineering* 35(3) (2002), 141-160.
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- 16) A. Mammino, L. Tonon and F. Tonon, Risk analysis as a design tool in the fire-safety retrofit of two Italian tunnels. *Transportation Research Record*, 1814 (2002), 93-102.
- 17) F. Tonon and B. Amadei, Stresses in anisotropic rock masses: an engineering perspective building on geological knowledge. *Int. J. Rock Mech. Min. Sci.*, 40 (2003), 1099-1120. **Invited paper** for special issue on rock stress measurement.
- 18) F. Tonon, Using Random Set Theory to propagate epistemic uncertainty through a mechanical system. *Reliability Engineering & System Safety*, 85 (2004), 169-181. **Invited paper.**
- 19) F. Tonon, On the use of Random Set Theory to bracket the results of Monte Carlo simulations. *Reliable Computing*, 10 (2004), 107-137.
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- 23)F. Tonon, Does elastic anisotropy significantly affect tunnel plane strain behavior? *Transportation Research Record*, 1868 (2004), 156-168.
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- 25)F. Tonon, A. Mammino, D. Vanni, P. G. Borghi and A. Bertero, Pretunnel technology: applications and design methods. *Geotechnical and Geological Engineering*, 23(5) 2005, 487 – 518. DOI: 10.1007/s10706-003-5397-9.
- 26)F. Tonon and S. Chen, Inclusion properties for random relations under the hypotheses of stochastic independence and non-interactivity. *Int. J. of General Systems* 34(5) 2005, 615 - 624. DOI: 10.1080/03081070500094411.
- 27)A. Mammino, F. Tonon and L. Tonon, Renovation of the 17th century Ponte Lungo Bridge in Chioggia, Italy, *ASCE Journal of Bridge Engineering* 11(1) 2006, 13-20. DOI: 10.1061/(ASCE)1084-0702(2006)11:1(13).
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- 31)F. Tonon, and Chen, S. Closed-form and numerical solutions for the probability distribution function of fracture diameters. *Int. J. of Rock Mech. and Mining Sci.* 44 (3), 2007, 332-350. DOI: 10.1016/j.ijrmms.2006.07.013.
- 32)F. Tonon, Analytical formulas for the geometric and inertia quantities of the largest removable blocks around tunnels. *Int. J. for Numerical and Analytical Methods in Geomechanics* 31(11), 2007, 1301-1327. DOI 10.1002/nag.593.
- 33)F. Tonon, Analysis of single rock blocks for general failure modes under conservative and non conservative forces. *Int. J. for Numerical and Analytical Methods in Geomechanics* 31(14), 2007, 1567–1608. DOI: 10.1002/nag.608.
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- 37)T. Fetz and F. Tonon, Probability bounds for series systems with variables constrained by sets of probability measures. *International Journal of Reliability and Safety* 2(4), 2008, 309-339. DOI: 10.1504/IJRS.2008.022079.

- 38)A. Bernardini and F. Tonon, Extreme probability distributions of random sets, fuzzy sets and p-boxes. *International Journal of Reliability and Safety*, 3(1/2/3), 2009, 57-78.
- 39)A. Bobet, A. Fakhimi, S. Johnson, J. Morris, F. Tonon, and M.R. Yeung, Numerical models in discontinuous media: review of advances for rock mechanics applications. *ASCE's Journal of Geotechnical and Geoenvironmental Engineering*, 135(11), 2009, 1547-1561. DOI: 10.1061/(ASCE)GT.1943-5606.0000133.
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- 49)H. Youn and F. Tonon, Numerical analysis on post grouted drilled shafts: A case study at the Brazo River Bridge, TX. *Computers and Geotechnics*, 37, 2010, 456–465. DOI: 10.1016/j.compgeo.2010.01.005
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- 53)H. Youn and F. Tonon, Effect of air-drying duration on the engineering properties of four clay-bearing rocks in Texas. *Engineering Geology*, 115, 2010, 58–67. DOI:10.1016/j.enggeo.2010.06.012.
- 54) S-H Kim and F. Tonon:
- Face stability and required support pressure for TBM driven tunnels with ideal face membrane - drained case. *Tunnelling and Underground Space Technology*, 25, 2010, 526-542. DOI: 10.1016/j.tust.2010.03.002.
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- 55)P. Asadollahi and F. Tonon, Definition of factor of safety for rock blocks. *International Journal of Rock Mechanics and Mining Sciences*, 47, 2010, 1384-1390. DOI: 10.1016/j.ijrmms.2010.07.009.
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- 57)Y. Wang and F. Tonon, Discrete Element modeling of rock fragmentation upon impact in rock fall analysis. *Rock Mechanics and Rock Engineering*, 44, 2011, 23–35. DOI: 10.1007/s00603-010-0110-9.
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- 64)X. You and F. Tonon, Event Tree Analysis with Imprecise Probabilities. *Risk Analysis*, 32, 2012, 330-344. DOI: 10.1111/j.1539-6924.2011.01721.x
- 65)Y. Wang and F. Tonon, Discrete Element Modeling of Drop Tests. *Rock Mechanics and Rock Engineering*, 44, 2012, 863-869. DOI 10.1007/s00603-012-0272-8.
- 66)M. Heidari and F. Tonon, Ground reaction curve for tunnels with jet grouting umbrellas considering jet grouting hardening. *Int. J. of Rock Mech. and Mining Sci.* 76, 2015, 200-208. DOI: 10.1016/j.ijrmms.2015.03.021
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- 68)A. Rabaikar and F. Tonon, Determination of material properties obtained in the verification core at the bottom of drilled shafts. *ASCE J. of Geotechnical and Geoenvironmental Engineering* (submitted).
- 69)P. Asadollahi and F. Tonon, Stability of a prism in the roof of a circular tunnel. *Rock Mechanics and Rock Engineering* (submitted).
- 70)F. Tonon, Dynamic amplification to the ovaling effects induced by earthquakes on circular tunnels. *Tunnelling and Underground Space Technology* (submitted).
- 71)S.-H. Kim and F. Tonon, Face stability and required support pressure for TBM driven tunnels - undrained case. *Tunnelling and Underground Space Technology* (submitted).
- 72)F. Tonon, Using Extended Interval Algebra in Discrete Mechanics. *Reliable Computing* (submitted).

12.3.2 Refereed conference proceedings

- 1) A. Bernardini and F. Tonon, A combined Fuzzy and Random Set approach to the multiobjective optimization of uncertain systems. *Proc 7th Specialty ASCE Conf. on Advances in Probabilistic Mechanics and Structural Reliability, PMC 96*, 7-9 August 1996 Worcester, Massachusetts, USA, 314-317. ASCE, New York, 1996.
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- 3) A. Mammino, Cadrobbi L., Valle C. and Tonon F. Stabilization of a huge rock block overhanging the inhabited area of Zambana Vecchia (Province of Trento, Italy). *Proc. ISRM International Symposium on Prediction and Performance in Rock Mechanics and Rock Engineering EUROCK '96* (G. Barla, ed.), Torino, Italy, 2-5 September 1996, Vol.1, 589-596. Balkema, Rotterdam, 1996.
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- 8) F. Tonon, B. Amadei and D.M. Frangopol, Far-field stress estimation in tunneling using a Bayesian approach. *Proc. 8th ASCE Joint Specialty Conf. on Probabilistic Mechanics and Structural Reliability PMC00*, University of Notre Dame, Notre Dame, Indiana, USA, July 24-26, paper 253. ASCE, Reston, VA, 2000.
- 9) F. Tonon and B. Amadei, Detection of weak rock mass ahead of a tunnel - a numerical investigation. *Proc. 4th North American Rock Mech. Symp. "Pacific Rocks: Rock Around the Rim"*, University of Washington, University of Washington, Seattle, WA, USA, July 31 - August 3, 2000, 105-111. Balkema, Rotterdam.

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- 12) A. Mammino, L. Tonon and F. Tonon, Risk analysis as a design tool in the fire-safety retrofit of two Italian tunnels. *Proc. 81st Transportation Research Board Meeting*, Washington, DC, January 13-17, 2002. TRB, Washington, DC.
- 13) A. Mammino and F. Tonon, Replacement of Pontesei bridge, Italy. *Proc. First Int. Conf. On Bridge Maintenance, Safety and Management, IABMAS '02*, Barcelona, Spain, July 14-17, 2002, 191-192.
- 14) F. Tonon, A. Mammino and A. Bernardini. Multiobjective Optimization under Uncertainty in the Design of Tunnel Support/Reinforcement. *ModeFrontier Users Meeting 2002*. October 2-4, 2002, Bergamo, Italy.
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- 16) A. Mammino, F. Tonon, E. Siviero, B. Brisegella, P. Faccio, T. Zordan, A new tunnel for the city of Mestre, Italy. *Proc. ACUUS 2002 - International Conference "Urban Underground Space: a Resource for Cities*, November 14-16, 2002, Turin, Italy.
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- 22) F. Tonon and C. Pettit, Structural reliability application of correlation in random-set valued variables. *Proc. 9th ASCE Joint Specialty Conf. on Probabilistic Mechanics and Structural Reliability, PMC04* (Wojtkiewicz, S., Ghanem, R. and Red-Horse, J., eds.), Albuquerque, NM, July 26-28, 2004, Paper no. 08_201. ASCE, Reston, VA.

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- 24) F. Tonon and S. Chen, Inclusion properties for random relations under the hypotheses of stochastic independence and non-interactivity. *Proc. Third M.I.T. Conference on Computational Fluid and Solid Mechanics*, Massachusetts Institute of Technology, (Cambridge, MA, USA), June 14-17, 2005.
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- 26) F. Tonon and S. Chen, Closed-form and numerical solutions for the probability distribution of discontinuity diameters. In *Proc. Alaska Rocks - 40th U.S. Rock Mechanics Symposium* (Anchorage, Alaska, USA), June 25-29, 2005, paper 05-832.
- 27) F. Tonon, Some open questions in reliability and risk analysis, *Proc. 11th International Conference of IACMAG*, the International Association of Computer Methods and Advances in Geomechanics, (Torino, Italy), June 19-24, 2005, Vol. 4, pp. 263-271. Patron Editore, Bologna, Italy. **Invited issue lecture.**
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- 29) F. Tonon, Using Extended Interval Algebra in Discrete Mechanics. NSF Workshop “Reliable Engineering Computing 2006: Modeling Errors and Uncertainty in Engineering Computations”, Rafi L. Muhanna and Robert L. Mullen eds., February 22-24, 2006, Georgia Institute of Technology, Savannah. <http://www.gtsav.gatech.edu/workshop/rec06/index.html>.
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- 32) F. Tonon and J.T. Kottenstette, Laser and photogrammetric methods for rock face characterization: a workshop. In *Proc. of the workshop “Laser and photogrammetric methods for rock face characterization”*, F. Tonon and J.T. Kottenstette eds., Golden, CO, June 17-18, 2006, 5-12; 2007 American Rock Mechanics Association (ARMA).
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- 36) P. Asadollahi and F. Tonon, Validation of general single rock block stability analysis. In Proc. *San Francisco Rocks – 42nd U.S. Rock Mechanics Symposium* (San Francisco, CA, USA), June 29-July 2, 2008, paper 50. ARMA, Washington, DC, USA.
- 37) F. Tonon, ADECO as an alternative to NATM: how it works, why it works. In Proc. *Rapid Excavation and Tunneling Conference (RETC) 2009*, Las Vegas, NV, June 14-17, 2009. Society for Mining, Metallurgy, and Exploration, Inc., Englewood, CO, USA.
- 38) Y. Wang and F. Tonon, Discrete element modeling of impact fragmentation in rock fall analysis. In Proc. *Asheville Rocks 2009, 43rd US Rock Mechanics Symposium and 4th U.S.-Canada Rock Mechanics Symposium*, (Asheville, NC, USA) June 28 – July 1, 2009, paper 153. ARMA, Washington, DC, USA.
- 39) P. Asadollahi and F. Tonon, Anisotropy of the strength, deformability, and dilatancy of rock fractures. In Proc. *Asheville Rocks 2009, 43rd US Rock Mechanics Symposium and 4th U.S.-Canada Rock Mechanics Symposium*, (Asheville, NC, USA) June 28 – July 1, 2009, paper 54. ARMA, Washington, DC, USA.
- 40) F. Tonon, ADECO as an alternative to NATM: 22 m wide, 14 m high full face tunnel excavation in clays. In Proc. *North American Tunneling Conference 2010*, Portland, OR, June 20-23, 2010. Society for Mining, Metallurgy, and Exploration, Inc., Englewood, CO, USA.
- 41) Y., Wang, F., Tonon, G. B., Crosta, F., Agliardi, Z.M. Zavodni, Rock Fragmentation Module in 3-D Rock-fall Analysis. In Proc. *44th US Rock Mechanics Symposium and 5th U.S.-Canada Rock Mechanics Symposium*, (Salt Lake City, UT, USA), June 27 – 30, 2010. ARMA, Washington, DC, USA.
- 42) P. Asadollahi and F. Tonon, Stability of Rock Blocks Subjected to High-Velocity Water Jet Impact. In Proc. *44th US Rock Mechanics Symposium and 5th U.S.-Canada Rock Mechanics Symposium*, (Salt Lake City, UT, USA), June 27 – 30, 2010. ARMA, Washington, DC, USA.
- 43) F. Tonon, Analysis of controlled deformations for tunneling in difficult conditions. In Proc. *GeoHunan 2011, Geotechnical Special Publications (GSP) 212-223* (Ghangsha, PRC), June 10-11, 2011. Invited Plenary Lecture. ASCE, Reston, VA, USA
- 44) R. Chen and F. Tonon, Rock fracture simulation for groundwater prediction in rock tunnels. In Proc. *Rapid Excavation and Tunneling Conference (RETC) 2011*, San Francisco, CA, June 19-22, 2011. Society for Mining, Metallurgy, and Exploration, Inc., Englewood, CO, USA.
- 45) P. Asadollahi and F. Tonon, Safety factor of a rock block. In Proc. *45th US Rock Mechanics Symposium*, (San Francisco, CA, USA), June 26 – 29, 2011. Paper 11-468. ARMA, Washington, DC, USA.
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- 47) Y. Wang, F. Tonon and R. Guardia, 2D rock-fall simulations taking into account rock fragmentation. In Proc. *45th US Rock Mechanics Symposium*, (San Francisco, CA, USA), June 26 – 29, 2011. Paper 11-167. ARMA, Washington, DC, USA.
- 48) S. Kim and F. Tonon, Development of simple prism-and-wedge upper bound model for support pressure for undrained tunnel face. In Proc. *North American Tunneling Conference 2012*,

Indianapolis, IN, June 24-27, 2012, 255-266. Society for Mining, Metallurgy, and Exploration, Inc., Englewood, CO, USA.

- 49) X. You and F. Tonon, Decision analysis with Imprecise Probabilities: optimal exploration plan for underground construction. In Proc. *North American Tunneling Conference 2012*, Indianapolis, IN, June 24-27, 2012, 484-492. Society for Mining, Metallurgy, and Exploration, Inc., Englewood, CO, USA.
- 50) R. Chen and F. Tonon, Rock tunnel groundwater prediction in a simulated rock fracture network In Proc. *North American Tunneling Conference 2012*, Indianapolis, IN, June 24-27, 2012, 401-410. Society for Mining, Metallurgy, and Exploration, Inc., Englewood, CO, USA.
- 51) F. Tonon, Tunneling in Difficult Conditions – The Squeezing Case – Keynote Lecture. In Proc. *GeoCongress 2012: State of the Art and Practice in Geotechnical Engineering, ASCE Special Geotechnical Publication No. 225* (Oakland, CA, USA), March 25-29, 2012, 380-397. ASCE, Reston, VA, USA.
- 52) X. You and F. Tonon, Event Tree and Fault Tree analyses in tunneling with Imprecise Probabilities. In Proc. *GeoCongress 2012: State of the Art and Practice in Geotechnical Engineering, ASCE Special Geotechnical Publication No. 225* (Oakland, CA, USA), March 25-29, 2012, 2885-2894. ASCE, Reston, VA, USA.
- 53) P. Asadollahi and F. Tonon, Anisotropic dilatant behavior of rock fractures. In Proc. *GeoCongress 2012: State of the Art and Practice in Geotechnical Engineering, ASCE Special Geotechnical Publication No. 225* (Oakland, CA, USA), March 25-29, 2012, 3332-3341. ASCE, Reston, VA, USA.
- 54) F. Tonon, Photogrammetry for the Characterization of Rock Masses: Two Case Histories for Slopes and Caverns. In Proc. *GeoCongress 2019: Eighth International Conference on Case Histories in Geotechnical Engineering. ASCE Special Geotechnical Publication No.313*. March 24–27, 2019, Philadelphia, Pennsylvania. 223-229. ASCE, Reston, VA, USA .
<https://doi.org/10.1061/9780784482155.024>

12.3.3 Other articles

- 1) F. Tonon, Italy-USA Two different schools of engineering. *C.E.A.E. Newsletter* (K. Gerstle, ed.), Spring 1999, pp. 13-14, Department of Civil, Environmental and Architectural Engineering, University of Colorado at Boulder.
- 2) F. Tonon, Academia-industry partnership: something is moving. *Geostrata*, ASCE, pages 12 and 16.

12.3.4 Reports

- 1) F. Tonon, A. Bernardini and A. Mammìno, Handling Murphy's and anti-Murphy's laws in Rock Engineering through Random Set Theory : Part I parameters. Part II functions of parameters. Internal Report R.I. 01/97 – June 1997. Department of Structural Mechanics, University of Padua, Italy.
- 2) B. Amadei and F. Tonon, *In situ* stress measurements at Seminole Dam. US Bureau of Reclamation Contract 1425-97-CA-81-20003. August 2000.
- 3) F., Tonon, A.P., Raibagkar, H. Youn. Effect of Verification Cores on Tip Capacity of Drilled Shafts. University of Texas at Austin, Center for Transportation Research (CTR), 2008. (CTR 5825-1)

12.3.5 Guidelines

International Tunneling Association (ITA), Working Group 2: “Guidelines for Tunneling Risk Management”. *Tunnelling and Underground Space Technology*, 19, 2004, 217–237. DOI: 10.1016/j.tust.2004.01.001.

13. Rock Mechanics Laboratory

The laboratory is certified ISO 9001:2015 (DNV-GL), and it is authorized by the Italian Ministry for Infrastructures (N. 410 dated 27/11/2015).

ITEM	DESCRIPTION	
1a	Direct Shear Test (ASTM D5607): one intact rock specimen, 1 normal load; peak and residual shear loads, normal and shear displacements.	
1b	Direct Shear Test (ASTM D5607): one specimen containing one fracture, 3 normal loads; peak and residual at each normal load: peak and residual shear loads, normal and shear displacements.	
1c	Direct Shear Test at constant normal stiffness on a specimen containing one fracture in order to obtain the (shear stress)-(shear displacement) law under constant stiffness.	
1d	Determination of normal and shear stiffness of a fracture.	In addition to 1b or 1c
		Independent test
2	Uniaxial Compressive Strength without Static Moduli (ASTM D7012).	
3	Uniaxial Compressive Strength with Static Moduli (ASTM D7012)	
4a	Triaxial Test on Core Specimens Without Pore Pressure Measurements (ASTM D 7012) in Hoek cells (very hard rock and medium-high confinement) or in rapid triaxial cell (medium hard rocks and medium confinement). One Stage, one specimen.	
4b	Triaxial Test on rock core specimens without pore pressure measurements (ASTM D 7012) in triaxial cell with soft membrane (soft rock and/or low confinement). One Stage, one specimen.	
5a	Consolidated/Undrained (CIU or CAU) triaxial test on rock samples with pore pressure measurement (ASTM D 4767) in triaxial cell with soft membrane (soft to medium hard rocks). One Stage, one specimen.	
5b	Multistage Unconsolidated-Undrained Triaxial Test on intact rock or on specimen with a single fracture without pore pressure measurement in triaxial cell with soft membrane in order to determine the entire total stress failure envelope from a single specimen. One specimen.	
5c	Multistage consolidated/undrained (CIU or CAU) triaxial test on rock samples with pore pressure measurement in triaxial cell with soft membrane (medium to hard rocks) in order to determine the entire failure effective stress envelope from a single specimen. One specimen.	
6	Splitting Tensile Strength (Brazilian) (ASTM D3967).	
7	Slake Durability (ASTM D4644).	
8.1	Unit Weight (Bulk Density) of Rock (ISRM Suggested Methods).	
8.2	Porosity of Rock (ISRM Suggested Methods).	
8.3	Specific Gravity of Solids of Rock (ISRM Suggested Methods).	
9	Moisture Content in Rock by Mass (ASTM D2216, Method A or ASTM D4643).	
10	Atterberg Limits (rock: includes rock crushing and grinding) (ASTM D4318).	
6	Splitting Tensile Strength (Brazilian) (ASTM D3967).	
7	Slake Durability (ASTM D4644).	
8.1	Unit Weight (Bulk Density) of Rock (ISRM Suggested Methods).	
8.2	Porosity of Rock (ISRM Suggested Methods).	
8.3	Specific Gravity of Solids of Rock (ISRM Suggested Methods).	
9	Moisture Content in Rock by Mass (ASTM D2216, Method A or ASTM D4643).	
10	Atterberg Limits (rock: includes rock crushing and grinding) (ASTM D4318).	

ITEM	DESCRIPTION
11	Rebound Hardness - Schmidt Hammer (ASTM D5873).
12	Cerchar Abrasivity Index (ASTM D7625).
13	Point Load Test (ASTM D5731).
	NTNU-SINTEF tests for predicting drill bit consumption or penetration rate and abrasion of rock TBM cutters:
14	Sievers J-number Drillability test.
15	Abrasion Value test or Abrasion Value Cutter Steel test.
16	Brittleness value S20 test.
17.1	NTNU-SINTEF Soil Abrasion Test (SAT).
17.2	Slurry Abrasivity (Miller Number) (ASTM G75)
17.3	Slurry Abrasion Response (SAR) (ASTM G75).
18.1	Thin Section Petrographic Analysis on competent rock.*
18.2	Thin Section Petrographic Analysis on non-competent rock (requires impregnation).*
18.3	Thin Section Petrographic Analysis on soil (requires impregnation).*
18.4	Determination of Equivalent Quartz Content (in addition to 18.1, 18.2 or 18.3).
18.5	Determination of Quartz Content in Soil Based on Visual Appraisal
19	Pulse Velocity & Dynamic Elastic Constants (ASTM D2845).
20	Mohs hardness tests (Manual of Physical Geology).
21	Vickers hardness tests, 5 indentations. (ASTM E 384 REV A) *
22	Shore Scleroscope test, 5 measurements (ASTM D2240) *
23.1	Axial Swelling Stress Test (ISRM Suggested Methods for Laboratory Testing of Swelling Rocks 1999)
23.2	Axial and Radial Free Swelling Strain (ISRM Suggested Methods for Laboratory Testing of Swelling Rocks 1999)
23.3	Axial Swelling Stress as a Function of Axial Swelling Strain (ISRM Suggested Methods for Laboratory Testing of Swelling Rocks 1999)
24	Huder-Amberg swelling test (Wittke, Rock Mechanics) *
25.1	Bulk and Detailed Clay (<4 micron) X-ray diffraction (XRD) Analysis* (soil, rock with supplement)
25.2	X-ray diffraction analysis to identify clay minerals for soil* (soil, rock with supplement)
25.3	Bulk (Whole-rock) Only X-ray diffraction (XRD) Analysis (soil, rock with supplement)
26	Supplement for X-ray diffraction analyses on rock (includes grinding)*
27	SCHIMAZEK Index (Antraquip)
28	Hydraulic conductivity of intact rock (Matest manual)
29	Punch penetration test (EMI, Colorado School of Mines)
30.1	Sieve Analysis (ASTM D6913)
30.2	Hydrometer Analysis (ASTM D422)
31	Simplified geologic description (Manual of Physical Geology)
32	Determination of water absorption (UNI-EN 13755)
33.1	Determination of Frost Resistance, Test A, Flexural Strength (UNI-EN 12371 and 12372)
33.2	Determination of Frost Resistance, Test A, Compressive Strength (UNI-EN 12371 and 1926)
33.3	Determination of Frost Resistance, Test B, Identification (UNI-EN 12371)
34	Determination of flexural strength (UNI-EN 12372)
35	Absorption and Bulk Specific Gravity, on 5 cubes (ASTM C97)
36	Compressive Strength on 5 cubes (ASTM C170)

ITEM	DESCRIPTION
37	Modulus of Rupture on 3 points, 5 slabs (ASTM C99)
38	Flexural Strength on 4 points, 5 slabs (ASTM 880)
39	Supplement to Items 36-38 for 48 freeze and thaw cycles
40	LCPC Broyability (AFNOR, P18-579)
41	LCPC Abrasiveness (AFNOR, P18-579)
42	Jar Slake Test (P. Santi, 1998)
43	Chert Content in Limestone
44.1	Methylene Blue Index of Clay; on clay supplied by client (ASTM C837)
44.2	Methylene blue adsorption on rock, includes rock pulverization (ASTM C837)
45.1	Resistance of Coarse Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus (ASTM D 6928), on aggregate supplied by client
45.2	Resistance of Coarse Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus (ASTM D 6928) on rock, includes crushing
46	Mode I Fracture Toughness Using Cracked Chevron Notched Brazilian Disc (CCNBD) Specimens, without displacement measurement (ISRM 1995)
47	Consolidation Test on Rock up to 38,000 kPa (ASTM D2435/D2435M, Method A)
48	Cyclic Triaxial Test on Rock, one specimen, 1,500 cycles (Modified ASTM D5311/D5311M: no consolidation and no pore water pressure measurement). Plots of: deviator stress vs cycles, axial strain vs cycles, stress vs strain, stiffness vs cycles, damping vs cycles.
49	Uniaxial Creep Test with Measurement of Axial Strain (ISRM Suggested methods)
50	Volumetric Thermal Expansion (20°C to 80°C) (Larsson 2001)
51	Identification and Classification of Dispersive Clay Soils by the Pinhole Test (ASTM D4647)

Clients so far include: Fugro (USA, Central America, South America, Europe, Middle East), Kleinfelder, PB, Kiewit, Hatch Mott MacDonald, Black and Veatch, Holt Engineering, Shannon and Wilson, Lachel and Associates, HVJ, AMEC, URS-AECOM, S&ME, Freese and Nichols, InTEC, BHP Billiton, Coffey Engineering, Poyry, Rakita Exploration doo Bor, Freeport-McMoRan, Erdbau, Geolabor, Rio Tinto, Tecno Piemonte and COCIV, Golder Associates, AECOM, Stantec, Wood, Thurber, DLZ, Kiso, Georicerche Srl, Geoland Srl, GeoTec S.p.A, SCS – Società Costruzioni Specializzate.

Representative projects include: Devil's Slide tunnel (CA), Downtown tunnel (Austin, TX), Rosslyn shaft expansion (DC Metro), Apex tunnel (NV), Silicon Valley Rapid Transit Project (CA), Muni Project (San Francisco, CA), South IH-35 Utility Infrastructure implementation Plan (Austin, TX), Los Angeles Outfall (CA), DWU SW pipeline West (Dallas, TX), Jollyville Tunnel (Austin, TX), Northeast Wastewater 30-Inch Main (Austin, TX), Harris Branch Wastewater Interceptor (Austin, TX), SR 99 Tunnel Project (Seattle, WA), Waller Creek Tunnel (Austin, TX), Panama City Subway Project (Panama), Boggy Creek Water Line Replacement (Austin, TX), SAWS Western Expansion B (San Antonio, TX), White Point Landslide (CA), Delta Habitat Conservation & Conveyance Program (CA), Eglinton Scarborough Crosstown (Toronto, Canada), Dry Comal Creek Flood Retarding Structure (Austin, TX), Mansfield Dam Rehabilitation (Austin, TX), EWS-Coloso Mine (Antofagasta, Chile), Minera Escondida (Chile), Westside Subway Extension (Los Angeles, CA), NorthEast Interceptor Sewer (NEIS) (Los Angeles, CA), Regional Connector (Los Angeles, CA), 64-km long 8.1-m dia. two-tube Brenner Base Tunnel (Italy-Austria), Drumanard Tunnel (IN-KY), Guadalajara subway (Mexico), MSD Deer Creek Tunnel (MO), JWPCP Effluent Outfall Tunnel Project (Los Angeles, CA), Central Bayside Tunnel (San Francisco, CA), New sewer along Isarco river between Cardano and Bolzano (BZ, Italy), Anderson Dam Seismic Retrofit Project (CA), Chukaru Peki mine exploration (Serbia), Hass Underground Wine Cellar (BZ, Italy), Loango Field (Offshore Congo), 2015 Elko Area Expansion Project (NV), Jadar Mine Exploration (Serbia), Saint-Nazaire offshore Wind Farm (France), Courseulles-sur-mer offshore Wind Farm (France), Tunnels for the Third Giovi Crossing (Terzo Valico dei Giovi) high-capacity railway line (Italy), Lealholm Fault study (UK), Gwynt Y Mor offshore Wind Farm (UK), Purple Line Metro Westside Extension (Los Angeles, CA), Observation tower (Dubai, UAE), Nuclear Power Plant Moorside Site Characterization (UK), Newell Creek Dam (Santa Cruz, CA), Scarborough Subway Extension (Toronto, Canada), Acajutla Liquid natural Gas Facility (El Salvador), RDP Tributaries CSO Tunnel (St. Louis, MO), California High-

Speed Rail Palmdale to Burbank (CA), Lower Meramec CSO Tunnel (St. Louis, MO), Hornsby Bend Irrigation System Improvements (Austin, TX), SAR WWTP Sludge Transfer Line (Austin, TX), McLoughlin Point WWTP (Victoria, British Columbia), EBMUD Mokelumne Tunnel (Bixler, California), Central Bayside System Improvement Project – CBSIP- (San Francisco, CA), 15-116 Mastfundamente Vinschgerbahan (BZ, Italy), Burj 2020 700-metres (2,300 ft) megatall skyscraper (Dubai, UAE), Dubai Creek Tower, tallest tower in the world (Dubai, UAE), BMT Timok copper and gold Mining Project (Rakita Exploration d.o.o., Serbia), A31 Valdastico Nord Highway Tunnel (VI, Italy), S. Antonio Hydropower Power Plant Cavern Enlargement (BZ, Italy), 1,800-MW Grand Eweng Hep Dam Phase 2 (Cameroon), DS233 Sewage Terminal Pumping Station (Jebel Ali, UAE), 7-km long 9.5-m dia. Scolmatore Bisagno Tunnel (GE, Italy), Cross Island Line (CRL, Singapore), Minimum Vital Flow system for the Hydroelectric Power Plant in Tel (Bozen, Italy), RDP Tributaries CSO Tunnel (St. Luis, MS), Newell Creek Dam inlet/outlet works replacement (Santa Cruz Co., CA), Bouldin Island investigation (San Joaquin Co., CA), Mokelumne Delta Tunnel investigation (Sacramento, CA), Klamath River Dam Removal (CA), DFW Taxiway investigation (Dallas, TX), I-75 Tunnel Investigation (MI), Toronto Transit Commission Relief Line South subway (Toronto, Canada), Narragansett Bay CSO Phase III (Pawtucket, RI), DC 02-03 Tunnel (St. Louis County, MO), North Texas Municipal Water District Segment C (Leonard, TX), C1029 Site Investigation for Land Transport Authority (LTA) Singapore, Hatta Pumped Storage Plant project (UAE), DS233 - Dubai Tunnel Stormwater System (Jebel Ali, UAE), Ganda Landslide (Appiano, BZ, Italy), DS 233/2 Dubai Deep Tunnel Stormwater System (Dubai, UAE), Sanierung Hangrutschung Gaid (Bolzano, Italy), PBG SNA GEO3 (Saint-Nazaire, France), Jekon irrigation pipeline (Bolzano, Italy), I-20 Ranger Hill realignment project (Eastland County, TX), Energia Costa Azul Mid-Scale Project (Ensenada, Baja California, Mexico), River des Peres Tributaries Tunnel (St. Louis, MO), New Ship Canal for the Area Fiera del Mare (Genova, Italy).

14. Grants and contracts at the University of Udine

Co-Investigators	Title	Sponsor	Grant Total	Tonon's share	Grant Period
-	Use of white furnace slug to improve the engineering properties of dredged soil	Acciaierie Bertoli Safau S.p.a., Udine, Italy	7,700 EUR	7,700 EUR	9/2018 – 9/2019
-	Feasibility study for the stabilization of a sliding river bank in the Brugnera city center	Comune di Brugnera (Brugnera Municipality)	28,000 EUR	28,000 EUR	7/2017-9/2018

15. Grants and contracts at the University of Texas at Austin

My share of research funds reached \$1,680,294; total funds have reached \$4,145,306.

Co-Investigators	Title	Sponsor	Grant Total	Tonon's share	Grant Period
-	Analysis of single rock blocks for general failure modes	University of Texas, Austin; Summer Research Assistantship	\$22,000	\$22,000	6/2006-7/2006
-	Unrestricted gift	American Rock Mechanics Association	\$11,180	\$11,180	August 2006-August 2009
-	Three-dimensional rock-fall analysis with impact fragmentation and fly-rock modelling	Rio Tinto, Australia	\$218,370	\$218,370	September 2006-August 2009
Jeff Keaton (PI), Randy Knott, Su Mishra, Peter Lagasse, Mike Rucker and Larry Hansen, Raj Valluvan, Erik Bollaert, Bill Haneberg, Johannes Wibowo, Herbert Einstein	NCHRP Project no. 24-29. Scour at Bridge Foundations on Rock	National Cooperative Highway Research Program (NCHRP)	\$750,000	\$0	September 2006-August 2009
Robert Gilbert and David Fowler (UT)	Influence of Verification Cores on Point Bearing Capacity of Drilled Shafts	Texas Department of Transportation	\$343,237	\$343,237	September 2006-August 2008
-	Concrete flow at bottom of drilled shafts	BASF, in-kind contribution	\$1,000	\$1,000	August 2007
-	Degradation of shales around verification cores	International Association of Foundation Drilling (ADSC) , in-kind contribution	\$8,000	\$8,000	August 2007
-	Concrete flow into verification cores	McKinney Drilling Co., in-kind contribution	\$4,000	\$4,000	August 2007

Co-Investigators	Title	Sponsor	Grant Total	Tonon's share	Grant Period
Andrew Wimsatt (PI), Tom Scullion, Stefan Hurlebaus, Dan Zollinger, Soheil Nazarian, Parisa Shokouhi	SHRP 2 R06(G); High-Speed Nondestructive Testing Methods for Mapping Voids, Debonding, Delaminations, Moisture, and Other Defects Behind or Within Tunnel Linings	Strategic Highway Research Program (SHRP2)	\$1,650,000	\$109,562	September 2009-December 2012
Herbert Einstein (PI), Antonio Bobet (PI), Matthew Mauldon, Conrad Felice, L.R. Sousa, Eric Asa, L. J. Pyrak-Nolte, M. Kuchta, J. Rostami, E. Detournay, E. Labuz	Cavern Design for the Deep Underground Science and Engineering Laboratory (DUSEL)	National Science Foundation	\$44,374	\$1,800	September 2009-August 31 st , 2010
-	International Tunneling Consortium (ITC)	Santa Clara Valley Transportation Authority, JF Shea, Herrenknecht, Concrete Systems Inc, Donovan and Hatem, Gall-Zeidler Consultants, Fugro-Brierley Associates, Maccaferri, Grace.	\$340,000	\$340,000	September 2007-August 2013
-	Third-Party rock testing for tunneling and open cut projects	William Lettis Associates, Fugro, Kleinfelder, Parsons Brinkerhoff, Kiewit, Hatch Mott McDonald, Black and Veatch, Holt Engineering, Shannon and Wilson, Lachel and Associates, HVJ, Rio Tinto	\$642,745	\$542,745	March 2007-ongoing
-	Trial on-line tunneling course	Jacobs Associates, CH2MHill and Herrenknecht Tunnelling	\$5,400	\$5,400	January-July 2009
-	On-line Certificate in Tunneling	Students' fees	105,000	105,000	Sept. 2010-Aug. 2012

16. Teaching

16.1 University of Udine, Italy

- “Underground Excavations” (Fall 2018): graduate course.
- “Foundations and Earth Retaining Structures” (Fall 2018, 2019): graduate course.
- “Geotechnical Engineering”: undergraduate first course on geotechnical engineering (Fall 2017, 2018, 2019).
- “Soil Slope Stability and Rock Slope Stability”: graduate course that covers stability of slopes in soil and rock, and the relevant stabilization methods (Fall 2017).

16.2 University of Texas, Austin

- CE 357 “Geotechnical Engineering”: undergraduate first course on geotechnical engineering (Fall 2005, Spring 2006, Fall 2007, Spring and Fall 2008, Fall 2009).
- CE 311K “Introduction to Computer Methods”: undergraduate first course on numerical methods and programming (Spring 2007, Fall 2008, Spring 2010, Fall 2010).
- CE397 “Rock Engineering”: graduate course on rock mechanics as it applies to civil engineering applications (Fall 2006, Spring 2008, Fall 2009, Spring 2011). This course had not been offered at UT for over a decade.
- CE 397 “Geotechnical Seminar”: graduate seminar on tunneling with 13 invited speakers from the US and overseas (Spring 2007).
- CE 397 “Design and Construction of Tunnels”: graduate course that starts from the understanding of the three-dimensional behavior of a tunnel and the importance of the ground ahead of the tunnel face as a stabilization measure. Characterization of tunnel behaviors A, B, and C and their stabilization systems including pre-confinement (precut, pretunnel, fiberglass reinforcement, umbrellas of: jet-grouting, permeation grouting, micropiles and drains) and confinement (radial bolts and dowels, shotcrete, steel sets, one pass and two pass segmental lining, cast-in-place lining and invert, shield with face pressure control). Excavation methods: hard rock Tunnel Boring Machines and blasting, soft ground shield tunneling with Earth Pressure Balance Machines and Slurry Shields and their face support. Numerical and analytical methods for continuum and discontinuum (Spring 2009, Fall 2010).
- On-line Certificate in Tunneling. Addressed to engineers or engineering geologists who want to obtain a working knowledge of tunnel design or construction management. Conceived of the idea, developed curriculum and over 150 hours of recorded teaching, found and coordinated about 50 invited speakers that add about 150 hours of industry experience and case histories. The program has been endorsed by the International Tunneling Association (ITA); first program outside of Europe and first on-line program to receive the ITA endorsement. (Fall 2010, first cycle).

16.2.1 Supervised Ph.D. students

16.2.1.1 Graduated Ph.D. students

- 1) Heejung Youn (Fall 2008): “Effect of Verification Core Hole on the Point Bearing Capacity of Drilled Shafts”.
- 2) Yuannian Wang (Summer 2009): “Three-dimensional Rock-fall Analysis with Impact Fragmentation and Fly-rock Modeling”.
- 3) Pooyan Asadollahi (Summer 2009): “Stability Analysis of a Single Three Dimensional Rock Block: Effect of Dilatancy and High-velocity Water Jet Impact”.
- 4) Ran Chen (Summer 2010): “Prediction of Groundwater Inflow in Rock Tunnels by Simulating Fracture Clusters”.
- 5) Sang Yeon Seo (Summer 2010): “Macro-synthetic fibers and glass-synthetic fiber blends as Reinforcement of Precast Segmental Liners”.
- 6) Xiaomin You (Summer 2010): “Risk Analysis in Tunneling with Imprecise Probabilities”.

- 7) Seung-Han Kim (Summer 2010): “Face Stability in Soft-ground Mechanized Tunneling”.
- 8) Xin Xian (co-advised) (Spring 2010). “Application of Neural Networks to the Prediction of Fragmentation During Rock Fall”. Faculty of Engineering. China University of Geosciences (Wuhan).
- 9) Mahdi Heidari (Summer 2013): “Time-dependent Analysis of Jet-grouted Tunnels in Difficult Ground Conditions”.

16.2.2 Supervised MS candidates

16.2.2.1 Graduated MS students

- 1) Sang Yeon Seo (Spring 2008)
- 2) Anay Raibagkar (Summer 2008)
- 3) Edmanuel Carrasco (Fall 2010)
- 4) Moo Yeon Kim (Fall 2011)
- 5) Singh Vasudev (Spring 2008). Co-advised with Dr. Mukul M. Sharma, Dept. of Petroleum and Geosystems Engineering, University of Texas of Austin.
- 6) Simone Addotto (Spring 2009). Co-advised with Dr. Daniele Peila, Dept. of. Geoengineering Turin Polytechnic, Italy.
- 7) Marco Invernizzi (Spring 2009). Co-advised with Dr. Daniele Peila, Dept. of. Geoengineering Turin Polytechnic, Italy.
- 8) Moo Yeon Kim (Fall 2011)
- 9) Chris Guy (Fall 2011)
- 10) Iraklis Koutrouvelis (Spring 2012)
- 11) Mehran Hosseini Seyed (Spring 2012). Co-advised with Dr. Jon E. Olson, Dept. of Petroleum and Geosystems Engineering.

16.2.3 Graduate committees

16.2.3.1 Ph.D. students

Geotechnical Group (CAEE): Choi, Won Kyoung; Songcheng, Li; Jeon, Seong Yeol; Freilich, Brian Jeremy.
Structural Group (CAEE): Kang, Jun Won; Thammarak, Punctet.

16.2.3.2 MS students

Geotechnical Group (CAEE): Carlos Guzman.

16.3 University of Utah

16.3.1 New courses

- GEO 5150 “Geological Engineering Design”, new capstone design course for the Geological Engineering major. Senior undergraduate-beginning graduate level.
- Geotechnical week for GEO 4550 “Field Geology for GE majors”. Junior-senior undergraduate level.
- GEO 3075-5075 “Introduction to Geological Engineering”, new introductory course to the GE major (undergraduate). The course is also offered at the beginning-graduate level.
- GEO 6920-7920 “Discontinua Engineering” (special topic course) that attracted graduate students from geophysics and civil engineering, as well as professional engineers and engineering geologists. Graduate-advanced graduate level.

16.3.2 Innovations

- Design studio setting for GEO 5150 to bridge the students to a professional environment, in which their projects (reports and drawings) undergo systematic reviews to arrive at the final release.
- Oral exams for GEO 5150 and 6920-7920 designed to measure not only the students subject matter retention, but also overall engineering maturity and breadth (GEO 5150), and their skills at chalkboard exposition and verbal exchange.

- Site visits to construction sites as an integral part of the students' learning experience. Sites visited: Diamond Fork tunnel, UT (twice); Kennecott mine, UT.
- Clar compass to measure discontinuity orientation in one operation: students' learning curve was much shorter than with the Brunton compass, and productivity much higher.

16.3.3 Supervision of graduate students

16.3.3.1 Post MS students preparing to take Ph.D. qualifying exam

Chen, Song (eventually opted for an ME degree).

16.3.3.2 Graduate committees

- Farnsworth, Clifton B.: Ph.D. in geotechnical engineering, Dept. of Civil Engineering, University of Utah, advisor Dr. Steve Bartlett.
- Abdullah, Ozer T.: Ph.D. in geotechnical engineering, Dept. of Civil Engineering, University of Utah, advisor Dr. Evert Lawton.
- LaMeres, Bruce J.: M.S. in geotechnical engineering, Dept. of Civil Engineering, University of Utah, advisor Dr. Evert Lawton.
- Puri, Saurabh: M.S. in mining engineering, Dept. of Mining Engineering, University of Utah, advisor Dr. William G. Pariseau.

16.4 Teaching awards

Nominated for the 2003-2004 departmental teaching award.

16.5 Teaching workshops

- ASCE EXCEED workshop, summer 2006, West Point Academy;
- ASEE mini-course in teaching excellence for science and engineering faculty, "Fresh Perspectives on Teaching", the American Society for Engineering Education at the University of Utah

16.6 Seminars

16.6.1 Departmental seminars

Dept. of Geology and Geophysics, University of Utah, Distinguished Lecture Series: "The new ISRM suggested methods for rock stress measurement", February 26, 2004.

16.6.2 Invited seminars (presentation 6 and following given while at the University of Texas)

- 1) *A Fuzzy/Random Set Approach to the Multiobjective Optimization of Uncertain Mechanical Systems*. University of Padua, Dept. of Structural Mechanics: "Multicriterion optimization of uncertain systems and structures", Padua, Italy, June 21, 1995.
- 2) *Multiobjective Optimization of Uncertain Structures: a Fuzzy Set Approach with Application to the Design of Tunnel Lining in Hard Rock*. University of Padua, Dept. of Structural Mechanics: "A Fuzzy Seminar", Padua, Italy, October 2, 1995.
- 3) *Some Applications of Random and Fuzzy Set Theories to Tunneling*; GEODATA, Turin, Italy, June 20, 1996.
- 4) *Green's Functions and BEM Formulation in 3-D Generally Anisotropic Solids*. Technical University of Graz, Austria, June 22, 1998.
- 5) *Final Lining ahead of a Tunnel Face by Means of the Pretunnel System: Equipment, Case Histories, and Design Procedures*. MIR 2000 – Mechanized Tunneling'. On request of Prof. G. Barla, Dept. of Civil Engineering, Turin Polytechnic, Italy, December 5-6, 2000.
- 6) *Using Random Set Theory to solve Challenge Problem B as proposed by the Epistemic Uncertainty Project*. Sandia National Laboratories: "Epistemic Uncertainty Workshop", August 6-7, 2002, Albuquerque, New Mexico.

- 7) *Rock Mass Classifications and Some New Q-value Correlations for Site Characterization*. Utah branch of the Association of Engineering Geologists, Salt Lake City, UT, January 9, 2003.
- 8) *Toward a Definition and Understanding of Correlation for Variables Constrained by Random Relations*. University of Bristol, Dept. of Civil Engineering: “Uncertainty and Decision-making in Civil Engineering”, Bristol, UK, July 22-23, 2004.
- 9) *A Search Algorithm for Calculating Validated Reliability Bounds*. Georgia Institute of Technology, Dept. of Civil Engineering, and NSF: “Reliable Engineering Computing”, September 14-17, 2004. Savannah, Georgia.
- 10) *Multiobjective Optimization of Tunnel Linings with Case Histories*. Jacobs Associates, San Francisco, CA, Dec. 2, 2005.
- 11) *Using Extended Interval Algebra in Discrete Mechanics*. Georgia Institute of Technology, Dept. of Civil Engineering, and NSF: “Reliable Engineering Computing 2006: Modeling Errors and Uncertainty in Engineering Computations”, February 22-24, 2006. Savannah, Georgia.
- 12) *State-of-the-Art Technology for Large Diameter Transportation Tunnels*. Transportation Research Board Meeting. Washington DC. January 15th, 2008.
- 13) *From the ADECO-RS Approach to Tunneling Industrialization*. Transportation Research Board Meeting. Washington DC. January 15th, 2008.
- 14) *A defunct Project for a Single Tube Subway in Seattle*. Transportation Research Board Meeting. Washington DC. January 15th, 2008.
- 15) *ADECO: Engineering the Tunnel Core for Underground Excavation in Difficult Ground*. URS; Oakland, CA, September 16, 2008.
- 16) *ADECO: Engineering the Tunnel Core for Underground Excavation in Difficult Ground*. Caltrans; Sacramento, CA, September 17, 2008.
- 17) *ADECO: Engineering the Tunnel Core for Underground Excavation in Difficult Ground*. Obayashi; South San Francisco, CA, September 18, 2008.
- 18) *ADECO: Engineering the Tunnel Core for Underground Excavation in Difficult Ground*. AECOM, URS Joint Venture for Silver Line Phase 4; Boston, MA, October 27, 2008.
- 19) *ADECO: Engineering the Tunnel Core for Underground Excavation in Difficult Ground*. AECOM; New York, NY, January 26, 2009.
- 20) *ADECO as an Alternative to NATM: How it Works, Why it Works*. Rapid Excavation and Tunneling Conference (RETC), Las Vegas, NV, June 14-17, 2009.
- 21) *A Historical Excursus on Sequential Excavation, NATM and ADECO*. RockSoil 30th Anniversary Symposium, Milan, Italy, October 16, 2010.
- 22) *ADECO: Engineering the Tunnel Core for Underground Excavation in Difficult Ground*. Balfour Beatty; London, UK, May 25, 2010.
- 23) *Ground Freezing with Case Histories*. Cross-Rail; London, UK, May 26, 2010.
- 24) *ADECO: Engineering the Tunnel Core for Underground Excavation in Difficult Ground*. Shandong Transportation Institute, Jinan, PRC, June 7 2010.
- 25) *ADECO: Engineering the Tunnel Core for Underground Excavation in Difficult Ground*. Changsha University of Science and Technology, Changsha, PRC, June 8 2010.
- 26) *ADECO: Engineering the Tunnel Core for Underground Excavation in Difficult Ground*. Tongji University, Shanghai, PRC, June 11 2010.
- 27) *ADECO: Engineering the Tunnel Core for Underground Excavation in Difficult Ground*. Beijing Jiaotong University, Beijing, PRC, June 12 2010.
- 28) *Design of Tunnel Support*. Training course of the International Tunneling and Underground Space Association. Helsinki, Finland, May 20-21, 2011.
- 29) *ADECO: Engineering the Tunnel Core for Underground Excavation in Difficult Ground*. Hohai University, Nanjing, PRC, June 14 2011.

- 30) *Bounding Uncertainty in Civil Engineering: Motivation and Basic Concepts*. Tutorial at ISIPTA '11 - Seventh International Symposium on Imprecise Probabilities: theories and applications. Innsbruck, Austria, July 27, 2011.

17. Professional service

17.1 University of Texas, Austin

17.1.1 Service to the University Texas, Austin

Department Committees:

- Distinguished Lecture Series, Member: 2005-2009. Invited speakers: Dr. R.E. Goodman (4/2006); Dr. W. F. Brumund (10/2006); Dr. E. Cording (4/2008); Dr. P. Marinos (1/2010).
- CE & ARE Curriculum, Member: 2006-2007.
- Undergrad Recruiting & Retention, Member: 2005- present.

17.1.2 Service to the profession and the public

17.1.2.1 Workshops and Short Courses Organized

- Laser and Photogrammetric Methods for Rock Face Characterization. Sponsors: US Bureau of Reclamation, Federal Highway Administration, and Split Engineering; amount \$ 16,000. In conjunction with GoldenRocks 2006, 41st U.S. Rock Mechanics Symposium, Colorado School of Mines, Golden, CO, June 17 - 18, 2006. 40 participants from four continents.
- Laser and Photogrammetric Methods for Rock Tunnel Characterization. In conjunction with 42nd U.S. Rock Mechanics Symposium, San Francisco, CA, June 28 - 29, 2008.
- Introduction to Tunneling; 4-hour course developed from scratch and delivered. In conjunction with GeoCongress 2012: State of the Art and Practice in Geotechnical Engineering (Oakland, CA, USA), March 25, 2012.

17.1.2.2 Paper review activity

Member of editorial board for:

- 1) Int. Journal of Reliability and Safety, editor in chief Zissimos P. Mourelatos (Inderscience Publisher).
- 2) Engineering Geology, editor in chief Gian Battista Crosta (Elsevier).

Reviewer for the following journals:

- ASCE Journal of Geotechnical and Geoenvironmental Engineering.
- Rock Mechanics and Rock Engineering.
- International Journal for Numerical and Analytical Methods in Geomechanics.
- Engineering Geology.
- Mathematical Geology.
- Reliability Engineering & System Safety.
- American Institute of Aeronautics and Astronautics (AIAA).
- ZAMM: Journal of Applied Mathematics and Mechanics, Zeitschrift für Angewandte Mathematik und Mechanik.
- Information Sciences.
- Computer-Aided Civil and Infrastructure Engineering.

Reviewer for the following Agencies:

- The National Science Foundation.
- The U.S. Civilian Research & Development Foundation (CRDF).
- TRB Committee AFS20, Soils and Rock Instrumentation.
- TRB Committee AFP30, Soils and Rock Properties.

- TRB Committee AFF60, Tunnels and Underground Structures.

17.2 University of Utah

17.2.1 Service to the University of Utah

Department Committees:

- Geological Engineering (GE): member 2002-2005; interim chair (7/2003-12/2003).
- Undergraduate Internship: 2002-2005.
- Undergraduate Affairs: 2004-2005.

Student advisor:

Advisor of the University of Utah student chapter of Engineers Without Borders – USA (EWB-USA): a non-profit organization established to help developing areas worldwide with their engineering needs, while involving and training a new kind of internationally responsible engineering student.

2002: Proposed to redesign and drafted new undergraduate curriculum for the GE program in order to remove ABET deficiency on curriculum identified in 1997, 2000, and January 2002 visits (Criterion I.C.3.a.(3)); the deficiency was removed in 2003 visit, when the GE program was re-accredited. Removed ABET deficiency on major design experience (Criterion I.C.3.d.(3)) identified in 1997, 2000, and January 2002 visits by developing GEO 5150 from scratch. These two deficiencies led to non-accreditation of the GE program in the January 2002 visit, but were identified by the undersigned before joining the University of Utah in February 2002. Developed new website for the GE program, developed ties with the Department of Civil Engineering of the University of Utah, organized 2 site visits to construction sites for GE students.

2003: Introduced John F Wallace, P.E. and principal of IGES, as a new member of the GE constituency, finalized ABET self-study for re-accreditation, served as interim chair of the GE committee during Dr. W. Johnson's leave, coordinated ABET visit for re-accreditation, collected coursework material and conducted GE course assessment for ABET (Spring 2003 semester) with Dr. W. Johnson, organized 1 site visit to a construction site for GE students.

2004: Collected coursework material and conducted GE course assessment (Fall 03 semester) for ABET, prepared GE brochure, saved \$1,000 by printing 1,000 GE brochures "in house", distributed GE brochures at the Union, and Calculus I and II, posted GE brochures around campus, participated in 3/27/04 incoming freshmen orientation, prepared recruiting letter to incoming engineering students (with Dr. P. Jewell), prepared GE presentation and booth at 2004 Engineering Day. Passed the Fundamental of Engineering (FE) exam required of GE majors for obtaining graduation (spring 2004).

17.2.2 Service to the profession and the public

17.2.2.1 Conference sessions organized and chaired

- "Generalized models of uncertainty for engineering mechanics". Attracted 7 papers. *9th ASCE Joint Specialty Conf. on Probabilistic Mechanics and Structural Reliability, PMC04* (Wojtkiewicz, S., Ghanem, R. and Red-Horse, J., eds.), Albuquerque, NM, July 26-28, 2004. (With M. Beer and C. Pettit.)
- "Engineering with Blocky Rock Masses" and "Laser Scanning and Photogrammetric Techniques". *41st US Rock Mechanics Symposium*. Golden, CO, June 17-21, 2006.
- "Large Tunnels for Transportation Projects". Transportation Research Board Meeting, Washington DC, January 15th, 2008.
- "Deep excavations & retaining structures, New frontiers in urban geotechnology, Tunneling and underground constructions", *Geoshanghai 2010*, Shanghai, PRC, June 3rd-5th, 2010.
- 2012 ASCE Geocongress, Oakland, CA, March 25-29, 2012:
 - Characterization and design in rock mechanics
 - Design and construction of rock tunnels
 - Analytical and numerical methods in discontinuous media

- Uncertainty and risk analysis in rock engineering applications
- Characterization, treatment, and rehabilitation of dam foundations in rock
- 2013 ASCE Geocongress, San Diego, CA, March 3-6, 2013:
 - Design and Analysis of Rock Slopes.
 - Characterization of Soil and Rock.

17.2.2.2 Conference sessions chaired

- 1) Session 4.6 “Tunneling projects”. *Soil and Rock America 2003 - 12th Panamerican Conference on Soil Mechanics and Geotechnical Engineering and 38th US Rock Mechanics Symposium*, Cambridge, Massachusetts, June 22-25, 2003.
- 2) “Numerical Modeling of Discontinuous Rock Masses” *GeoFlorida 2010*, Palm Beach, FL, February 20-24, 2010.
- 3) “Tunneling II” *45th US Rock Mechanics Symposium*, (San Francisco, CA, USA), June 26 – 29, 2011.

18. Other activities

(11)1996-(10)1997 Civil Service in Italy.

1999-present: Translation from Italian into English of grant proposals addressed to the European Community for the Architecture and Civil Engineering Departments of the Universities of Ancona and Venice, Italy, and of technical papers for Parsons Brinckerhoff (USA).

Fulvio Tonon, P.E, Ph.D.

March 10, 2020

