MALEK M. SMADI, PH.D., P.E.

Senior Geotechnical Consultant Engineer

EDUCATION

- Ph.D., Civil Engineering , University of Illinois at Urbana Champaign, 2001
- Strategic Management, Harvard University, 2012
- M.S., Civil Engineering (Geotechnical Engineering), Jordan University of Science and Technology, 1991
- B.S., Civil Engineering, Jordan University of Science and Technology, 1988

PROFESSIONAL REGISTRATION

- Professional Engineer, Indiana, No. PE10505390
- Professional Engineer, Iowa, No. 16962
- Professional Engineer, Illinois, No. 062.066716
- Professional Engineer, Ohio, No. 79428
- Professional Engineer, Michigan, No. 6201061574
- Professional Engineer, Kentucky, No. 30363
- Professional Engineer, Missouri, No. 2015023714
- Professional Engineer, Connecticut, No. PEN.0031923

PROFESSIONAL SUMMARY

Dr. Smadi has 28 years of experience in geotechnical engineering 17 of them in Indiana. He worked for about 5 years at Indiana Department of Transportation (INDOT) as Geotechnical Design Team Leader. His team was responsible for the geotechnical work covering three districts, Greenfield, LaPorte and Seymour. He provided geotechnical engineering services which include highways, railroads, tunnels in soft clay and rock, shafts in soils and rock, instrumentation programs, multi span and long span bridges, airport facilities, stadiums, embankments and levee evaluations and designs, industrial plants, high rise and commercial structures, water and wastewater treatment plants, power generating stations, hydropower structures and dams, waterfront and docking facilities, slope stabilization and retaining structures. Dr. Smadi taught the soil mechanics course at Purdue University at Fort Wayne. Dr. Smadi through his research at University of Illinois at Urbana-Champaign developed simplified method to calculate horizontal deformation under foundations, tunnels, retaining walls, embankments, levees and dams. He is the recipient of the 1998 Ralph B. Peck Fellow for Outstanding Achievement in Geotechnical Engineering at UIUC and the 2011 State of Indiana Governor Spot Bonus Award for Excellence in High Performance.

PROFESSIONAL EXPERIENCE

Principal Engineer
GEOTILL

- Dr. Smadi provided geotechnical engineering services which include airport facilities, tunneling, stadiums, embankments and levee evaluations and designs, multi span and long span bridges, highways, railroads, industrial plants, high-rise and commercial structures, water and wastewater treatment plants, power generating stations, hydropower structures and dams, waterfront and docking facilities including the hydrodynamic pressure resulting from earthquakes, slope stabilization and retaining structures. Dr. Smadi developed instrumentation packages for many projects. The instrumentation packages included analyzing data and subsurface soil with data assessment and conclusions. Currently, Dr. Smadi Coauthoring a book titled "Geotechnical Field Instrumentation and Automation". The book will have full chapter about "Instrument systems for soft ground and rock tunnels"

Adjunct Faculty
Purdue University at Fort Wayne

- Dr. Smadi taught courses in the area of geotechnical engineering and in related areas such as soil mechanics and foundation engineering.

Geotechnical Design Team Leader
Indiana Department of Transportation (INDOT)

- Group Leader / Supervisor in the Division of Production Management, Office of Geotechnical Engineering. Responsible for developing the Department's geotechnical design strategies, policies, and procedures. Independently develops geotechnical design policies, procedures, and directives based on field observation & testing. Prepares and/or reviews plans and design for state, city, and county highway improvement projects, new construction, bridge replacement, roadway rehabilitation, etc. Provides engineering advice regarding design and rehabilitation strategies to geotechnical and design consultants, and public agencies. Assigns work to the team members and monitors the performance and productivity of the individual team members.

- In charge of the instrumentation design programs and interpretation of monitoring data for all Indiana department of transportation projects.

- Managed the installation of monitoring instrumentation including vibrating wire piezometers, slope inclinometers, tiltmeters, settlement plates, pressure cells, soil extensometers and accelerometers.

- Reviewed instrumentation monitoring reports.

- Performed and reviewed initial calibration and monitoring of instrumentation.

- Developed and implemented several landslide monitoring sites that provided real-time data. The data is then accessed via internet and provided to the engineers. Solar

powered battery systems provided power to the site instrumentation. Instrumentation was programmed to record data hourly, except during times of intense precipitation when data was recorded every 15 minutes.

Projects Experience

- **Pressure Tunnel Chile, South America.** The adduction tunnel is considered to be a fundamental part for the operations of the hydroelectric central El Paso, located in the central southern part of Chile. The head difference in the adduction tunnel is 490 m. The hydroelectric central consist of a water intake. a pressure tunnel 4.5 kms long and an underground machine house. The slope throughout the tunnel is approximately 11%. The design flow is 8 m3/s. The adduction tunnel is intercepted by an access window of 322 m length. The intention of this window is to have 2 construction fronts. The tunnel construction will be excavated in stratified rock mass. The rock quality in general is considered to be of medium quality. Dr. Smadi designed the tunnel linning in order to provide stability to the rock mass.

- **Evanston Tunnel in Chicago Clay.** Participated in the instrumentation program for the tunnel. The sewer tunnel for the City of Evanston was 4300 ft in length and 12 ft in diameter, excavated at an average depth of 36 ft using a conventional Lovat shield. Typical subsurface conditions: fill over glacial silty clay deposits resting on limestone. The project involved monitoring program, installed, calibrated and monitored geotechnical instruments in three test sections during and after tunneling. Instruments in tunnel lining included load cells, curvometer-distometer integrated system and tape extensometer. Instruments surrounding the tunnel included deep settlement points, pneumatic piezometers and inclinometer-Sondex system. Instruments at the ground surface included masonry nails and 4-ft-long settlement points. In addition, monitored about 25 other stations composed of masonry nails and 4-ft-long settlement points, and monitored adjacent houses close to the tunnel alignment. .

- **Geotechnical Instrumentation Program - Doha Metro - Red Line Tunnel, Doha, Qatar.** Prebid study and geotechnical proposal for evaluation of ground behavior and support requirements in the tunnel during construction and instrumentation of concrete segment supports, and ground movements in and around the tunnel opening. The tunnel was designed to be constructed in a drill and blast sequence with the installation of the primary liner followed by the secondary liner. The tunnel has a bore diameter of 24.2 ft with a finished diameter of 20.2 ft. The tunnel length about 8.7 miles and depth of about 82 ft from the existing ground surface. The other significant structures along the alignment are the interchange/modal stations. The depth of the excavation for the station was 82 ft deep to be constructed using diaphragm walls with excavation sequence from top to bottom. We established the need for monitoring at each of the interchange stations and every 650 ft along the tunnel alignment. Each monitoring station had inclinometers, piezometers and ground surface settlement points, in addition, the vibration monitoring during rock blasting activities. The instrumentation program included 41 conventional inclinometers, 222 real time inclinometers, 610 vibrating wire piezometers, 733 settlement points and 8 vibration monitoring equipment

- **Los Angeles Metro - Red Line Segment 1, CA,** A consulting service to provide comprehensive investigations of the existing conditions and structural integrity of tunnels for the Los Angeles County Metropolitan Transportation Authority (LACMTA). Twin tunnels of 7 km in length and 6.4 to 6.7 m in diameter excavated in alluvium and weak sedimentary rocks at depths of 6 to 28.5 m. Participated in

analyzing available pre-bid geotechnical data, construction history, lining thickness records and grout placement records. Participated in analyzing ground penetrating radar investigation data, lining cores and post-construction tunnel survey data (such as crack patterns, flow lines and groundwater inflow locations on lining).

- **US 31 / Indiana Department of Transportation / Indianapolis, IN.** Soft compressible marl soils are present to depths of over 70 feet at this location. Roadway widening and culvert replacement/extension will place new fill loads on this marl stratum. To limit post-construction settlement of the marl to acceptable levels, the design included in the contract at this project location incorporates Expanded PolyStyrene (EPS) fill in the embankment. Conventional earth fill is included over the EPS for load distribution and to provide weight to resist buoyancy of the EPS during the design flood condition. The design also includes a geomembrane over the EPS for protection against petroleum spills, and an 8-footconstruction phase surcharge load over the EPS , to further limit post-construction settlement. In order to control power water pressure and deformation during construction, Dr. Smadi design instrumentation program that include vibrating wire piezometers, multi-level VW piezometers, inclinometer, settlement cells and settlement extensometers.

- **Milton-Madison Bridge over Ohio River / Indiana Department of Transportation, IN.** Reviewed and approved all the geotechnical and foundation design including field instrumentation program for the bridge that has construction cost of about $106 million. The bridge included replacing the old bridge except for several piers in the waterway that were rehabilitated and widened to accommodate a new, wider steel-truss superstructure. Scour mitigation also performed on the existing piers. The new bridge was designed to close for only 10 days during construction rather than an anticipated year-long closure. The design used an innovative construction method called “truss sliding” to “slide” the 2,427 -foot-long truss into place along steel rails and plates and “slide” into place atop the existing piers. This construction method made the bridge the fastest modern-day bridge built across the Ohio River.

- **Ingredion Expansion / Indianapolis, IN.** Geotechnical and foundation design for the Ingredion expansion project in Indianapolis that has construction cost of about $110 million. The project consisted of a 17,500-square-foot building at Raymond Street plant to house a fourth spray dryer and a 15,500-square-foot building at Drover Street plant that would house a second fluid bed reactor, a specialized device to control the temperature of materials during processing.

- **Super Interstate I-70 / Indiana Department of Transportation / Indianapolis, IN.** Designed the highest MSE wall (Mechanically Stabilized Reinforced Earth Wall) in State of Indiana on Super Interstate I-70. The stretch of I-70 from the I-465 east leg to downtown of Indianapolis is one of the most heavily traveled roadways in the state of Indiana, carrying nearly 180,000 vehicles per day. The MSE wall for the overpass at Sherman Drive was made to improve visibility and drainage (I-70 previously used to pass underneath Sherman Drive).

- **Lucas Oil Stadium / Indiana Stadium and Convention Building Authority (ISCBA) / Indianapolis, IN.** Calculated the lateral movement in the soil mass that is located under 60x20x10 feet spread footings that support the super columns. The structure included a concrete frame seating bowl with a structural steel roof system that has construction cost of about $720 million. Typical column loads were in the range of 500 to 2,500 kips/column, although loading on four super columns were as

great as approximately 12,000 kips/column. Lucas Oil Stadium is a state-of-the-art retractable roof, multi-purpose facility seating over 67,000 people.

- **Kokomo Baseball Stadium / City of Kokomo, IN.** Geotechnical and foundation design for the Baseball Stadium project that has construction cost of about $18 million. The Stadium has a capacity of 4,000 people in lawn and fixed seating. It has a suite level, concessions, restrooms, and locker rooms for both teams. The facility is specifically designed to host baseball games, but can also be converted for soccer, concerts or other events.

- **Interstate I-74 Slide Correction / Indiana Department of Transportation / Dearborn County, IN.** Introduced for the first time in the State of Indiana the use of geofoam (EPS) to stabilize slopes on Interstate I-74 Slide Correction. The slide located about 1.5 miles east of SR 1 in Dearborn County, Indiana. The failed soil was removed under the Interstate for about 20 feet deep then light weight expanded polystyrene fill (EPS) was placed as fill material. Used the observational method to verify stability by installing real time inclinometers.

- **Geotechnical Engineering / T-Mobile USA, Inc. / Northeast Region, OH.** Geotechnical investigations for Communications Transmission Towers for over 40 guyed, freestanding and monopole 80 to 300 ft high cellular telephone transmission towers. In addition to projects for various clients involving high mast lights poles and power transmission poles.

- **Geotechnical Engineering / Indiana Department of Transportation / Switzerland County, IN.** Geotechnical investigation for State Road 56 Landslide Correction Project in Switzerland County, Indiana. The project included measures to correct a landslide-prone portion of State Road 56 which was constructed on the side of a hill that rises above the terrace in the Ohio River valley. The design and analysis included several anchored slopes and landslide stabilization systems. Then, based on the results of these analyses, tied-back, drilled shaft walls extending a minimum of 5 ft into the "competent" bedrock have been designed to correct the slides. Used the observational method to verify stability by installing inclinometers along the alignment.

- **Geotechnical Engineering / Indiana Department of Transportation / Lake County, IN.** Geotechnical investigation for Indiana Toll Road Improvement projects (Interstate 90 – Milepost 21, Intersection of I-90 and I-94) in Lake County, Indiana. The project included 13,000 ft of drilling. The design and analysis included twenty two major bridges over, I-90, I-94, railroad and other streets, mechanically stabilized earth retaining walls, steel H-piles, drilled piers, ground improvement to prevent potentially excessive settlement beneath mechanically stabilized earth retaining walls and conventional earth embankments.

- **Geotechnical Engineering / Indiana Department of Transportation / Lake County, IN.** Geotechnical investigation for Indiana Toll Road Improvement projects (Interstate 90 – Milepost 10) in Lake County, Indiana. The design and analysis included three major bridges over the Grand Calumet River, railroads and other streets, one concrete arch bridge, one continuous bridge 2,000 feet long that runs partially over the Grand Calumet River, mechanically stabilized earth retaining walls, steel H-piles, pipe piles, drilled piers and auger-cast concrete piles, lightweight fill Embankments required due to potentially excessive settlement of a conventional embankment, conventional earth embankments, sheet pile and tangent pile retaining walls. In order to control settlement and deformation, full instrumentation program was implemented at this project.

- **Geotechnical Engineering / Indiana Department of Transportation / Lake County, IN.** Geotechnical investigation for Indiana Toll Road Improvement projects (Interstate 90 – Milepost 13) in Lake County, Indiana. The design and analysis included four major bridges over the Grand Calumet River and other streets, soil stabilization through soil mixing, mechanically stabilized earth retaining walls, steel H-piles and drilled piers, lightweight fill Embankments required due to potentially excessive settlement of a conventional embankment, conventional earth embankments. In order to control settlement and deformation, full instrumentation program was implemented at this project.

- **Geotechnical Engineering / Indiana Department of Transportation / Lake County, IN.** Geotechnical investigation for Indiana Toll Road Improvement projects (Interstate 90 – Milepost 15) in Lake County, Indiana. The design and analysis included three major bridges over railroad and other streets, mechanically stabilized earth retaining walls, steel H-piles, pipe piles and auger-cast concrete piles, lightweight fill Embankments required due to potentially excessive settlement of a conventional embankment and to prevent damage to sanitary sewers and petroleum pipline, conventional earth embankments. In order to control settlement and deformation, full instrumentation program was implemented at this project.

- **Geotechnical Engineering / Indiana Department of Transportation / Lake County, IN.** Geotechnical investigation for Gary Marina Access Road in Lake County, Indiana. The design and analysis included seven major bridges over railroads and other streets, mechanically stabilized earth retaining walls, steel H-piles, and drilled piers, conventional earth embankments.

- **Geotechnical Engineering / American Structurepoint, Inc. / Lawrenceburg, Dearborn County, IN.** Geotechnical investigation for U.S. Route 50 Bridge over Tanners Creek in Dearborn County, Indiana. The design and analysis included seven spans bridge that span over Shipping Street, Central Railroad of Indiana, the Lawrenceburg Conservancy District's flood control levee and Tanners Creek, steel shell encased concrete piles (pipe piles), mechanically stabilized earth (MSE) retaining walls, a conventional cantilever concrete retaining wall, modular block walls, conventional earth embankments, and modification of the existing subsurface materials by installing "rammed aggregate piers" (also known as "Geopiers") required due to potentially excessive settlement in the 20 ft of fill exists below areas of relatively high retaining walls and conventional earth embankments.

- **Geotechnical Engineering / Indiana Department of Natural Resources / Lowell, IN.** Performed geotechnical investigation for small earth dam to impound storm water on Rising Run Ditch in Lowell, Indiana.

- **Geotechnical Engineering / Public Service Indiana / Indianapolis, IN.** Geotechnical investigation for evaluating excessive differential settlement under the Elderly Housing Building. This project included design and specifying compaction-grouting solution to stop the settlement.

- **Geotechnical Engineering / Corps of Engineers / Lawrenceburg, IN.** Geotechnical Study for a levee near the Ohio River, Lawrenceburg, IN. Study included test borings, laboratory tests and engineering analyses for settlement and stability of shale fill embankments over soft clay foundations to heights of 40 ft. Special considerations included analysis of slope protection and stability analyses for stage construction as well as long term performance. In order to control settlement and deformation, full instrumentation program was implemented at this project.

- **Geotechnical Engineering / American Structurepoint, Inc. / Dearborn and Ohio County, IN.** Geotechnical Study for highway widening project, State Road 56 between Rising Sun and Aurora, Indiana. The major geotechnical challenges in this project due the fact that the highway passes through unstable steep zones with pre-exciting shear surfaces near the Ohio River. In order to control settlement and deformation, full instrumentation program was implemented at this project.

- **Geotechnical Engineering / Anderson Municipal Light & power / Anderson, IN.** Performed geotechnical investigation for electrical substation that includes transformers, switchgear and A-frames. The study included test borings, laboratory testing and analyses to control the stability and settlement of the structures.

- **Geotechnical Engineering / Marathon Ashland Petroleum Illinois Refinery / Robinson, IL.** Performed geotechnical investigation for Nitrogen Plant in Robinson, Illinois. The main elements of the project include a cold box structure, a buffer vessel and a booster. This project included test borings, laboratory testing, design mat foundation and shallow spread footings.

- **Geotechnical Engineering / Meijer, Wal-Mart, Target, Home Depot, Kroger and Kohl's / Indiana, Illinois and Ohio.** Performed geotechnical investigation for many retail stores in Indiana, Illinois and Ohio. The studies include soil borings, laboratory testing, engineering analyses for bearing capacity of spread footings, floor slabs, pavement design and recommendations regarding construction and dewatering.

- **Geotechnical Engineering / Indiana-American Water Company, Inc. / IN.** Performed geotechnical investigation for many water storage tanks in Indiana. The studies include soil borings, laboratory testing, engineering analyses for bearing capacity of spread footings, mat foundation or a "ring-type" foundation and recommendations regarding construction and dewatering.
- prepared cost estimates for changes.

PRESENTATIONS AT CONFERENCES AND UNIVERSITIES

- "Ground Improvement Methods Using Column-Type Techniques" Road School Conference at Purdue University, March 2016.
- "Design and Construction of Auger Cast Piles" Road School Conference at Purdue University, March 2015.
- "Mechanisms and Mitigation of Highway Landslide Collapse" Road School Conference at Purdue University, March 2014.
- "Control of Embankments Construction Using Instrumentation by Observing Lateral Deformation" ASCE Conference, Indiana, April 2007.
- "Common Pile Driving Problems and Solutions" ASCE Conference, Indiana, April 2014.
- "Reinforced Slopes and Yeager Airport Runway Failure" ASCE Conference, Indiana, April 2016.
- "Sinkholes and Mines Subsidence under Bridge Abutments" County Bridge Conference, at Purdue University, November 2013.

TRAINING AND CERTIFICATIONS

- Dam Safety Technical Seminar, Emergency Management Institute, National Emergency Training Center
- ATC-20 "Post-earthquake Safety Evaluation of Buildings" under the supervision of the Illinois Emergency Management Agency
- Building Leadership Excellence, INDOT manager / leadership workshop series
- Design and Construction of Driven Pile Foundations, NHI Courses No. 132021 and 13022 offered by the Federal Highway Administration (FHWA)
- Drilled Shafts: Construction Procedures and LRFD Design Methods , NHI Course No. 132014 offered by the Federal Highway Administration (FHWA)
- Tunnel Safety Inspection, NHI Course No. 130110 offered by the Federal Highway Administration (FHWA)
- LRFD for Highway Bridge Substructures and Earth Retaining Structures, NHI Course No. 130082A offered by the Federal Highway Administration (FHWA)
- Design and Construction of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes, NHI Courses No. 132042 and 132043 offered by the Federal Highway Administration (FHWA)
- Soil Slope and Embankment Design, NHI Course No. 132033 offered by the Federal Highway Administration (FHWA)
- Soil and Foundations, NHI Course No. 132012 offered by the Federal Highway Administration (FHWA)
- Geotechnical Earthquake Engineering, NHI Course No. 13239 offered by the Federal Highway Administration (FHWA)
- Enhanced In-Situ Testing for Geotechnical Analyses and Foundation Design, Georgia Institute of Technology

PAPERS AND PUBLICATIONS

- Smadi, M.M. (1991). "Strength of Reinforced Cemented Granular Soils," Masters Thesis, Jordan University of Science and Technology, Jordan.
- Basma, A.A., Al-Homoud, A.S., Taqieddine, S., and Smadi, M.M. (1997). "Laboratory Studies on Factors that Influence the Strength of Reinforced Cemented Sand," Environmental and Engineering Geoscience, Vol. III, No. 3, pp. 411-422.
- Mesri, G., Shahien, M., Smadi, M. M., Alzoubi, M., Vardhanabhuti, B., and Ooraikul, A. (2000). "Potential Consequences of Earthquakes to Mid-America Waterfront Structures," Report submitted to Mid-America Earthquake Center.
- Smadi, M. M. (2001). "Lateral Deformation and Associated Settlement resulting from Embankment Loading of Soft Clay and Silt Deposits," Ph.D. Thesis, University of Illinois at Urbana-Champaign.
- Mesri, G., and Smadi, M. M. (2001). "Time-Related Increases in the Shaft Capacities of Driven Piles in Sand," Geotechnique, Vol. 51, No. 5, pp. 475-476.
- Smadi, M. M. (2008). “INDOT Geotechnical Manual,”
- Smadi, M. M. (2011). “INDOT Retaining Wall Design Manual,”

PROFESSIONAL ACTIVITIES

- American Society of Civil Engineers
- International Society for Soil Mechanics and Foundation Engineering
- Geo-Institute of A.S.C.E.
- Association of State Dam Safety Officials ASDSO.
- The Honor Society of Phi Kappa Phi – Recognizing and promoting academic excellence in all fields of higher education

AWARDS

- Recipient of the 1998 Ralph B. Peck Fellow for Outstanding Achievement in Geotechnical Engineering at UIUC
- Recipient of the 2011 State of Indiana Governor Award for Excellence in High Performance