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ALFREDO EDUARDO ARENAS ARMIJO

BIO

Dr. Alfredo E. Arenas, Numerical Modeling and Geotechnical Leader.

Dr. Arenas is a Principal Civil Engineer with 25 years of experience in geotechnical engineering. He has led important geotechnical and structural designs, such as Concrete Faced Rock Dams (CFRD), Mechanically Stabilized Earth (MSE) walls, waste dumps and tailings storage facilities. He has conducted Dam Safety Review (DSR) assessments and TSF inspections. Additionally, he has assessed slope stability and liquefaction potential for a multitude of projects. He has conducted seismic hazard analysis, including spectral matching of real seismic events and has conducted several dam breach analyses.

EXPERTISE

He has been the leader for numerical modelling in the civil and mining sectors, having developed this role in south America and Australia. He has led a multitude of analyses using FLAC/FLAC3D. He has modelled static and dynamic conditions, incorporating liquefaction potential analysis and cyclic compaction, using advanced constitutive models. He has developed a series of methodologies for delivering numerical analyses in a such a way that allow for the delivery of results in a short time and at reasonable low cost. Finally, he has developed a standalone software for producing high efficiency meshes for FLAC and FLAC3D within few hours.

He has worked for different client sectors, including numerical analyses for NASA, forensic analyses of civil structures under litigation, governmental institutions and important mining projects.

PERSONAL SKILLS

- Responsible, professional, ethical and a good communicator at all levels.
- Technical excellence, with solid formation to face any challenge.
- Analytical and practical decision maker.
- Team Leader.

JOB HISTORY

- Geo Meshing Engineering PTY LTD – CEO March 2025 to Present
- ATC Williams, Perth, Australia. Senior Principal Engineer – Feb 2024 to March 2025
- Red Earth Engineering, Australia Principal Engineer / Global Numerical Modelling team leader – April 2022 to Jan 2024
- Knight Piesold External Consultant – November 2022 to April 2023
- WSP/Golder Associates, Chile – Australia – March 2011 to March 2022.

- Independent consultant, NASA and others, USA – August 2004 to December 2010
- “Ministerio de Obras Publicas”, Chile – July 2000 to July 2004

EDUCACION

- Geotechnical Civil Engineering Pontificia Universidad Católica, Chile, 2000
- Masters in science Texas Tech University, USA, 2006
- Philosophy Doctor Virginia Tech University, USA, 2010

SUPPLEMENTAL SKILLS

Advanced user of software such as, FLAC, FLAC3D, Opensees, seep/w, slope/w, slide, phase 2, sigma/w. Advanced programmer in C++, C#, Visual Basic and WPF.

DEVELOPMENT

Geo Meshing Software

Geo Meshing is a software specifically designed for developing 3D meshes for FLAC3D® and 2D meshes for FLAC®.

Geo Meshing greatly simplifies the complex process of producing advanced 3D meshes for FLAC3D®, and therefore, reduces the cost associated with those tasks. The major advantage of Geo Meshing, when creating 3D earth structures, is the parametric input of the user interface, avoiding the need of developing 3D bodies prior to the meshing process. In addition, since it is parametric, modification of the mesh is as easy as changing one parameter value.

Likewise, Geo Meshing effortlessly produces meshes for FLAC®, automatically computing grid element numbers, ratios and geometries.

Although Geo Meshing was specifically tailored for FLAC3D® and FLAC®, it can also be used with other software by post processing and modifying the output files. This software has been used with other software such OpenSees and for dam breach analyses.

Free download from www.geomeshing.com.

SELECTED PUBLICATIONS

Green, R, A Arenas, J Lee and W Cameron. 2011.Conference Proceedings, Evaluation of various definitions for characteristic period of earthquake ground motions for site response analyses. 5th International Conference on Earthquake Geotechnical Engineering (ICEGE), January.

A. Arenas. Geotechnical Magazine. “New Meshing Algorithm”. Geotechnical News Magazine, September 2012, pg. 19 – 21.

A. Arenas. Geotechnical Magazine, “Geo Meshing – Free FLAC3D meshing tool”. Geotechnical News Magazine, June 2018, pg. 41 – 43.

A. Torres, A. Arenas. National Geotechnical Conference (IX Congreso Chileno de Ingenieria Geotecnica), “Compactacion Ciclica de Muros de Arena de Relave en Análisis Numerico”. December 2016

Cubillos, A. Arenas. National Geotechnical Conference (IX Congreso Chileno de Ingenieria Geotecnica), "Consideraciones para Modelamiento Numérico Bidimensional usando FLAC3D" December 2018

C. Vallejos, A. Arenas.National Geotechnical Conference (IX Congreso Chileno de Ingenieria Geotecnica), "Modelamiento Numérico del Embalse Murallas Viejas Efectos de Incorporar pantalla de Hormigón" December 2018

A. Arenas, Keynote speaker. National Geotechnical Conference (IX Congreso Chileno de Ingenieria Geotecnica), "Compactación Ciclica de las arenas de Relave" (tailing sand cyclic compaction) December 2018.

Alexandra Halliday, Alfredo Arenas. Tailing conference 2019, "Impacts of Topography Quality on Dam Breach Assessments" July 2019

Alexandra Halliday, Alfredo Arenas. Tailing and Mine Waste conference 2019, "The value of Detailed Topographic Survey for Consequence Classification Using Dam Breach Assessments" November 2019

A. Arenas. Symposium, FLAC3D Meshing Tool. 3rd International FLAC/dem Sysposium, October 2013, HangZhou, China.

Halliday, A., Vulpe, C., Fourie, A., Arenas, A., Valsaraj, N., Duong, M (2023). A comparison of finite element software for use in tailings applications. Submitted for publication ICOLD 2023 (June 2023), Gothemburg Sweden.

Halliday, A., Vulpe, C., Fourie, A., Arenas, A. (2023). Limitations of Classic Constitutive Soil Models and Their Suitability to Represent Tailings Behaviour. In: Barla, M., Di Donna, A., Sterpi, D., Insana, A. (eds) Challenges and Innovations in Geomechanics. IACMAG 2022. Lecture Notes in Civil Engineering, vol 288. Springer, Cham. https://doi.org/10.1007/978-3-031-12851-6_13

A. Arenas, D. Reid, R. Fanni, K. Smith, A.Fourie (2023). Numerical assessment of drilling-induced static liquefaction triggering of Feijão Dam I. Proceedings 10th NUMGE 2023. 10th European Conference on Numerical Methods in Geotechnical Engineering.

Halliday, A., Vulpe, C., Fourie, A., Arenas, A. (2022). Application of advanced constitutive soil models in tailings practice. Nov 2022: Tailings and Mine Waste Conference proceedings November 2022. Denver Colorado.

Kheirkhah Gildeh, H., Halliday, A., Arenas, A., & Zhang, H. (2021). Tailings dam breach analysis: a review of methods, practices, and uncertainties. Mine Water and the Environment, 40(1), 128-150.

Arenas A., Pereira N. (2024). Feijão Dam I 3D Numerical Simulation: a comprehensive approach, from triggering to dam breach. Proceedings of Tailings and Mine Waste 2024 November 10-13, 2024, Colorado, USA

Chang K., Fanni R., Reid D., Labanda N., Arenas A. Three-dimensional Extension of UBCHyst Constitutive Model: Implementation and Application. ICOLD Congress 2025.

Pereira N., Lines S., Arenas A. Considerations for 2D and 3D slope stability analysis for closure of a tailings storage facility. Mine Closure Conference, 2024, Perth Australia.

About This Resume

This resume is mostly focussed on presenting numerical modelling projects. Nevertheless, the reader is encouraged to see beyond this specific set of skills. In fact, to understand and produce state of practice / art numerical model analyses a series of competences are need. To name a few:

- **Solid technical background**: Dr. Arenas has completed undergraduate studies on geotechnical engineering (Chile, 2000) and post graduate studies in geotechnical engineering (MSc, 2004, PhD, 2010). This strong formation good leads to a comprehensive understanding of soil behaviour, applicable to different disciplines and areas of civil engineering.
- **Civil and Mining design knowledge**: Dr. Arenas has a wide experience in Civil and Mining structure designs. Knowing the design purpose and function is key to develop solutioned suited to client's needs.
- **Business oriented products**: Dr. Arenas has developed throughout his career methodologies to produce valuable products in reasonable times and within the budget. Dr. Arenas has an impeccable record of delivery on time.
- **Team leader**: Dr. Arenas usually leads anywhere from 1 to 6 projects simultaneously. This requires good leadership and communications skills.
- **Client oriented**. Dr. Arenas has vast experience with clients and ITRBs presenting the team's designs.

Roles and Positions Held

- **Responsible Technical Person (RTP):** Dr. Arenas took the role of responsible technical person for a TSF complex compromising 25 TSFs. In this role the main responsibilities were i) performing site annual site inspections, ii) submit the bi-annual Dam Safety Review (DSR) report and iii) assist the client with technical inquires to assure the active facilities are in compliance with current legislation (DMIRS) and standards (GISTM, ANCOLD, ICOLD).
- **Task Leader:** Dr. Arenas has been appointed on several occasions as a task leader on geotechnical components. He has the role to make key technical decisions that keep the projects moving forward and for completing the objectives on time.
- **Lead Designer:** Also, Dr arenas **h**as been appointed as lead designer. Where throughout his experience complete design are developed for the appointed job. One example is a CFRD dam detail design. This design involved structural components such as the concrete slab and plinth, and geotechnical engineering as well.
- **Due Diligence Principal:** Geotechnical main reviewer for company's new projects.
- **Field and Laboratory Campaign Leader:** Main engineer in charge of developing field and laboratory campaign, for suiting project's specific needs.
- **Principal Geotechnical Engineer Reviewer:** Peer and final reviewer on geotechnical matters, before and after analyses are completed.

Detailed Project Experience

PROJECT	DESCRIPTION
Mount Arthur Tailing Storage Facility, Numerical Modeling, BHP, Jan 2025, New South Wales, Australia	Numerical modeling for four 2D sections of the Mount Arthur mine site. The modeling included a static analysis by replicating the construction sequence of each 2D section. Once the geo static stresses were in place, a simplified dynamic total stress analyses was performed. Three spectrally matched seismic signals were imposed at the bottom of each 2D model. The model verified that deformations were tolerable and the facilities were stable.
Dam Safety Review (DSR), Narngulu TSF complex, Illuka, Dec 2024. Western Australia, Australia	Narngulu facility is composed of 25 TSFs, with seven of them being under active operation. Dr. Arenas lead the Dam Safety Review (DSR) assessment for this complex. The assessment of the complex was done in accordance with the following regulations: Department of Energy, Mines, Industry Regulation and Safety (DEMIRS), Tailings Storage Facility Audit – Guide (2017), DMP, Tailings Storage Facilities in Western Australia, Code of Practice (2013), ANCOLD Guidelines on Tailings Dams (July 2019) and Global Industry Standard on Tailings Management (GISTM, 2021).
Technical Responsible Person (RTP) for Narngulu TSF complex, Illuka, 2024 – 2025 Western Australia, Australia	Narngulu facility is composed of 25 TSFs, with seven of them being under active operation. The role involves supporting the client with geotechnical related decisions and also assisting the client with the TSF complex compliance. Among those functions are the Dam Safety Review (DSR) assessment and the regular sipe inspection and reporting.
Independent reviewer for Vaguada Norte, Cobre and Aguzadera TSF. Static and Dynamic Deformation, Rio Tinto, June – 2024, Spain.	Independent reviewer of static and dynamic analysis. Two detailed FLAC3D models were developed to assess the static and dynamic performance of each twin TSF (Cobre and Aguzadera TSFs). This is one of the permit requirements requested by local authorities, thus the TSF can operate at the new elevation of 417 m.a.s.l. Limited information was available for these analyses, making even more challenging the projects.
Bobadil Tailing Storage Facility, MMG Australia Limited, April 2024 to Feb 2025, Tasmania, Australia.	Static and dynamic analysis. Several evaluations of an upstream TSF facility covering from stage 10 raise to stage 12 raise. Static analysis covered a detailed construction sequence simulation and static liquefaction analysis using NorSand and P2PSand advance constitutive models. Both of them calibrated with field and laboratory data. Dynamic analysis performed with P2PSAnd constitutive model. The analysis covered the TSF evaluation under the 1:10,000 years earthquake event. Performance based response evaluated including strain, stresses, displacements, liquefaction potential, amplification and natura period response.

Las Bambas Storage Facility, MMG, August 2024, Apurimac, Peru

Static and dynamic analysis. Two section evaluations of a downstream TSF facility, the main and saddle dam. Static analysis covered a detailed construction sequence simulation, including structural element integration to represent the upstream liner system and the steeper slope grid reinforcement. Dynamic analysis performed under total stresses with UBCHyst constitutive model. The analysis covered the TSF evaluation under the 1:10,000 years earthquake event. Performance based response evaluated including strain, stresses, displacements, liquefaction potential, amplification and natura period response.

Independent reviewer for Huachacaja TSF. Static and Dynamic Deformation, April – 2024, Sociedad Minera El Brocal, Peru.

Independent reviewer of static and dynamic analysis. TSF founded in old glacial till, which is under layered by a lacustric deposit compromising alternances of sandy silt and silty clays, with high liquefaction potential. Analysis involved CPTu field testing to assess the lacustric deposit strength and state distribution, followed by laboratory testing to determine the critical state line and finally by the detailed P2PSand constitutive model calibration.

Independent reviewer for Cortadera TSF. Static and Dynamic Deformation, December – 2024, Quellaveco, Anglo American, Peru.

Independent reviewer of static and dynamic analysis. This TSF in its nineth raise is eliminating the geotextile placed in the upstream face. Numerical models were requested by local authorities to demonstrate that by eliminating the geotextile the impermeable upstream system is not compromising its integrity.

Independent reviewer for Antamina TSF. Static and Dynamic Deformation, 2023 – 2024, Ancash, Peru.

Independent reviewer of static and dynamic analysis of the tallest rockfill dam in the world. 7 different contracts. Elevation 4165 (280 m) therough 4180 (295 m) were analyzed with FLAC. In addition, FLAC3D models were developed for the system of the open pit, TUSEF waste dump and Antamina TSF, as well a detailed TSF model using up to 5 million elements. Strength and deformation properties were derived from large scale triaxial testing (1 m diameter) and large-scale odometer testing (60 cm diameter). Eight samples were sheared under four confinements. Half of the sample included 20 cycles of unloading and loading stress path to determine volumetric deformations.

Ramp 6 Stability and MPM analysis, December 2023. Perth, Australia.

A retrofit of Ramp 6 TSF crest required to widen it to allow traffic of bigger equipment. Given the completxity of the geometry and the material distribution, FLAC3D stability analysis using SRF was required to compute the 3D factor of safety. In addition, MPM breach analysis were carried out to determine the potential distance that the retrofitted facility slope might reach in case of failure.

Torro Deformation and stability analysis, July 2023, Perth, Australia

2D FLAC deformation and stability analysis were performed for two sections of Torro TSF. Extensive field and laboratory information was used to derive the advance parameters for consitutive models. The analysis included fully coupled construction sequence using Norsand model to determine the pre earthquake pore pressure distribution. P2PSAnd was calibrated for the dynamic analysis portion. Assessments for liquefaction potential and Static and Post Dynamic Stability were considered as well.

Geotechnical Principal Engineer at Red Earth Engineering, 2022 – 2023, Perth, Australia

Principal geotechnical engineer, task leader of geotechnical aspects for several projects. Among others; CPTu evaluation and analysis, state parameter interpretation, CPTu characteristic strength definition, design definition parameters, laboratory testing interpretation, slope stability analysis, flow analysis, trafficability assessment, field campaign definition, due diligence reviews, report reviews, on site audits, client business development, numerical modelling leader, etc.

Gemco MPM analysis, March 2023, Perth, Australia.

As part of the emergy plan for re mining Gemco TSF, it was required to calculate the potencial distance that a internal bench might reach in case of an hypothetical failure. A full 3D MPM analysis was performed for the TSF facility under the assumption of fully residual strength of the contractive material determined during CPTu field explaration. The results allowed to determine the safe distance at which work can be performed.

Stability Analysis, Pond 5, Rio Tinto, Perth, February 2023, Australia

In preparation for closure conditions, Pond 5 project, RT, needs to flatten the downstream slope of its TSF. Given that 2D limited equilibrium (LEM) analysis did not provide an optimal solution in term of earth work, a 3D numerical modelling was developed in FLAC3D for assessing the 3D stability. The stability assessment was done using SRF built in analysis tool. The 3D failure surface provided a higher factor of safety for similar conditions that were previously analysed using LEM. The results allowed the client to use the intended equipment, instead of a lighter option.

Geotechnical Engineer Consultant, Las Tortolas, March 2022, Santiago, Chile

2D and 3D numerical analysis for Las Tortolas sand stack TSF were requested to obtain deposition permits. The sand stack is mostly constructed with the downstream methodology. Given the limited mine space left for future raises, part of the dam went undergoing centre line construction, using MSE wall technique. One the main objective was to analyse the performance under the MCE earthquake for the maximum section, using a 2D model. In addition, a full 3D model was requested to assess the interaction of the centre line raise with the downstream line raise. The change of axis construction was also coincident with a change in dam alignment. Advance constitutive model P2PSAnd was used to simulate the tailing liquefaction process and HYST3D was used to simulate the hysteretic behaviour of the sand stack.

Stability and deformation Assessment, Granny Smith Mine, Phase II, March 2022, Perth, Australia

Performance analysis, stability and deformation, of section B and C of the tailing storage facility (TSF) of the Granny Smith gold mine. Continuation of the Phase I.

Stability and deformation Assessment, Alcoa, December 2021, Perth, Australia

Performance analysis, stability and deformation, of section RSA K and RSA F6 of the tailing storage facility (TSF) Alcoa. A first analysis of CPTU campaign, performed at each facility, revealed that the state parameter computed with Plewes was falling out of range. Therefore, widget methodology was used to calibrate and compute the field state parameter. Following the field information analysis, the advance constitutive model P2PSand was calibrated to reproduce key behaviours of the tailing material. Later this calibration was incorporated in 2D sections to analyse static liquefaction potential and dynamic response. Advance interpolation techniques were used to distribute and calculate the state parameter throughout the numerical model. Numerical modelling was used to optimize the buttress design.

Phase IV, Kennedy cape, NASA. 3D numerical analysis
June 2021
Florida
USA

NASA run full scale geotechnical field tests by rolling the crawler at different speeds and loads along the crawlway. The purpose of these tests is to monitor the loose materials underlying the crawlway to support numerical modelling. The rocket load was replicated by loading the crawler with concrete blocks. Several instruments were placed in the crawler path, including inclinometers, VWPs, load cells and topography prisms. After each pass of the crawler, the information was calibrated in the fully coupled – Biot theory 3D model and reported within a week. The calibration process was complex given the amount of information gathered from the field and the constrained response time. In addition, FOS were reported from SRF analyses from 3 different sources; classical approach of 2D sections, advanced 2D sections considering side shear forces and full 3D SRF analyses.

Granny Smith Mine. Section G and D. Lead designer. Numerical stability analysis
March 2021
Perth
Australia

Granny Smith Mine project is an upstream constructed TSF that comprises oxide, primary tailings and interbedded tailings. The geotechnical – geological foundation is a complex combination of cemented ferrierite soil, alluvial and paleochannel deposits, saprolite soils, weathered rock and sounding rock.

Supported the field and laboratory campaign and numerical modelling development as the lead consultant. The laboratory testing campaign included a comprehensive set of testing, comprising CIU, CID, CKoU, DSS and CDSS.

The variable tailings behavior was represented using the constitutive model P2PSand in a novel and advanced manner, calibrating a single set of parameters (24 in total), to represent drained, undrained, static and cyclic conditions. . Later this calibration was incorporated in 2D sections to analyse static liquefaction potential and dynamic response. Advance interpolation techniques were developed to distribute and calculate the state parameter throughout the numerical model. Static construction simulation, static liquefaction and dynamic analyses were performed for two 2D sections. The dynamic analyses were carried out for MCE and SEE levels, each considering two records.

The numerical modelling results allowed an optimization of the buttress design (designed with LEM methodologies), saving the client about 10 million dollars.

Quebradona TSF
December 2020
Jericó, Antioquia,
Colombia

Dry stack deformation and stability analysis, for static and dynamic conditions. The dry stack was built around and above a small heap leach embankment, potentially liquefiable, thus possibly jeopardizing the TSF stability. Geotechnical characterization, and drained constitutive model calibrations for the TSF, as well as undrained constitutive model calibration for the heap leach were performed as part of the project. The dynamic phase considered 3 MCE signals, spectrally matched to the 84th percentile of the DSHA.

Feasibility Engineering, Portezuelo Llau-Llau, El Mauro
September 2020
Región de Coquimbo
Chile

FLAC numerical model for a bidimensional section of the Portezuelo Llau-Llau secondary dam, El Mauro Dam. Model characterization based on available data. Development of a SEEP/W simple model to determine the pore pressure distribution for a given phreatic surface. Implementation of a FLAC code to add the resulting pore pressure for each gridpoint of the model.

Development of a deconvolution methodology using FLAC to calculate the input seismic signal in order to obtain the design spectrum at the model surface, for a base rock with variating shear wave velocity in depth. UBCHYST constitutive model calibration.

DRE Construction, Centinela
July 2020
Región de Antofagasta
Chile

FLAC numerical model for a bidimensional section of the Centinela DRE due to a change in the material to be used in the construction of the main dam. Two models were carried out for the MCE and OBE seismic condition to compare the displacement contours when considering a rockfill dam as original designed, and a combination of rockfill and borrow materials as updated.

Detailed Engineering – Magistral TSF Project.
June 2020
Provincia de Pallasca, Perú

Bidimensional numerical analysis of a tailing storage facility with a low permeability core at the main dam. Model with over 600.000 elements. Static analysis results for a centerline dam constructed by layers. The study considered the geotechnical characterization and model calibration for rockfill, colluvial foundation soil, tailings, compacted tailings, filter, transition materials, and low permeability material of the core. All of them for both, static and the dynamic condition.

An additional analysis was carried out for a change in the design of the main dam. Results were obtained for three seismic records spectrally matched to an 84th percentile design spectrum.

Spence Detailed Engineering – Ing. Aditional SGO
June 2020
Región de Antofagasta
Chile

FLAC numerical model update for the Spence Growth Project (SGO) main dam. Rockfill re-characterization due to changes in the material to be used in the dam construction. UBCSand model recalibration for measuring volumetric strains according to new large triaxial tests results with loading and unloading cycles. A method developed by the modelling team of Golder was used to compute the volumetric strain against the shear strains for each test. Model calibration was carried out for 1 and 20 loading-unloading cycles.

Antamina, Full 3D model update.
March 2020
Provincia de Huari, Perú

Update of the full and detailed 3D numerical model of the largest rockfill dam in South America. Currently constructed up to an elevation of 300 m. The detailed model compromised modeling the 1.1 km long TSF, with 2 axis alignments. About 11 million elements were used to model all features of the downstream and centerline TSF. Development of FLAC3D 7.0 codes for the construction of the Antamina Tailing Storage Facility, using at least 8 different techniques for refining and attaching meshes. The construction sequence involved about 400 construction stages.

Growth Engineering Dam J y B229, Centinela. November 2019
Región de Antofagasta, Chile

Bidimensional numerical analysis of borrow dams 1 and 2, southern area of the Thickened Tailings Storage Facility, Centinela mine. 2D mesh generation and static and dynamic analysis development using same characterization and calibration as main and secondary dam models.

Tailing Design Leader. Ovejeria TSF. Codelco. November 2019.
Metropolitana, Chile

Ovejeria TSF is undergoing a design phase for increasing its capacity. The dam will increase its height from aprox 70 m to 130 m. The dam is constructed with the coarse fraction of the tailings, separated at the cyclone station. The tailing design manager oversees the coordination of all technical activities of the TSF design, with more focus in geotechnical engineering. The general tasks related to the design are deposition plan, water balance and the hydrogeological analysis. The geotechnical specific tasks are definition of field campaign [borehole and test pits location, seismic refraction definition, provide guidelines for sample selection and definition of laboratory testing], geotechnical characterization and geological model for the TSF facility, preliminary stability analysis with LEM methodology and three stability – deformation analyses, two 2-dimensional and one 3 tridimensional models.

Engineer of Record. Numerical analysis El Soldado Sept 2019
Región de Valparaíso, Chile

Support engineering for engineer of record of El Torito TSF (TET) and Dam No. 4 (T4), El Soldado mine. Developed of geotechnical model for two sections of the TSF, North and Central. Definition of static and dynamic laboratory testing, and field work as well. Calibration of UBCSAND models for simulation of sand cyclic compaction. Development of numerical model in FLAC using Geo Meshing. Static analysis including construction sequence. Dynamic analysis for 3 seismic signals, with outcrop verification.

CMTQB/TMF Detail Design. Numerical Model. Quebrada Blanca 2. Aug 2019
Región de Tarapacá, Chile

Bidimensional numerical model update for the starter and main dam of Quebrada Blanca 2. Remeshing based on new construction sequence, geotechnical characterization update and recalibration of dynamic advanced models based on cyclic lab testing. Results provided for rockfill starter dam (120 m), wetting process of rockfill under first deposition of pumped sand, sand dam year 2 (~ 160 m) and final configuration of Sand Dam (310 m)

Spence Detailed Engineering Mar 2019
Región de Antofagasta, Chile

FLAC numerical model update. Elaboration of different sections of the Main and secondary dams (7 sections). Development of numerical models including phreatic surface and potentially liquefiable zones, within the dam body and near the downstream toe. In addition, elaboration of coupled model to prove fast flow and dissipation of excess pore pressure in rockfill material. Finally, implementation of interface to simulate relative displacement during earthquake events at the geotextile laying over the drains.

"Asesoría de Proyecto Estudio de Factibilidad y Estabilidad Embalse" Pocuro
Feb 2019
Región de Valparaíso, Chile

Development of a full FLAC3D numerical model of a CFRD water dam, using Geo Meshing. The model was used for simulating excavation of plinth area, construction of massive rockfill sequence and assessing dynamic performance with and without the full reservoir. Previous to the dynamic stage, seismic records were spectrally matched for adjusting the signals to the design spectrum defined in the seismic hazard study. One of the major challenges of this project was the intensive time constrains, in a little over 3 weeks the team analyzed the available information, going from the geotechnical conceptual model to full 3D dynamic analysis and reporting.

Spence Detailed Engineering
Jan 2019
Región de Antofagasta Chile

Several FLAC numerical models updates has been performed throughout the last years for different sections of the main and secondary dams of the Spence Growth Project (SGO). Additional analyses include development of numerical models including two levels of phreatic surface and potentially liquefiable zones at the base of the main dam, for two seismic records; analysis of basal and upstream slope liners behaviour; analysis of the protection dyke crest strains and remeshing of the main dam model due to protection dyke crest width reduction.

Antamina – Sidehill Deformation Analysis
Jan 2019
Provincia de Huari, Perú

Development of a bidimensional numerical deformation model in FLAC, for simulating tailing deposition over a sidehill structure. The project was developed from the geotechnical characterization of materials to the full construction sequence. The model considered soil-structure-interface implementation. The major challenge was the implementation of FISH routines to obtain momentum and shear forces diagram along the sidehill. This is a very easy task when 1D FLAC structural elements are used, but it is very challenging when concrete structures are represented with FLAC zones.

Deformation Numerical Model, PAD 4A
Oct 2018
Provincia de Arequipa, Perú

Full development of a bidimensional numerical model for simulating the construction and dynamic performance of a leach pad. Use of CPTU results to define perched water zone and phreatic level with potential of liquefaction. Generation of FLAC model using Geo Meshing. Assessment of static and dynamic performance under three MCE everts.

Heap Leach Pad . Minera El Abra, FMI.
Sept 2018
Región de Antofagasta, Chile

Full development of a bidimensional numerical model for simulating the construction and dynamic performance of a leach pad. Among other tasks, the project considered geotechnical static and dynamic characterization of materials, calibration and implementation of advanced constitutive models, two-dimension mesh generation, construction simulation according to mine plan, developing of spectrally matched seismic records, and reporting.

Phase III, Kennedy cape, NASA – 2018. 3D numerical analysis
Florida, USA

Update of the loads and speed applied to the fully coupled - Biot theory, full 3D numerical model. In addition, SRF analysis developed over the 2D centerline crawler section. FOS were provided for a wide range of load and speed, creating a map of responses of the coupled of excess pore pressure increment.

Stability and Deformation Analysis, Tailing Facility "Distrito Minero Centinela", Minera Esperanza
May 2018
Sierra Gorda, Chile

This is an update of the previous work performed for this project. The update consisted in major laboratory testing for getting static and dynamic rockfill properties. A large scale oedometer was performed over a 60 cm in diameter sample. In addition, a series of 3 large scale triaxial with loading and unloading cycles were performed for assessing dynamics properties. Calibration of the UBCSAND model was performed by comparing lab test results with those simulated using 1-element in FLAC.

Basic Engineering, DRE Main Dam, Centinela Región de Antofagasta, Chile
April 2018

FLAC numerical model update for the Thickened Tailing Storage Facility (DRE) main dan. The main task was to calibrate UBCSand model for implementing it on rockfill material, in order to measure volumetric strains according to large triaxial tests results with loading and unloading cycles. A method developed by the modelling team of Golder was used to compute the volumetric strain against the shear strains for each test. Due to lab results inconsistencies, a very strict engineering criteria was used to obtain the appropriate curves.

The analysis considered reprocessing and recharacterization of the materials given a new set of field and laboratory test results.

Stability and Deformation Analysis, Pastos Largos Dam.
March 2018
Barrick
Coquimbo, Chile

The performance of a 50 m dam was evaluated under static and dynamic loads. The dam is located in a very narrow valley and it is made out of compacted borrow material. The dam facility is not only storing tailing, but also it is a decant sediment impoundment and water storage facility. A full 3D model was developed including all alluvial and fluvial materials. For the major part of the analysis, Mohr Coulomb, Hysteretic and Finn models were used in the calibration.

Stability and Deformation Analysis, El Mauro TSF, Pelambres
February 2018
Caimanes, Los Vilos, Chile

This is an update of the previous work performed for this project. The update consisted in calibrating UBCSAND against laboratory testing performed over the tailing sand. The laboratory testing included bender elements for measuring the shear wave velocity, drained and undrained DSS tests for characterizing the sand behavior and consolidation sand test, for interpreting sand field state.

Task Leader, Stability Assesmenet Spence Growth Option Project (SGO), BHP Billiton
January 2018
Antofagasta, Chile

This is a third update of previous work performed for this project. A second revision by local authority requested to include, in at least one section, an interface in the dynamic models for representing the base liner. A FLAC 2D model was developed for simulating the discontinuity. A lot of public data is available, included the one developed for this project, for static geomembrane properties, but little and confusing data is available for dynamic properties. Conservative approach was used for addressing this issue.

Stability and Deformation Analysis, El Mauro TSF, Pelambres
November 2017
Caimanes, Los Vilos, Chile

Stability and deformation assessment performed for a downstream line sand dam. The Mauro dam will be one of the highest projected dam in Chile, reaching up to 240 m at the center section. It is built with cycloned tailing for producing fine sand with up to 18% fines content. The dam has slopes of 2:1 in the upstream direction and 3:1 in the downstream direction. The model was developed for addressing the impact of measured piezometric levels developed within the sand dam body. They reached considerable elevation, of about one third of the height at the upstream toe. UBCSAND constitutive model was used for representing the dynamic behavior of the tailings, the drained sand stack and the undrained sand stack.

Dam breach analysis Collahuasi.
September 2017
Iquique, Chile

This is an update of the previous work performed for this project. At request of the authority, additional section need to be analyzed. Given the new section involved complex dam geometries and twisted downstream topography, the update analysis was performed with Dan3D. New set of inundation plan were developed. Finally, sensitivity analyses were performed to quantify the impacts of changing properties.

Stability and Deformation Analysis, Senior consulting, Round Mountain Mine. Kingross
August 2017
Reno, Nevada USA

Static stability and deformation analysis were performed for back analyzing an instable pit wall in Reno, USA. After mining of benches the wall started to increase the rate of movement. The accumulated displacement at the moment of undertaking the project was about 50 ft. The unstable south wall has a total high of about 1000 ft. Full FLAC 3D model was developed, including major fault systems, geology, mining sequence, joints and the “Blackjack” fault. This last one is a major sub horizontal fault, dipping toward the pit, which controls most of the wall movement. The back-analysis benchmark was radar displacement contours and field observed mechanisms.

Task Leader, Stability Assesmenet Spence Growth Option Project (SGO), BHP Billiton
June 2017
Antofagasta, Chile

This is a second update of previous work performed for this project. The authority requested to increase the number of analyzed sections for the sand dams. This request was based on the extension of the dam by about 12 km. The number of sections analyzed increased from 1 to 6. Field work was needed for gathering information for these new sections; the field work included a series of open pit excavations and MASW.

In addition, a tear analysis of the geomembrane was included, due to the dynamic deformation imposed on it. These analyses were performed for those liners located at the upstream face of the main dam and the sand dam. The analysis was an indirect measurement of the geomembrane extension, using model strain compatibility.

Finally, an earth rockfill replaced the borrow material of the operational dike. The rockfill dike was modeled using UBCHYST. Calibration was done using public and private data on rockfill.

Stability and Deformation Analysis of Murallas Viejas. MOP
May 2017
Combarbalá, Chile

This is a refinement of the previous work performed for this project. The refinement comprised an improved mesh and updated properties. The new improved mesh was created using the preliminary results as a guide. Updated properties were obtained from field campaign results, such as MASW and lab tests.

Stability and Deformation Analysis, Mantoverde TSF, Mantos Copper
March 2017
Chañaral, Chile

Static and dynamic evaluation performance of a tailing storage facility. The facility is comprised of a borrow material starter dam of about 23 m, a centerline sand dam of about 80 m and downstream slope of 4:1, and an impoundment capacity of about 231 million tonnes. Constitutive model were calibrated against the available database for similar materials. For the sand dam, complete behavior was modeled, including the effect of shear modulus degradation and volumetric compaction induced by cyclic loading.

Stability and Deformation Analysis, Quebrada Blanca, Teck
March 2017
Iquique, Chile

A series of 2D stability and deformation analysis for Quebrada Blanca tailing storage facility was performed. The analysis is an extension of the previous model developed in august 2016. The additional work included an improved computation for determine volumetric changes in the rockfill due to wetting process. The previous assessment was followed by dynamic analysis of the starter dam (rockfill, 120 m). These analyses evaluated different phreatic level in the foundation and liquefaction potential. Finally a full dynamic 2D model of the full sand stack was performed. The sand dam has a height of 300 m with intermediate benches of up to 500 m. The downstream slope is 3.5:1 (H:V) and the evaluation was carried out using the MCE earthquake level. UBCSAND was used for computing the cyclic induced volumetric changes.

Dam Breach Analysis, Tailing Facility "Distrito Minero Centinela", Minera Esperanza
February 2017
Sierra Gorda, Chile

Dam breach analyses were performed using Dan-W and an empirical/geometrical methodologies. The distance cover by an hypothetical dam failure was computed for two section, named south and north dams. For each case, different locations, mechanisms and conditions, such as sunny and rainy day, were considered. Inundation plans for each scenario and methodology were developed.

Task Leader, Stability Assesmenet Spence Growth Option Project (SGO), BHP Billiton
January 2017
Antofagasta, Chile

This is an update of previous work performed. This version included an intense field and laboratory program to support numerical analysis parameters. Field testing included, density measurements and MASW, among others. Laboratory testing included drained and undrained DSS tests for a wide variety of shear strains and CSRs, bender elements, oedometer, consolidation, CIU and CID monotonic triaxial tests and cyclic drained triaxial tests. All these was used to calibrate UBCSAND model under different conditions, for different materials.

In addition to the previous work, a partial 3D model was developed in FLAC3D, for assessing static and dynamic behavior of a very sharp corner in the sand dam alignment. This corner was also located near the highest sand dam elevation.

Stability and Deformation Analysis, Tailing Facility Germano Dam. Samarco.
November 2016
Minas Gerais, Brasil

After the failure of Fundao Dam, Samarco mining company request to perform a dynamics analysis of Germano Dam. Even though this is localed in Brasil, which is considered a low seismic area, the panel review analyzing Fundao failure described 2 earthquake events that may have contributed to the failure. Germano dam is a large structure, built from silty sand, which is a subproduct of the iron operation. The dam has two major substructures within the dam body, an impermeable core starter dam and a secondary rockfill starter dam. A FLAC 2D model was developed for the site and a preliminary run was done using general calibration for UBCSAND and UBCHYST constitutive models.

Stability and Deformation Analysis, Tailing Facility "Distrito Minero Centinela", Minera Esperanza
October 2016
Sierra Gorda, Chile

Static and dynamic evaluation of perimetric tailing facility dam, with height from 20 m to 70 m. Site and laboratory characterization was used to calibrate numerical models. UBCSAND was used to model the tailing undrained behavior. Other materials were modelled using UBCHYST and Mohr Coulomb.

The three 2D sections were analyzed. One section corresponding to the south dam, constructed with borrow material. The second section corresponding to the North dam, constructed with rockfill and the last section was the full tailing impoundment. This last section want to assess potential overtopping under dynamic loading.

Dam Breach Analysis, Pastos Largos Dam.
October 2016
Barrick
Coquimbo, Chile

Dam breach analysis in consistency with "Decreto Supremo 248". The dam has about 50 m height and it store about 1 million m^3 of tailing. Using Dan-W and a non newtonian viscous model, the distance covered by tailings was assessed. Finally a water breach analysis was computed using HEC-RAS.

Stability and Deformation Analysis, Tailing Facility El Torito. Mina El Soldado
October 2016
Nogales, Chile

Stability and deformation analysis for tailing facility El Torito. The dam has about 92 m height and it crest runs for about 2 km. Both, the static and dynamic analyses, were performed with FLAC3D. the main objective was addressing the performance impact of including the MAEN dam into the designs. Mohr Coulomb and Finn models were used in the calibration.

Stability and Deformation Analysis, Starter Dam, Quebrada Blanca, Teck
August 2016
Iquique, Chile

A 2D stability and deformation analysis for Quebrada Blanca mine starter dam was performed. The starter has 120 m height, made of rockfill waste material. Throughout the support of numerical analysis, the deformation that the starter dam may suffer under wetting conditions was assessed. Literature and laboratory data was used to get the model parameters, but in accordance with volumetric deformation in the range of 0.25 – 0.5%.

Stability Assessment Task Leader. Spence Growth Option Project (SGO) – BHP Billiton
January – July 2016
Antofagasta, Chile

Perimetral sand dam with impermeable geomembrane in the upstream face. The dams have a variable height from 40 m to 120 m and they run for 12 km. The tailing facility can store 1000 million m^3 over a 13 km^2 area.

Use of advanced constitutive models, such as UBCSAND and PM4. Main objective is capturing the main mechanism of the soil behavior, governing the static and dynamic performance of the material under the action of gravitational and dynamic forces. Advance testing program included drained DSS to measure volumetric induced change during cyclic loading.

In addition, seismic hazard is assessed, and time-acceleration histories are elaborated, based on real seed seismic events and spectral matching techniques.

Project manager and Task Leader. Geotechnical, Seismic hazard and Stability assessment. Consulting Assistant, Pocuro Dam. MOP
June 2016
Los Andes, Chile

CFRD dam of 60 m height, 800 m crest length, useful volume of 110 million m^3 and 10 million m^3 of fills.

As project manager and task leader he is supervising and leading the design of the geotechnical aspects, such as the plinth and parapet; the definition of the seismic hazard for the site and; the stability static and dynamic assessments.

Dam breach analysis Spence.
April 2016
Antofagasta, Chile

Dam breach analysis in consistency with "Decreto Supremo 248".Dams have a variable height between 28 m and 65 m, designed with rockfill material or cyclone sand, and with a fill volume of up to 14 million m^3. Storage capacity of 487 million m^3

Differents failure mechanism were evaluated, included overtopping, seismicity and pipping. The distance covered by runaway tailing was computed with Dan-W, using a non-newtonian model. When a water-dominated failure mechanism system was analyzed, HEC-RAS and a newtonian flux models were used.

Task leader. Geotechnical, Seismic hazard and Stability assessment of Murallas Viejas. MOP
March 2016
Combarbalá, Chile

CFRD dam of 100 m height, 700 m crest length, useful volume of 50 million m^3 and 6 million m^3 of fills. The plinth is located directly at fresh rock, at about 30 m below the alluvial surface. During construction, a cofferdam wil deviate water collected by the collector channel and through the deviation tunnel.

As a task leader, he is responsible for designing the field exploration campaign, defining tests and collection sample plan for laboratory testing program, assist geologist in the definition of the geological – geotechnical valley model. In addition, he is in charge of the stability assessment, from the elaboration of the seismic hazard analysis throughout the 3D numerical analysis with FLAC3D.

Dam breach analysis Collahuasi.
January 2016
Iquique, Chile

Dam breach analysis in consistency with "Decreto Supremo 248". The tailing facility storage is composed by three dams, and they vary the height between 33 m and 130m. They are designed with rockfill or borrow material, reaching up to 94 million m^3. They were analyzed under different breach mechanism, included overtopping, seismicity and pipping. The distance covered by runaway tailing was computed with Dan-W, using a non-newtonian model. When a water-dominated failure mechanism system was analyzed, HEC-RAS and a newtonian flux models were used.

Dam breach analysis. Quebrada Blanca II.
January 2016
Iquique, Chile

Dam breach analysis in consistency with "Decreto Supremo 248".The dam has a height of about 300 m, its starter dam has a height of 120 m. It is designed with cyclone sand and the storage capacity is about 608 million m^3.

Different failure mechanism were evaluated, included overtopping, seismicity and pipping. The distance covered by runaway tailing was computed with Dan-W, using a non-newtonian model. Although no free will present on the system at the end of its life, water-like model were analyzed. The water-dominated failure mechanism system were analyzed with HEC-RAS and a newtonian flux models were used.

Quebrada Blanca II. 2D stability assessment
January 2016
Iquique, Chile

Stability and deformation analysis for Quebrada Blanca main dam was performed. The sand stack wall has approximately 300 m of cyclone sand fill, constructed with downstream technique. UBCSAND model was used to simulate the drained behavior of the sand stack, while Finn model was used to simulate the undrained behavior of the tailing.

Project Manager. Consulting Services, Catemu Dam. MOP
July 2015
Los Andes, Chile

A CFRD dam of 66 m height, 1200 m of crest length and about 180 million m^3 of water storage capacity. The dam body will require approximately 10 million m3 of selected granular materials. For impermeabilizing the valley bottom, an in situ cut off wall of 54 m deep will be constructed. It has a collector channel of about 21 km, including tunnels ranging from 4 km to 9 km.

The main task was reviewing the feasibility designs and assist the client on important matter decision. They cover hydraulic, geotechnical and geological matters mainly, with special focus on the dam, spillway and collector channel.

Project Manager. Consulting Services, Pocuro Dam. MOP
July 2015
Los Andes, Chile

A CFRD dam of 60 m height, 800 m of crest length and about 110 million m^3 of water storage capacity. The dam body will require approximately 10 million m3 of selected granular materials. For impermeabilizing the valley bottom, an in situ cut off wall is required. The collector channel is about 23 km and it has considered a 300 m tunnel.

The main task was reviewing the feasibility designs and assist the client on important matter decision. They cover hydraulic, geotechnical and geological matters mainly, with special focus on the dam, spillway and collector channel.

Expert review of main dam deformation model, Collahuasi
February, 2015
Iquique, Chile

Panel review member of stability and deformation analysis of main dam, Minera Collahuasi. The panel review two independent reports of the dam assessment. Review of the report was based in dam performance evaluated in common check points for both models, and for different benchmarking, including displacements at the end of the simulation, shear strains, displacements histories and response spectrums. Finally, the most comprehensive and suited report was selected to be presented for construction permission.

Quebrada Blanca II, Numerical analysis, Port foundation. Patache
January 2015
Iquique, Chile

3D numerical analysis of the Patache port´s foundation. The analysis assessed whether anchors were needed at the foundation bottom. For answering the technical issue, six state of load were modeled, one static and 5 dynamic. Conclusions showed that a shear key was better solution over the anchors.

Deformation analysis, El Abra, Waste dump
December 2014
Calama, Chile

Stability and deformation analysis of the waste dump-ored pile, belonging to “Sociedad Contractual Minera El Abra”.Three sections were analyzed, under two seismic levels; one for operation basis, in which the ored material was considered saturated, as recently deposited; and the other for MCE seismic level, but the material was considered unsaturated. For the analysis, the Mohr Coulomb model coupled with hysteretic damping and FINN model were used throughout the entire simulations.

Dam breach analysis. Collahuasi October 2014
Iquique, Chile

Dam breach analysis in accordance with “Decreto Supremo 248”. The main dam has a maximum height of 130 m, designed with rockfill or borrow material, and with a fill volume of up to 94 million m^3. Storage capacity of 650 million m^3. The breach length considered for the analysis is 1000 m.

Different failure mechanism were evaluated, included overtopping, seismicity and pipping. The distance covered by runaway tailing was computed with Dan-W, using a non-newtonian model. Given the clear water pond was located over 2 km away from the main dam, no HEC-RAS type of analysis was considered.

Bingham Canyon deformation backanalysis, KUC August 2014
Utah, USA

Back analysis of the massive displacements occurred in the open mine pit Bingham Canyon Mine, belonging to Rio Tinto. A three- dimensional model was developed for the East wall of the pit, including all geological units and construction sequences (current and projected). Ubiquitous joint model was used along with advanced meshing techniques, thereby accounting for weak planes or bedding in the models.

Deformation analysis of trestle, April 2014
Victoria, Canada

3D deformation analysis using FLAC3D of a civil use trestle located in Victoria, Canada. The analysis considered the concrete deck, the structural support of the deck, over 300 driven piles and the foundation profile. The loads applied to the deck were computed using several 2D sections analysis performed with FLAC. Once the entire set of loads were defined, these were applied to the 3D model´s deck and contour of moments, forces and displacements of the most solicited piles were developed.

Quebrada Blanca I, Waste Dam 11 Stability Assessment
Iquique, Chile

Stability Assessment was conducted for Quebrada Blanca I project, Waste Dam 11. At beginning it included an exploration campaign for drillings, pits and superficial mapping. Laboratory essays were also carried out. Waste dam is 150m global high and is located in a tight valley. Additionally, stability assessment, rockfalls evaluations and failure flows were also developed.

Quebrada Blanca II Stability Assessment
Iquique, Chile

Stability assessment for 10 geotechnical structures were carried out for Quebrada Blanca II project. At beginning it included an exploration campaign for drillings, pits and superficial mapping. Laboratory essays were also carried out. Highest structure analyzed was 300m high. Additionally, stability assessment, rockfalls evaluations and failure flows were also developed.

Tailing Facility. Full 3D Model. Antamina
Ancash, Peru

A detailed 3D model plan of tailings deposit was developed. Analysis considered rock topography, rockfill dam with its transition filling and tailings. More than 360 stages of construction sequence were logged along with 50 stages of tailings deposits. The entire model has around 3.7 million of elements and allowed responding enquiries concerning filter and settling issues.

Tailing Facility. Calibration Stage Antamina
Ancash, Peru

A series of 2D analyses were done by using software FLAC2D to calibrate and to validate hysteretic constitutive UBCSand model. Using this model, rockfill dynamic behavior was simulated. Calibration target was a dam located in Mexico, Infiernillo Dam. This dam was undergoing a major earthquake event and it has very competent instrumentation.

Stability and Deformation Assessment. Relincho
Huasco,Chile

Stability assessment of NAG dam which has a 320 m general high and about 6 km longitude by 1.2 km width and 5.6 km2 footprint. At beginning it included an exploration campaign for drillings, pits and superficial mapping. Laboratory tests were also carried out.

Stability assessment and Tailing facility design. Volcan waste dam
Chile

A detailed stability assessment was conducted over the developing years of the waste deposits, identifying critical sections and possible improvement to the deposit plan. Recommendations were made on hazard and security matters, especially those related to the operation. A design of the tailing facility was carried out, including stability analysis and water management.

Crusher System Analysis. Lomas Bayas
Chile

The crusher system included a bedrock foundation, an adjacent 28 m MSE wall, a 2 m concrete slab and the crusher structure. Analysis considered the topography representation, the MSE wall construction sequence and the slab and crusher loads. In addition, a simplified model of the crusher, matching mechanical analysis of the structure in term of natural oscillation period, was calibrated and included in the full geotechnical model. Finally, full dynamic analyses were performed on the full model.

Quebrada Blanca tailing facility analysis using FLAC2D
Chile

This project considered a review of the seismic hazard definition. Performing constitutive model calibration using CIU triaxial tests. Detailed construction sequence simulation and full dynamic analysis using seven spectrally matched seismic records.

Pascua Lama geotechnical characterization of waste materials and stability assessment
Chile

A series of geotechnical tests were performed for geotechnical material characterization. In addition, a preliminary assessment was conducted on the waste dam deposit.

Constellation project Phase II, Kennedy cape, NASA – 2010. 3D numerical analysis
Florida, USA

During this phase NASA tested the crawler over the embankment with different loads. Each load corresponded to a percentage of the rocket weight. As the crawler was increasingly loaded, measurements were performed in several instrument positioned in the crawler path. This field information was used to ultimate calibrated the 3D models developed in Phase I and II. **Project-of-the-Year Award, Florida Section of ASCE, 2011.**

MSE analysis, Jim Collins Group – 2010
NC, USA

A series of numerical analyses were performed to calculate deformations and geogrid tensions for the almost 100 ft Wall #9 at Berrington Village in Buncombe County, North Carolina. The mechanically stabilized earth (MSE) wall consists of concrete blocks, geogrid reinforcement, and compacted backfill. Special challenge offer representing the highly non lineal behavior of the geogrid reinforcement in FLAC3D, given the software only allows lineal behavior for this type of reinforcing.

New soil improvement techniques, GEOPIER – January 2010.
USA

Analysis of a new soil improvement technique. This new technique is under development and it is oriented to help in resisting surface loads. During this preliminary phase, the seismic response of the improved section was analyzed; especial attention was paid to the seismic induced stress ratios.

Constellation project Phase I, Kennedy cape, NASA – August 2009. 3D numerical analysis.
Florida, USA

NASA contracted an extensive exploration campaign. With this information and as an extension of Phase I, the 3D models of the crawler and the embankment was updated. The updated model incorporated new soil stratus and new mechanical properties. Additionally, the foundations of the VAB were analyzed using FLAC3D software. FLAC3D was also used to analyze one of the main structural components of the embankment, the service tunnel. Finally, the stability analysis performed in Phase I was updated and further analyzed using Phase software.

Constellation project Phase I, Kennedy cape, NASA – March 2008. 3D numerical analysis.
Florida, USA

Numerical analysis study performed for NASA for its Constellation project. This project was completed in 8 months and during this time highly complex and advanced numerical analysis were implemented using the software OpenSees. OpenSees represent the state of the art in finite element analysis software. Mainly, the model numerically recreates the crawler as its moves over the embankment connecting the vertical assembly building (VAB) with the launching pad. This study answered whether slope stability problems would arise as the crawler was moving on the surface and the excess pore pressure was increasing in the silty sand layer. Finally, SLIDE was used to further analyze the embankment slope stability.

Seismic hazard analysis for US embassy in Guayaquil, Ecuador. For Schnabel Company – May 2007
Virginia, USA

Seismic hazard analysis for USA facility located in Guayaquil, Ecuador. This analysis was requested by the Schnabel company. This integral study contemplated from the seismic data collection to the generation of synthetic and real-escalated registers. Additionally this study included the seismic hazard de-aggregation and the possible probabilistic and deterministic scenarios.

Punilla Dam
Chile

Punilla Dam, 885 Hm3. Inspection of boreholes, open pits y Lugeon y Lefranc tests. Seismic hazard study. Development of requirements and terms

Chacrillas Dam
Chile

Chacrillas Dam, 27 Hm3. Inspection of boreholes, open pits y Lugeon y Lefranc tests. Seismic hazard study. Spillway study. Development of plinth computation software. Slope stability study. Static and dynamic dam stability study. Dam foundation study.

Convento Viejo Dam
Chile

Convento Viejo Dam, 450 Hm3. Inspection of boreholes, open pits y Lugeon y Lefranc tests. Computation of Creager profile and general check up of spillway. Seismic hazard study. Slope stability study. Static and dynamic dam stability study.

Puntilla del Viento Dam
Chile

Puntilla del Viento Dam, 85 Hm3. Inspection of boreholes, open pits y Lugeon y Lefranc tests. Seismic hazard study. Development of requirements and terms for replacing international highway.