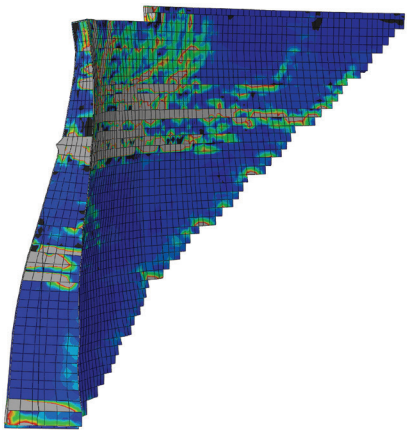
Structural Integrity Associates, Inc.®

DAMS AND WATERWAY INFRASTRUCTURE



INTRODUCTION

Structural Integrity Associates (SI) was founded in 1983 and has grown to approximately 300 professional staff. SI is experienced in evaluating both concrete and earthen dams for seismic stability and safety. We solve the most complex problems in the design of new and existing dams and hydropower infrastructure. Our staff is experienced in providing nonlinear evaluations of both unreinforced concrete dams and intake towers to determining the structural vulnerabilities of the as-built structure as well as incorporating design modifications and assessing the efficacy of retrofit options. We are a valued, top consultant for utilities during evaluations of their portfolio of aging infrastructure by providing extended service life options and by analytically getting the most out of these high-valued assets.

SERVICES

CONCRETE STRUCTURAL ANALYSIS AND DESIGN

- Non-linear FEA of Dams, Intake/Outlet Structures, Spillways, etc.
- Dam Stability Analysis
- Seismic Vulnerability Evaluation of Existing Infrastructure
- Retrofit Assessments and Design
- Thermal/Stress Analysis for Mass Concrete Pours

GATES AND LOCKS

- Evaluation and Repair

PENSTOCK INSPECTION AND EVALUATION

- Wall Loss Evaluations Using Phased Array and Ultrasonic Techniques
- Fracture Mechanics, Fatigue, and Life Assessments

SPECIALTY INSTRUMENTATION

- Displacement and Vibration Monitoring
- Frequencies of Vibration and Mode Shapes

SOIL FRAGILITY

- Probabilistic Risk Assessment of Soil Fragility Liquefaction
- Slope Stability and Lateral Spreading
- Soil Displacements and Monitoring

MATERIALS & METALURGY LAB

- Material Types and Properties
- Concrete Degradation Assessments
- Alkali Silica Reaction (ASR) and Freeze-Thaw

BLAST, SHOCK, AND IMPACT ANALYSIS

- Terrorist Threats - Blast Vulnerabilities
- Load Drops, Aircraft Impacts, Shock Isolation, etc.
- Missile Impacts – Wind, Equipment Failures, External, etc.
- Barrier Design

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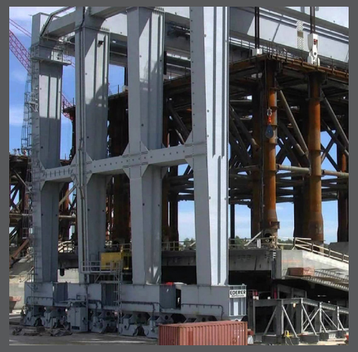

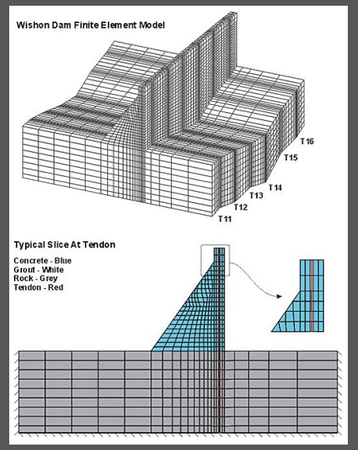

PROJECTS

US ARMY COE, OLMSTED DAM AND LOCK MASS CONCRETE THERMAL ANALYSIS

The Olmstead Dam and Lock project is located between Illinois and Kentucky. Following the general requirements of USACE ETL 1110-2-365 Nonlinear, Incremental Structural Analysis of Massive Concrete Structures in accordance to the US Army Corp of Engineers.

The primary objective of this project was to perform a thermal mechanical analysis as part of the final design of the float-in dam foundation. Using an in-house ANACAP software program, the prediction was provided that the thermally induced stress behavior of the structure based on the established geometry and concrete mix laboratory test results. As a result, estimates were provided for concrete mechanical properties and recommendations for placement temperature, lift height, and reinforcement requirements.

CRESTA DAM SEISMIC STABILITY ANALYSIS

Cresta dam is owned by Pacific Gas and Electric Company (PG&E) and is one of three PG&E FERC Projects located along the main stem North Fork Feather River (NFFR), upstream of the Oroville/P-2100 Project in Plumas and Butte counties, California.

Piezometer readings taken at the Cresta dam site were measured as being higher than historical records, which initiated a response by Pacific Gas and Electric Company (PG&E) to evaluate the Dam for stability under the increased uplift pressures beneath the dam. Under direction from the Federal Energy Regulatory Commission (FERC), PG&E agreed to re-evaluate the sliding stability of the Cresta dam.

The objective of this project was to evaluate the stability under the increased uplift pressures under the dam. Initial analysis took into consideration the fact the probable seismic hazard assessment (PSHA) for this site had been updated, which showed an increase in seismic hazard. Utilizing the latest uplift pressure information and the new seismic hazard information an overall dam safety and stability analysis was successfully performed, providing need information to PG&E.

WISHON DAM STRUCTURAL EVALUATION

The earthen and rockfill gravity dam, located in Fresno County, CA, was constructed in 1958 by Pacific Gas and Electric Company (PG&E) with a height of 260 feet and a length of 3,330 feet at its crest, and is an element of PG&E's Hass-Kings River Project.

The objective of this project was to perform a structural evaluation on the overall stability of the dam and the use of rock anchors. A new hydrological study indicated higher probable maximum flood levels. With the initial concern about overturning, an additional evaluation of the design for installing rock anchors from crest to foundation was also completed.

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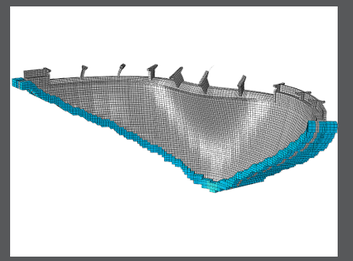
LOST CREEK ARCH DAM SEISMIC UPGRADE

The 1923-24 Lost Creek Dam is located east of Oroville, California on a tributary of the south fork of the Feather River. This unreinforced concrete dam is a component of the South Feather Power Project owned and operated by the South Feather Water and Power Agency (SFWPA) and licensed by the Federal Energy Regulation Commission (FERC).
The purpose of the project was to address the design and safety issues associated with the proposed modifications to Lost Creek Dam. A nonlinear dynamic time history seismic analyses was performed with finite element models representing the existing conditions. Further revisions to those proposed modifications were recommended based on the assessment results. Critical to achieving meaningful results from the analysis of the concrete arch dam was the ability of our models to accurately capture tensile cracking, subsequent redistribution of stresses and changing load paths as damage progresses during a seismic event.

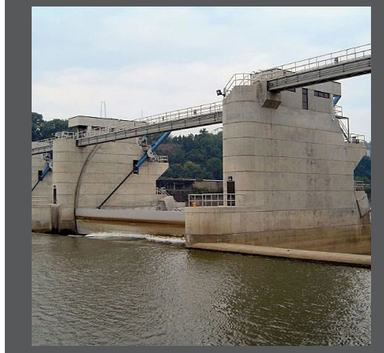
The 3D nonlinear finite element seismic analysis of the existing condition of the dam indicated significant cracking develops in a horizontal plane across the two interior monoliths that could lead to an unanticipated immediate draw-down event of the impounded reservoir. The structure with modifications showed that it could adequately withstand the seismic demands imposed by the prescribed earthquake record. While the analysis affirmed the survivability of the structure, it also indicated the possible formation of horizontal and diagonal cracks on the upstream face that penetrate through to the new facing, potentially creating adverse effects that could damage the geo-composite membrane liner covering the upstream face. Follow up revisions to the structure modifications were proposed to mitigate significant cracking from developing avoiding a potential long-term maintenance issue.

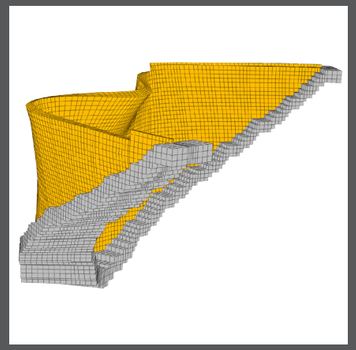


US ARMY CORPS OF ENGINEERS, BRADDOCK DAM MASS CONCRETE THERMAL ANALYSIS

The Braddock Locks & Dam built in 1999 (previously named Monongahela Locks and Dam No 2) is one of nine navigational structures on the Monongahela River between Pittsburgh, PA and Fairmont, WV.

The primary objective of this project was to perform a thermal mechanical analysis as part of the final design of the float-in dam foundation for the US Army Corps of Engineers in accordance with the general requirements of USACE ETL 1110-2-365 Nonlinear, Incremental Structural Analysis of Massive Concrete Structures. Using in-house ANACAP software program, to predict of the thermally induced stress behavior of the structure based on the established geometry and concrete mix laboratory test results. As a result, estimates of concrete mechanical properties and recommendations for placement temperature, lift height, and reinforcement requirements were provided.





ROCK CREEK DAM SEISMIC STABILITY ANALYSIS
Rock Creek dam is owned by Pacific Gas and Electric Company (PG&E) and is one of three PG&E FERC Projects that are located along the main stem North Fork Feather River (NFFR), upstream of the Oroville/P-2100 Project in Plumas and Butte counties, California.

Piezometer readings taken at the Rock Creek dam site were measured as being higher than historical records, which initiated a response by Pacific Gas and Electric Company (PG&E) to evaluate the Dam for stability under the increased uplift pressures beneath the dam. Under direction from the Federal Energy Regulatory Commission (FERC), PG&E agreed to re-evaluate the sliding stability of the Rock Creek dam.

The objective of this project was to evaluate the stability under the increased uplift pressures under the dam. Initial analysis took into consideration the fact the probable seismic hazard assessment (PSHA) for this site had been updated, which showed an increase in seismic hazard. Utilizing the latest uplift pressure information and the new seismic hazard information an overall dam safety and stability analysis was successfully performed, providing need information to PG&E.

UPPER MISSISSIPPI LOCK CONCRETE ANALYSIS
The Upper Mississippi locks and dams was evaluated for the thermal stresses and cracking which consisted of performing a "Level 2" thermal evaluation, based on USACE ETL 1110-2-542 "Thermal Studies of Mass Concrete Structures", in support of the concrete mix design and construction specifications for these new lock structures. This level of evaluation typically involves 1D or 2D finite element models for a "more rigorous" determination of the concrete temperature history than "Level 1" analyses but allows simplified procedures to evaluate the thermal changes in volume, based on these calculated temperatures, and estimate cracking potential.

The project objective was to perform the cracking analysis procedure which requires assumptions and approximations for the effects of constraints, along with simplifications in the interactions with concrete aging, shrinkage, and creep. The analysis adequately predicted the behavior of the mass concrete during the placement and curing process of these Upper Mississippi Locks.

FMIC DIVERSION AND ENERGY DISSIPATOR STRUCTURE, ALLYN DEVELOPMENT COMPANY
The primary object was the responsibility for the structural engineering design, detail, and quality control for a large cast-in-place diversion structure, spillway and energy dissipater for a private development in Colorado Springs, Colorado.

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OTHER PROJECTS

CABRILLO BRIDGE
Preliminary investigations of the historic Cabrillo Bridge indicated that structural deficiencies existed when subjected to seismic actions. SI's engineers were responsible for developing and defending to the State, an adequate seismic retrofit strategy that meets seismic performance objectives that also did not affect the appearance of the bridge.

A seismic retrofit strategy was developed that included the longitudinal coupling of pier segments using unbonded post-tensioning running full length of the bridge. Column displacement and shear capacities were increased through the implementation of internal shotcrete walls with post-tensioning. Due to the historic nature of the bridge, the State seismic review panel review and quickly approved the concept.

CALIFORNIA TOWER MUSEUM OF MAN
The California Tower at the Museum of Man in San Diego, CA was constructed for the 1915 Panama-California Exposition. The main tower was built using a combination of concrete and block and the main building a dome and concrete system. Over the years, this building has received a variety of structural upgrades.

The primary objective was to provide consulting services to a local engineering firm relating to the analysis of this complex structural system. The aged nature of the structure required special attention to system details to develop appropriate modeling assumptions. Additionally, consulting was provided relating to the seismic capacity and inelastic abilities of a variety of key components within the main tower.

NAVAL REACTORS SPENT NUCLEAR FUEL HANDLING FACILITY
The Bechtel Marin Propulsion Corporation needed our engineering experience in the design of a $2 billion-dollar grass roots facility in the Idaho National Engineering Lab. The facility includes two processing lines for the anticipated spent fuel housed in a new superstructure. The processing lines consists of a series of duplex stainless steel lined cast-in-place concrete storage pools, transfer pools, and handling pools. The facility accommodates eight cranes ranging from 40 tons to 310 tons for a superstructure that is nearly 1,000 feet in length and 110 feet tall designed to DOE-STD-1020 SDC-3 through SCD-5 natural hazard loading. The foundation concepts included a raft foundation concept and drilled pier supported strip foundation systems concepts.

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KEY PROFESSIONAL STAFF

Daniel Parker, PE., has over 25 years of structural analysis experience using linear and non-linear finite element analysis methods. Mr. Parker specializes in performance based, beyond design basis, seismic analysis of plain concrete, reinforced concrete, and steel structures. He recently has served as lead structural engineer on several hydroelectric infrastructure projects including seismic stability analyses for several mid-size dams and seismic vulnerability and retrofit evaluations on several unreinforced and lightly reinforced concrete reservoir intake towers.

Derrick Watkins, PhD, SE.,has over 20 years of experience in the seismic design, analysis, construction, and repair of heavy industrial structures, including fossil and nuclear facilities. This includes over 10 years of experience working on projects at DOE sites. His skills include complex finite element analysis, seismic design for moderate and extreme earthquake events, design of rotating and vibrating equipment supports and foundations, anchorage to concrete, and equipment seismic qualification.

Eric Kjolsing, PhD, PE., is experienced in both the design and analysis of civil infrastructure. He is a member of ACI Committee 447 – Finite Element Analysis of Reinforced Concrete Structures and is heavily involved with the development of finite element models to support owners of power-generating assets. Representative work includes in-field modal testing; bridge design; static, seismic, and impact analyses of concrete structures; and fragility assessment of mechanical equipment.

STRUCTURAL INTEGRITY ASSOCIATES, INC.®

KEY DIFFERENTIATORS

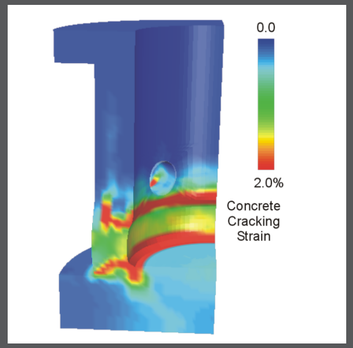
PROVEN FRAGILITY EXPERIENCE
SI employs industry recognized fragility experts who are knowledgeable in Seismic Probabilistic Risk Assessments (SPRA's), and who understand the unique features of any design.

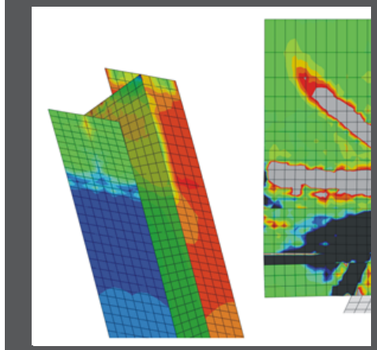
FLUID-STRUCTURE INTERACTION (FSI) EXPERIENCE
SI has a team with significant experience performing fluid-structure interaction analysis in ANSYS on very large complex models of critical components, with subsequent acceptance by the regulatory authorities.

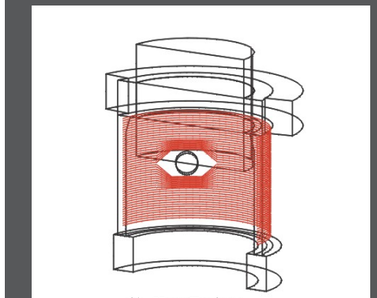
ANSYS SOFTWARE AND PARALLEL COMPUTING
SI has powerful supercomputers and high-performance computing pack software that facilitates powerful multi-threaded parallel processing to reduce large analytical computation times that are typically associated with response history analysis of fluid-structure interaction problems.

ANACAP SOFTWARE, NON-LINEAR CONCRETE MODELING
SI has specialized expertise and finite element analysis computing power to evaluate the non-linear behavior of concrete using ANSYS, LSDYNA, ABAQUS and ANACAP. ANACAP, Structural Integrity's in-house concrete analysis package, has been laboratory benchmarked for accuracy and can evaluate long-term irradiation effects, ASR, post-tensioning losses, concrete crushing, crack propagation, creep, shrinkage, and other non-linear concrete material behaviors.

COMPUTER AUTOMATED DESIGN
SI's key structural staff have produced code-based drawings and designs in AutoCAD, CADWorx, MicroStation, SolidWorks, and Revit.







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