INDIAN GEOTECHNICAL SOCIETY
CHENNAI CHAPTER
in collaboration with DFI India

Cordially invites you to the

Lecture on

"Repairs to Wolf Creek and Mosul Dams to Mitigate Dam Safety Issues"

By

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Venue : **Viswesvaraya Seminar Hall,**
Dept of Civil Engg., IIT Madras

Time & Date: **6:00 PM on MONDAY, 3rd June 2019**
Tea: **5.45 pm.**

Dr. R.G.Robinson
Secretary

Dr. V.K. Stalin
Chairman

Abstract

Wolf Creek Dam, Kentucky, USA

Wolf Creek Dam is a combination concrete gravity and earth fill structure located on the Cumberland River near Jamestown, Kentucky. The Dam contains a hydroelectric powerhouse. The Dam is 5,736 feet long, includes the concrete section, which is 1,796 feet long, ties into the left abutment, and extends across the old river channel toward the right abutment. It has a maximum structural height of 258 feet (dam crest to base of concrete dam) and contains a gate control section, a powerhouse section, and non-overflow sections on both ends. The earth embankment is 3,940 feet long and includes a section which wraps around both the upstream and downstream sides of the right end of the concrete monolith. By volume, Wolf Creek Dam holds back the largest manmade reservoir east of the Mississippi River, and the ninth largest in the United States.

The dam foundation is comprised of karstic limestone units which continue to solution creating voids resulting in increased seepage. The internal erosion failure modes were evaluated and judged to create unacceptable risk of failure. In the 1970's the US Army Corps of Engineers (USACE) installed a partial concrete cutoff wall that did not extend full length through the earthfill section. Based upon instrumentation which showed increasing pore pressures in the foundation, USACE made a decision to install a second cutoff wall upstream of the original wall that would extend deeper and full length. This presentation discusses the dam safety issues and technologies utilized to construct the cutoff walls.

Mosul Dam, Iraq

Mosul Dam is a 3.4 km long, earth fill dam, located in Northern Iraq located on the Tigris River, approximately 40 km northwest of Mosul. The construction of Mosul Dam was completed in 1984. The dam is a multi-purpose dam providing flood control, irrigation, power generation, and water supply. The dam is located on an extremely problematic karstic foundation which has the potential to erode due to the presence of dissolvable gypsum and carbonate layers. As the gypsum dissolves it can form interconnecting openings in the foundation that could compromise the stability of the dam. This issue has been addressed by maintenance grouting over the years; however, the deteriorating foundation of the dam poses a risk that if not fully addressed, could result in catastrophic loss of life, economic damage, and geopolitical instability.

In late 2014, the Government of Iraq requested assistance from the US Army Corps of Engineers to implement emergency repairs to the dam. This presentation discusses the dam safety issues, design of repairs, technology, grout mixes, grouting methodology, equipment and computer-based monitoring systems used from late 2016 and 2019 to address the foundation issues.

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Professional Registration:
- Registered Engineer in Colorado, # 20355, expires 10/31/2019

Professional Societies:
- American Society of Civil Engineers (ASCE)
- United States Society on Dams (USSD)
    - Member of Committee – Construction and Rehabilitation
    - Member of Committee – Materials for Fill Dams
    - Association of State Dam Safety Officials (ASDSO)
- International Commission on Large Dams (ICOLD)
    - USSD Representative to Embankment Dams Committee
- Deep Foundations Institute
    - Trustee

Experience:

January 2019 – present

- SME for Oroville Dam Risk Analysis for California Department of Water Resources (DWR)

February 2017 – December 2018 – Senior Advisor to USACE HQ and Dam Safety Officer, Mosul Dam Task Force, Iraq

- Senior Advisor to USACE HQ Dam and Levee Safety Programs

- Dam Safety Officer (DSO) for Mosul Dam Task Force which is managing the emergency repairs to Mosul Dam, Iraq for the Government of Iraq and the Department of State

February 2015 – February 2017 – Special Assistant for Dam Safety, US Army Corps of Engineers, Washington, D.C.

- Special Assistant for Dam Safety at USACE HQ in Washington, D.C. responsible managing the USACE's portfolio of 715 dams. National Specialist on critical infrastructure design, dam design, levee design, construction engineering, engineering risk assessments, and dam and levee safety modifications performed as part of USACE Dam Safety management activities

- Dam Safety Officer for the Mosul Dam Task Force which is managing the emergency repairs to Mosul Dam in Iraq.

April 2010 – February 2015 – Lead Civil Engineer, US Army Corps of Engineers, Risk Management Center, Denver, CO

- Lead Civil Engineer for the Risk Management Center in Denver, CO. Served as the National Construction Liaison Engineer for the Risk Management Center.
- Served as U.S. Army Corps of Engineers (USACE) national specialist on critical infrastructure design, dam and levee design, construction engineering, and construction management to support engineering risk assessments, interim risk reduction measures (IRRM), and dam and levee safety modifications performed as part of USACE dam and levee safety programs.
- Member of Training Cadre for dam safety training programs Thailand, Mekong River Commission, Taiwan, and Brazil
- Team Leader for development of new USACE Seepage Control Cutoffs for Dams and Levees Engineering Manual (EM).

May 1978- April 2010 – US Bureau of Reclamation, Construction Management Group, Technical Service Center, Denver, CO

Significant projects:

New Waddell Dam and Waddell Pump/Generating Plant – Arizona – Principal Engineer for the design of the New Waddell Dam and Waddell Pump//Generating Plant. New Waddell Dam is the principal storage reservoir for the Central Arizona Project (CAP). The zoned earth fill dam is 440 feet high and contains 20 million cubic yards of earth fill. Over 1,000,000 l.f. of drilling was completed with approximately 1,000,000 bags of cement injected. Drilling depths of 650 feet were routinely drilled on the right abutment ridge. The grouting program utilized a "state of the art" computer monitor system which allowed real time monitoring of the grouting operations. The Waddell Pump/Generating Plant contains 8 units: 4 generators and 4 pump/generator (P/G) units. The P/G units are variable speed and are used to fill the reservoir (Lake Pleasant) during the winter months from the CAP canal. The Plant produces peaking power during the summer when water is released back into the CAP canal for distribution.

Mt. Elbert Forebay Reservoir Lining Project – Colorado - Lead Engineer for preparation of design and specifications for installing a geo-membrane liner in the 300 acre Mt. Elbert Forebay Reservoir. At the time (1980), it was the largest geo-membrane installation in the world. Responsible for all phases of laboratory testing and preparation of specifications. Technical Advisor to Field Engineer for all phases of installation of geo-membrane lining during construction.

Drop 2 Terminal Storage Reservoir – Arizona – Technical Advisor for Drop 2 Reservoir design and construction. The Drop 2 Reservoir allows for more efficient operation of the All American and Cochella Canal systems. Advisor to the Construction Office on inspection and QA/QC of lining the 650 acre reservoir with geo-membrane to limit seepage.

Animas La Plata Project – Colorado / New Mexico – Construction Liaison Engineer for the Animas La Plata Project. Principal features include Ridges Basin Dam; a 290 foot high zoned earthfill structure (5.5 million cy) that included a concrete lined low level outlet works tunnel through the left abutment, Durango Pumping Plant (8 pumps with a total capacity of 280 cfs), Ridges Basin inlet conduit (3 mile long, 72 inch steel pipe) and Navajo Nation Municipal Pipeline (30 miles, 12 inch) from Farmington, NM to Shiprock, AZ).

Twin Lakes Dam, Fryingpan-Arkansas Project - Colorado - Lead Engineer for designs to modify Twin Lakes Dam to control under seepage. Pore pressures in the foundation downstream of the dam caused unsafe seepage conditions during first filling. Responsible for design of three-stage filter and berm at the D/S toe of the dam.

San Justo Dam and Dike, San Felipe Project - California - Member of Design Team for design and construction of San Justo Dam and Dike outside of Hollister, CA. The dam and

dike are in an active seismic area between the San Andreas and Calaveras faults. Lead Engineer for designing the membrane lining system that was installed to reduce reservoir seepage. The system consisted of 50 acres of high-density polyethylene (HDPE) lining installed over previous sand beds which were exposed in the reservoir bottom to limit seepage.

Team Leader for Hu Shan Dam Review Team– Taiwan Water Resources Agency – The US Bureau of Reclamation (Reclamation) provides technical assistance to the Taiwanese Government for design and construction of dams and water diversion structures. Team Leader of Technical Team providing technical assistance for the design and construction of Hu Shan Dam outside of Taichung. The dam consists of three separate embankments, 350 foot high (18 million cy). A plastic concrete cutoff wall (panel method), approximately 130 feet deep, 5,000 feet long was installed through the foundation to limit seepage.

TVA Kingston Coal Ash Containment Failure – Tennessee - Technical Advisor to EPA Region 4 in remediation of the coal ash impoundment failure at the TVA Kingston facility outside of Kingston, TN on the Emory River. In May of 2009, EPA Region 4 assumed responsibility for cleanup and restoration of the site. Performed technical review of designs that were prepared and implemented to stabilize remaining dike containment structures and removal of ash from the Emory River by dredging and clamshell excavation.

Spirit Lake Containment Structures – North Dakota - Technical Advisor to BIA, USACE, FHWA, and Spirit Lake Tribe for construction of 5 miles of earth embankments to contain rising water levels. Spirit Lake is a large natural lake with no natural outlets in north central North Dakota (Devils Lake). Existing roadways were modified into earth dams and new earthen embankments were constructed to contain rising water levels and prevent overflow into the Sheyenne and Red Rivers resulting in significant flooding to a significant portion of North Dakota.

AV Watkins Dam Cement Bentonite Cutoff Wall – Utah – Technical Advisor on construction of the 5 mile long cement bentonite cutoff wall constructed through the crest of the dam and pervious foundation units. The depth of the wall varied from a maximum of 65 feet to a minimum of 35 feet, averaging 55 feet.

Truckee Canal and V-Line Canal Failures – Newlands Project, Nevada - Member of Reclamation's Technical Review Team that assisted Regional, Area Office and Truckee Carson Irrigation District with the failure evaluation and emergency repairs to the Truckee Canal which failed in January 2008 and flooded Fernley NV. Supervised emergency repairs to the V-Line canal that failed in June 2008.

Mississinnewa Dam Cutoff Wall – Indiana - COE Louisville District - Technical Advisor to USACE Louisville District in the evaluation of the dam and development of designs and specifications for construction of the concrete cutoff wall through the right abutment of the dam. The dam is on the Wabash River and the foundation has limestone units with large cavities present similar to Wolf Creek Dam

Navajo Dam- New Mexico – Technical Advisor on a slurry loss issue that occurred when hydrostatic pressures during excavation of a 250 foot deep panel caused hydro fracturing of the embankment causing complete of slurry which exited on the downstream groin.

Twin Buttes Dam – Texas – Technical Advisor to the Design Team on excavation and construction methods for the cutoff wall installed at the upstream toe of the Dam. The design was unique because a geo-membrane was anchored into the cutoff wall backfill and tied into the impervious core of the dam.

Beaver Dam – Arkansas - USACE Little Rock District – Technical Advisor to the USACE Little Rock District when the original excavation method (rock mill) was not successful due to geology. The construction methodology was changed to large diameter secant pile. Secant pile cutoffs were constructed at New Waddell Dam through volcanic geologic units on the right abutment which was the first application of such methods in the United States.

Other Experience:

Principal Designer for the following Reclamation projects: New Waddell Dam Cutoff Wall; New Waddell Dam-Stage I and Stage II; New Waddell Dam-Right Abutment Ridge Grouting-Phases 1 and 2; Como Dam Modification; New Ganado Dam; Tucson Terminal Storage Reservoir Feasibility study; and Santa Cruz Riverbank Stabilization project in Tucson.

Principal Designer for the following environmental remediation projects for various EPA Regions: Summitville Mine-Cropsy Removal Action Phases 1, 2, and 3; Summitville Mine-Heap Leach Pad-Phases 1 and 2; Summitville Mine Water Treatment O&M; Gary Lagoons PCB Removal; Belding Superfund Site (removal of radioactive materials); Benton Harbor Superfund Site(removal of radioactive materials); Eagle/Picher Smelter Site; New World Mine; Ralph Gray Trucking Superfund Site; Gilt Edge Mine- Ruby Gulch Repository Geo-membrane Cap Phases 1 and 2.

Education:

- B.S. Agricultural Engineering/Soil and Water, University of Illinois, Urbana-Champaign, 1978
- Graduate classes in Civil/Geotechnical Engineering at University of Colorado at Boulder and Denver, 1978-1985
- Graduate studies program “Special Program in Soil Mechanics for Practicing Engineers” at Oklahoma State University, Stillwater, OK, Spring Semester 1982