

## **Kenneth D. Hansen, P.E.**

**EXPERTISE:** Roller-Compacted Concrete, Soil-Cement and Concrete Engineering

**EDUCATION:** M.S./1961/University of Colorado, B.S./1955/University of New Mexico

**REGISTRATION:** Professional Engineer - Colorado, New Mexico (Inactive)

### **SUMMARY:**

Mr. Hansen is an individual consultant specializing in RCC, concrete, and soil-cement applications for dams. He is probably the most recognized author, lecturer, and consultant on RCC and soil -cement for new dams and the rehabilitation of existing dams in the United States. Prior to establishing his private practice in early 2009, Mr. Hansen worked as a consultant for Schnabel Engineering for nearly 12 years and the Portland Cement Association (PCA) for nearly 37 years. His studies and experience on what works and what does not work on previously constructed projects is invaluable in the design of future projects.

His consulting assignments on RCC, concrete and soil-cement for dams now total nearly 100 in 11 countries. Five of these dams are greater than 300 ft (91m) high, including the 710 ft (216.5m) high Longtan Dam in China.

One of Ken's main contributions to the development of RCC and soil-cement for new dams and the rehabilitation of existing dams has been to take education to the construction site. He has organized and taught at 24 RCC dam short course/tours in thirteen states, while with PCA, Schnabel Engineering and as an individual consultant. In addition, he conducted ten similar soil-cement short course/tours while with PCA.

He was the course director and featured lecturer at the International RCC Dams Seminar and Study Tour. Six such educational programs were successfully conducted, starting in 1998. His most recent RCC Seminar, Training Session and Study Tour was conducted in 2011 at Atlanta, Georgia with 92 in attendance from 13 countries. Ken was also the course director for the two-day RCC 2009 Dams Short Course and Taum Sauk Dam Tour held in St. Louis, Missouri.

### **LECTURES:**

Mr. Hansen has given more than 400 presentations on RCC dams throughout the United States, but also by invitation in Canada, Mexico, Brazil, Chile, Australia, China, Argentina, India, Spain, Turkey and Peru. Ken was co-chairman of both specialty conferences on RCC sponsored by three ASCE divisions- Construction, Materials, and Geotechnical-held in San Diego in 1988 and 1992. At the 1992 RCC III conference, he presented the keynote address, "RCC for Rehabilitation of Dams in the USA-An Overview". He has also presented one of the initial special invited lectures at the International Symposium on RCC Dams in Spain in 1995 and again in 2003, the second National Seminar on RCC Dams in Brazil in 1996, and the International RCC conference in China in 1999, the RCC Seminar, 2008 Dams and Pavements in Australia, and the International Forum on Concrete in Mexico in 2009. Ken also presented the Webinar on RCC Applications for ASDSO in 2013.

Mr. Hansen's experience with soil-cement water control design and construction predates his work with RCC and starts with slope protection for Ute Dam, New Mexico, in 1963. His lecturing on soil-cement now also totals nearly 250 presentations in the United States, Canada, Brazil and Australia.

### **PUBLICATIONS:**

Ken Hansen is primary author of the book "Roller-Compacted Concrete Dams" published by McGraw-Hill (copyright 1991) and "Design Manual for Small RCC Dams" published by PCA. He has edited or co-edited all three ASCE's books on RCC. They are "Roller-Compacted Concrete" a compilation of ten papers presented at the 1985 ASCE Spring Convention in Denver, "Roller Compacted Concrete II", the 487 page proceedings of the 1988 specialty conference in San Diego and "Roller Compacted Concrete III", the 509 page proceedings of the 1992 specialty conference, also conducted in San Diego. He has authored or co-

authored more than 80 papers on RCC, soil-cement and concrete applications in dams.

Ken is also the author of the 88-page ICOLD Bulletin "Soil-Cement for Embankment Dams". Mr. Hansen was the author or co-author of twelve technical papers on soil-cement design and construction as well as being retained on PCA to update several of its publications on soil-cement. He was a contributor to the ICOLD Bulletin "Roller Compacted Concrete" and USSD's "Annotated Bibliography on Roller-Compacted Concrete Dams" and "RCC Construction for Dam Rehabilitation."

#### **AWARDS:**

International Water Power & Dam Construction Magazine selected Mr. Hansen as one of the **60 most influential people in the global hydro and dams business over the last 60 years**, October 2009.

Ken was selected by the ASDSO Board of Directors as an Honorary Member in September 2009.

Mr. Hansen was honored as a Distinguished Engineering Alumni by the University of New Mexico School of Engineering in March, 2001.

American Concrete Institute-Elected Fellow-1988.

Ken was selected as Civil Engineer of the Year for 1988 by the Colorado Section of ASCE.

#### **PROFESSIONAL AFFILIATIONS:**

##### **Fellow, American Society of Civil Engineers (ASCE)**

Former National Director District 16 (seven states)

Former President - Colorado Section and Albuquerque Branch

Former Chairman, Professional Activities Committee (PAC)

Former Member - National Water Policy Committee (six years)

##### **Fellow, American Concrete Institute (ACI)**

Former Chairman - Committee 207 - Mass Concrete (4 years)

Member - Committee 230 - Soil-Cement

##### **Member, US Society on Dams (USSD)**

Member - Construction and Rehabilitation Committee

Former Member - Concrete Committee

##### **Honorary Member, Association of State Dam Safety Officials (ASDSO)**

The papers he has written or co-authored on RCC, soil-cement, or concrete dams include:

##### **Roller-Compacted Concrete**

Dinchak, W.G. & Hansen, K.D., "Consider Roller-Compacted Concrete for Hydro-Power Facilities," 5th Miami International Conference on Energy Sources, Miami Beach, Florida, December 1982.

Hansen, K.D., "Roller-Compacted Concrete Developments in the USA," Water Power and Dam Construction, January 1986.

Hansen, K.D. and France, J., "RCC-A Dam Rehab Solution Unearthed," Civil Engineering – ASCE, September 1986.

Hansen, K.D., "Roller Compacted Concrete Dams Worldwide". Water Power and Dam Construction Handbook, February 1987.

Tarbox, G.S. & Hansen, K.D., "Planning Design and Cost Estimates for RCC Dams," Roller Compacted Concrete II, ASCE, New York, February 1988, pp. 21-38.

Hansen, K.D., "Performance of Roller Compacted Concrete Dam Rehabilitations," Proceedings of Association of State Dam Safety Officials (ASDSO) 1989 Annual Conference, Albuquerque, New Mexico, October 1989.

Hansen, K.D., "The Use of Roller Compacted Concrete in USA Dam Construction," presented at NRMCA 1990 Convention, Perth, Australia, September 1990.

Jackson, H.E., Forrest M. P. and Hansen, K.D., "Rebuilding Quail Creek Dike With RCC," Proceedings of Association of State Dam Safety Officials (ASDSO) 1990 Annual Conference, New Orleans, Louisiana, October 1990.

Hansen, K.D., "Advantages of Roller Compacted Concrete Dams," RCC Newsletter, Vol. 7 No.1, Portland Cement Association Skokie, IL, Spring/Summer 1991, PL 332.01W.

Hansen, K.D., "RCC for Rehabilitation of Dams in the USA - An Overview," Roller Compacted Concrete III, ASCE, New York, February 1992.

Arnold, T.E., Feldsher, T.B., & Hansen, K.D., "RCC Test Specimen Preparation – Developments Toward A Standard Method," Roller-Compacted Concrete III, ASCE, New York, February 1992.

Hansen, K.D., "Roller-Compacted Concrete for Overtopping Protection of Embankment Dams," Proceedings of USCOLD 1992 Annual Meeting, Fort Worth, Texas, April 1992.

McLean, F.G. and Hansen, K.D., "Roller Compacted Concrete for Embankment Overtopping Protection," Geotechnical Practice for Dam Rehabilitation, ASCE New York, Raleigh, North Carolina, April 1993.

Hansen, K.D. "Using Roller-Compacted Concrete for Cost-Effective Dam Modification," Hydro Review, April 1993.

McLean, F.G. and Hansen, K.D., "RCC: Rehab Results," Civil Engineering - ASCE, August 1993.

Hansen, K.D. "Built in the USA – RCC Dams of the 1990s," Water Power and Dam Construction, April 1994.

Hansen, K.D. "Dam Rehabilitation Using Roller Compacted Concrete in the USA," Proceedings of Canadian Dam Safety Conference, Winnipeg, Manitoba, October, 1994. pp 281-293.

Hansen, K.D. "Roller Compacted Concrete Overtopping Protection in the USA," Canadian Dam Safety Newsletter, Vol. 6, No. 2, April 1995.

Hansen, K.D. & McLean, F.G. "Roller Compacted Concrete for Overtopping Protection: An Overview," Proceedings ASCE International Conference on Water Resources Engineering, San Antonio, Texas, August 1995. Vol. 2 pp. 1016-1020.

Hansen, K.D. "Roller-Compacted Concrete Dams in the USA: 1995," Proceedings of International Symposium, Roller Compacted Concrete Dams, Santander, Spain, Oct. 1995 Vol. 3

Hansen, K.D. "Roller Compacted Concrete: A Civil Engineering Innovation," – Concrete International, March 1996, pp. 49-53.

Hansen, K.D. "Erosion Resistance of Roller-Compacted Concrete," presented at ACI 1996 Spring Convention, Denver, Colorado, March 1996.

Hansen, K.D., "Roller Compacted Concrete for Overtopping Protection-1996," Proceedings Association of State Dam Safety Officials (ASDSO) Southeast Regional Conference Nashville, Tennessee. June 1996, pp 77-83.

Hansen, K.D. "Roller-Compacted Concrete Dams in the USA Lessons Learned – 1995," Relatos, II Seminario Nacional De Concreto Compactado Com Rolo, Curitiba, Brazil, 1996, pp. 1-21.

Hansen, K.D. "Diverging Views on RCC," International Water Power & Dam Construction, August 1996.

Hansen, K.D. "Combining Function and Aesthetics in RCC Dams and Dam Rehabilitations," Proceedings 36th Annual Conference Association of Conservation Engineers, Savannah, Georgia. Oct. 1997.

Hansen, K.D. "Current RCC Dam Activity in the USA," Hydropower & Dams Issue Five, 1997.

Hansen, K.D. "Form Follows Function in RCC Dams Too," International Journal on Hydropower & Dams Volume Five, Issue Three 1998.

Bass, R.P. and Hansen, K.D. "RCC Overtopping Protection Turns 50," Proceedings of Association of State Dam Safety Officials (ASDSO) 1998 Annual Conference, Las Vegas, Nevada, October 1998.

Hansen, K.D. "Combining Function with Aesthetics in RCC Dam Projects," Proceedings of Association of State Dam Safety Officials (ASDSO) 1998 Annual Conference, Las Vegas, Nevada, October 1998.

Hansen, K.D., Mclean, F.G. & Forbes, B. "Shear Strength of Roller Compacted Concrete Dams," Proceedings of International Symposium on Roller Compacted Concrete Dam-China RCC '99 Chengdu, China, April 1999.

Bass, R.P. and Hansen, K.D. "Dam Safety Modifications Using Roller-Compacted Concrete," 19<sup>th</sup> Annual USCOLD Lecture Series, Atlanta, Georgia, May 1999.

Hansen, K.D. and Bass, R.P. "How Old Dams are Reborn," International Water Power & Dam Construction, June 1999.

Hansen, K.D. "Roller Compacted Concrete Dams – Entering the 21st Century in Asia," Presented at International Conference on Global Power Requirements for the 21st Century, Jabalpur, India, Nov. 1999

Hansen, K.D. "What Will the Chinese Think of Next? – Recent Developments in RCC Dams Design and Construction," Proceedings of Association of State Dam Safety Officials (ASDSO) 2000 Annual Conference, Providence, Rhode Island, September 2000.

Hansen, K.D. "The Many Faces of RCC," Civil Engineering-ASCE, April 2001.

Bass, R.P. and Hansen, K.D. "RCC for Replacement Dams-Why?" Proceedings of Association of State Dam Safety Officials (ASDSO) 2001 Annual Conference, Snowbird, Utah. September 2001.

Hansen, K.D. "Erosion and Abrasion Resistance of Soil-Cement and Roller-Compacted Concrete," Portland Cement Association. Skokie, Illinois, R&D Bulletin 126, 2002.

Hansen, K. D. "Roller Compacted Concrete Dams - Why?" Presented at Seminar on Roller Compacted Concrete Dams, New Delhi, India, May 2002.

Arnold, T.E. and Hansen, K.D. "Seepage Performance of RCC Dams: Then and Now," 22<sup>nd</sup> Annual USSD Lecture Series, San Diego, California, June, 2002.

Hansen, K.D. and Kahler, C.M. "RCC Tests, Testing and Test Sections – Lessons Learned," Proceedings of Association of State Dam Safety Officials (ASDSO) 2002 Annual Conference, Tampa, Florida, September 2002.

Hansen, K.D. "RCC Overlays For Increasing Spillway Capacity -Lessons Learned," Proceedings of 23<sup>rd</sup> Annual USSD Conference, Charleston, South Carolina, April 2003.

Hansen, K.D., "RCC Use in Dam Rehabilitation Projects," Proceedings of International Symposium on Roller Compacted Concrete Dams, Madrid, Spain, November 2003.

Hansen, K.D. and Kahler, C.M. "RCC Tests, Testing and Test Sections – Lessons Learned" The Journal of Dam Safety, ASDSO, Lexington, Kentucky, Winter 2004.

Arnold, T.E. and Hansen, K.D. "Improvement and Advances in Seepage Control Systems for RCC Dams," Hydro Review, February 2004.

Hansen, K.D. and Bass, R.P. "Twenty Years of RCC Overtopping Protection – Then and Now" Proceedings of Association of State Dam Safety Officials (ASDSO) 2004 Annual Conference, Phoenix, Arizona, September 2004.

Choi, Y.K. and Hansen, K.D. "RCC/Soil-Cement: What's the Difference?" Journal of Materials in Civil Engineering, ASCE, July/August 2005.

Hansen, K.D. "Development of RCC Overtopping Protection in the Western United States" Proceedings of the West Regional Conference of the Association of State Dam Safety Officials (ASDSO), Santa Fe, New Mexico, April, 2005.

Hansen, K.D. and Campbell, D.B., "RCC Overtopping Protection – What are the Design Options," Proceedings of Association of State Dam Safety Officials (ASDSO), 2006 Annual Conference, Boston, Massachusetts, September, 2006.

Fitzgerald, T.J., Hansen, K.D., and Bowen, J., "Grout Enriched RCC – The Past and Future in the USA," Proceedings of the 2007 Annual ASDSO Annual Conference, Austin, Texas, September 2007.

Forbes, B.A., Hansen, K. D., and Fitzgerald, T. J. "State of the Practice- Grout Enriched RCC in Dams" Proceedings of the 28<sup>th</sup> Annual USSD Conference, Portland, Oregon. April – May 2008.

Hansen, K.D. "Design considerations for small RCC dams' The International Journal on Hydropower & Dams" Volume Fifteen, Issue 3, 2008.

Hansen, K.D. "Surviving the First Five Years of RCC Dams in the U. S. " Proceedings of Association of State Dam Safety Officials (ASDSO), 2008 Annual Conference, Indian Wells, California, September 2008.

Hansen, K.D., "Lessons from the past," International Water Power & Dam Construction, November 2008.

Hansen, K.D., "Why Do Dams Need to be Replaced? and Why With RCC? Presented at RCC 2009 Short Course and Tour, St. Louis, Missouri September 2009.

Hansen, K.D., and Johnson, D. "The use of RCC for Cofferdams" International Journal on Hydropower and Dams, Eighteenth Volume, Issue Four, 2011.

Fitzgerald, T., Hansen, K.D. and Marshall T. "Hot Dam! – Mass Concrete Expected vs Actual Performance," Proceedings of the Association State Dam Safety Officials (ASDSO) 2011 Annual Conference, Washington, DC, September, 2011.

Hansen, K.D. and Forbes, B.A. "Some of These Dams Are Not What They Are Cracked Up To Be – Thermal Performance of RCC Dams," Proceedings of the Association of Dam Safety Officials (ASDSO) 2012 Annual Conference, Denver, Colorado September, 2012.

Hansen, K.D. and Johnson, D.L. "RCC use in Cofferdams," 6<sup>th</sup> International Symposium on Roller Compacted Concrete (RCC) Dams, Zaragoza, Spain, October, 2012.

Hansen, K.D. and Forbes, B.A. "Thermal Cracking Performance of RCC Dams," 6<sup>th</sup> International Symposium on Roller Compacted Concrete (RCC) Dams, Zaragoza, Spain, October, 2012.

Hansen, K.D., Bass, R.P., and Fitzgerald, T. "Lessons Learned – More Than 100 RCC Overtopping Spillways in the United States," 6<sup>th</sup> International Symposium on Roller Compacted Concrete (RCC) Dams, Zaragoza, Spain, October, 2012.

Johnson, D.L., and Hansen, K.D. "Reduce Risk of Cofferdam Failure with RCC – An Historical Perspective," Proceedings of 33<sup>rd</sup> Annual USSD Conference, Glendale, Arizona, February 2013.

Hansen, K.D. and Johnson, D.L. "Water Over the Dam – RCC Dams/Cofferdams Performance When Overtopping During Construction" Proceedings of the 34<sup>th</sup> Annual USSD Conference, San Francisco, California, April 2014.

Hansen, K.D. and Fitzgerald, T.J. "Lessons Learned in the Past Ten Years Regarding the Performance of RCC Used for Overtopping Protection and Spillways," Proceedings of the Association of Dam Safety Officials (ASDSO) 2014 Annual Conference, San Diego, CA September 2014.

### **Concrete Use in Dams**

Hansen, K.D., "Cost of Mass Concrete in Dams," Portland Cement Association, Skokie, Illinois, 1979, MS 260 W.

Hansen, K.D. and Roehm, L.H., "Response of Concrete Dams to Earthquakes," International Water Power and Dam Construction, April 1979.

Hansen, K.D. and Nuss, L.K. "Lessons Learned from the Earthquake Performance of Concrete Dams" International Water Power and Dam Construction, July, 2011.

Nuss, Larry K., Matsumoto, Nori, and Hansen, Kenneth D. "Shaken, but not Stirred-Earthquake Performance of Concrete Dams" Proceedings of the 32<sup>nd</sup> Annual USSD Conference, New Orleans, Louisiana, April 2012.

Hansen, K.D. and Nuss, L.K. "Seismic Upgrades for Concrete Dams – Then and Now" Proceedings of the Association of Dam Safety Officials (ASDSO) 2013 Annual Conference; Providence, Rhode Island, September 2013.

Hansen, K.D. and Nuss, L.K. "Seismic Upgrades for Concrete Dams – Then and Now", The Journal of Dam Safety Officials, Volume II, Issue 4, 2013, Lexington, Kentucky.

Hansen, K.D. and Nuss, L.K. "Lessons Learned from Concrete Dam Failures Since St. Francis Dam" Proceedings of 34<sup>th</sup> Annual USSD Conference, San Francisco, California, April 2014.

Davidson, R.R. and Hansen, K.D. "Revisiting a Forgotten Dam Building Technology: Concrete Core Walls in 'Embankment Dams" Proceedings of 35<sup>th</sup> Annual Conference, Louisville, Kentucky, April 2015.

## Soil-Cement

Holtz, W.D. and Hansen, K.D., "The Use of Compacted Soil-Cement in Water Control Structures," transactions of 12<sup>th</sup> International Congress on Large Dams, Mexico City, Mexico, Q44 R13 pp. 251-278, 1976.

Hansen, K.D. and Avera, J.K., "Dams That Never End," Water Power and Dam Construction, March 1978.

Wulliman, J.T. and Hansen, K.D., "Design and Construction of Soil-Cement Drop Structures," presented at 1990 National Conference on Hydraulic Engineering, ASCE, San Diego, California, August 1990.

Hansen, K.D. "Soil-Cement Is Big In Texas Water Projects," Concrete International, January 1991.

VanRiessen, G.J. and Hansen, K.D., "Cement-Stabilized Soil for Coal Retaining Berms," Grouting, Soil Improvement, and Geosynthetics, ASCE, New York, February 1992.

Clem, D.A., Hansen, K.D. and Kowalsky, J.B. "Flowable Backfill for Pipeline Bedding at the Denver International Airport," Controlled Low-Strength Materials, American Concrete Institute SP-150, Detroit, 1994. pp. 87-96.

Hansen, K.D. and Lynch, J.P. "Controlling Floods in the Desert with Soil-Cement," Proceedings of Second CANMET/ACI Int. Symposium on Advances in Concrete Technology. Las Vegas, Nevada, June 1995.

Richards, D.L. and Hansen, K.D., "Soil-Cement for Channel Bank Stabilization," Proceedings of 1998 International Water Resources Engineering Conference, Memphis, Tennessee, August 1998.

Hansen, K.D. and Schexnayder, C., "Construction of Stair-Stepped Soil-Cement Bank Protection," Proceedings of GEO Institute GeoDenver 2000 Specialty Conference, ASCE, Denver, Colorado, August 2000.

Hansen, K.D. "Erosion and Abrasion Resistance of Soil-Cement and Roller-Compacted Concrete," Portland Cement Association, Skokie, Illinois, R&D Bulletin 126, 2002.

Choi, Y.K. and Hansen, K.D. "RCC/Soil-Cement: What's the Difference?" Journal of Materials in Civil Engineering, ASCE, July/August 2005.

Hansen, K.D., Richards, D.L. and Krebs, M.E. "Performance of Flood – Tested Soil-Cement Protected Levees," Proceedings of the 31<sup>st</sup> Annual USSD Conference, San Diego, California, April 2011

Hansen, K.D., Rutledge, J. Rutigliano, N. and Kirksey, B. "An Evaluation of Soil-Cement Slope Protection for Embankments – Stair Stepped vs. Plating," Proceedings of the Association of States Dam Safety Officials (ASDSO) Annual Conference, New Orleans, Louisiana, September 2015.

## Roller Compacted Concrete Dams:

**C51 Reservoir, West Palm Beach, Florida** – Reviewed design and specifications for AMEC, Lakeland, FL, for a 23 ft. high RCC gravity section and RCC plated embankment that forms a new water supply reservoir for the West Palm Beach area. The reservoir, which sits on 2,200 acres of land owned by Palm Beach Aggregates provides both above and below grade storage in a mined out limestone aggregate pit (2014).

**San Julian Dam, State of Chihuahua, Mexico:** Reviewed geology, geotechnical and hydrology reports prepared by Comisión Federal de Electricidad, for a new 44 m high RCC dam that will supply water for a new silver and gold mine being built by Fresnillo, plc. Provided input on design including elimination of the spillway, RCC mixture preparations, facing systems and specifications. Visited site to provide input on material supply and construction methods. (2014-2015)

**Clear Lake Replacement Dam, Georgetown, Colorado:** Consulted to W.W. Wheeler and Associates on the design and specifications for a 37-ft high RCC replacement dam for a 110-year old embankment dam, owned by Xcel Energy with serious dam safety deficiencies. Then served on a 4-person FERC required **Board of Consultants** to provide an independent peer review of the design and execution of RCC test section (2013-2015).

**Cobbs Creek Dam, Cumberland County, Virginia:** Prepared detailed cost estimate for RCC dam alternative for water supply dam (2012) Schnabel Engineering, Greensboro, North Carolina.

**Grindstone Canyon Dam Study, Ruidoso, New Mexico:** Provided input on present static and earthquake stability of 24-year old RCC dam, (2010-2011) AMEC Earth and Environmental,

Albuquerque, New Mexico.

**Pervari Dam, southeastern Turkey**-Participated in preliminary design for 541 ft. high RCC hydroelectric dam, MPR, Alexandria, Virginia for NTF Construction, Ankara, Turkey (2009)

**Ragged Mountain Dam, Charlottesville, Virginia:** Provided internal review of Schnabel Engineering reports for the design and cost estimate prepared by another consultant for a new RCC dam (2008) Prepared report on aggregate sources and cost for Schnabel (2010) Rivanna Water and Sewer Authority, Charlottesville, Virginia.

**Traveston Crossing Dam, Australia:** Consulted on design and promotional aspects for design –build proposal for planned composite RCC water supply dam for Queensland (2008). URS Corporation, Brisbane, Australia.

**Laurelmor Clubhouse Dam, Boone, North Carolina:** Consulted on preliminary RCC mixture proportions, facing systems, cost and thermal considerations for planned 115 ft high RCC dam for 6600 acre resort development for Ginn Properties (2006-2007). S&ME, Charlotte, North Carolina.

**Rocky Pen Run Dam, Stafford County, Virginia:** Participated in Value Engineering study on preliminary design and cost estimate by URS for 140 ft high RCC dam with earth embankment wings on each side (2005, 2008). Stafford County, Virginia.

**Hickory Log Creek Dam, Canton, Georgia:** While with Schnabel Engineering, provided input on the dam type selection study that resulted in the selection of RCC for the 188 ft. high water supply dam for the Cobb County Marietta Water Authority and the City of Canton. Consulted on RCC mixture proportions, the cost estimate and performed the thermal cracking and joint spacing analysis. (2004-2007). Cobb County Marietta Water Authority and City of Canton, Georgia.

**Keren Dam - Eritrea:** Preliminary Design consulting (2001-2002) for Michael W. West & Associates, Centennial, Colorado.

**Portugues Dam, Puerto Rico:** Presentation and consulting on preliminary design for RCC gravity arch dam (2002). Jacksonville District Corps of Engineers.

**Deep Creek Dam, Site 5D, Yadkin County, North Carolina:** While with Schnabel Engineering, and then as an individual consultant, provided input on the preliminary design details for the RCC portion of this 72 ft. high composite RCC/earthfill dam for water supply and flood control. Also provided consultation on the final cost estimate, reviewed the revised specifications in NRCS format and aided with oversight and evaluation of the RCC test section construction (2008-2009). NRCS, Raleigh, North Carolina.

**Ghatghar Hydro Project Dams, India:** Consulting on constructability and cost saving items for three RCC dams (2002) ASI RCC, Buena Vista, Colorado & Patel Engineering, Mumbai, India.

**Saluda Backup Dam, Columbia, South Carolina:** Served as **FERC's expert consultant** for five years on the design, construction, mixture proportions and RCC test section evaluation for this 208 ft. high seismic safety related backup dam for South Carolina Electric and Gas Company. The new dam required more than 1.3 million cu. Yds. of RCC (2000-2005).

**Tobesofkee Creek Replacement Dam, Forsyth, Georgia:** Provided input on the design of this RCC replacement water supply dam for the City of Forsyth after the original embankment dam washed out due to overtopping during a flood. Also provided on-site coordination on the RCC test section construction and testing (1999) City of Forsyth, Georgia.

**Olivenhain Dam, Encinitas, California:** Member of **Board of Senior Consultants** for 308.5 ft. (94m) high RCC dam (1998-2000) San Diego County Water Authority, San Diego, California.

**Cine Dam, Turkey:** Consulting on construction of 130m high RCC dam (1998-2003) Ozkar Construction Company, Ankara, Turkey.

**Yahoola Creek Dam, Dahlonega, Georgia:** Preliminary Design for 60' high RCC dam (1998) Lumpkin County, Georgia.

**Minera Horizonte Project Tailing Dam, Peru:** Conceptual design for an RCC tailings dam at Alpa Marca site (1998) Knight Piesold, LLC, Denver, Colorado.

**Pascua Project Tailings Storage Dam, Chile:** Conceptual Design for 242m high RCC Dam to be built in three stages (1998) Knight Piesold, LLC, Denver, Colorado.

**Buckhorn Dam, Wilson, North Carolina:** Assistance with Bid Preparation (1998) Branch Highways, Inc., Roanoke, Virginia.

**Toker Dam, Eritrea:** Estimating Cost Study (1995) Woodward Clyde Consultants, Denver, Colorado.

**Mopan Dam, Guatemala:** Preliminary Design Report (1995) Hydro Mopan, Idaho Falls, Idaho.

**Longtan Dam, China:** (192 m) - Design Review and Tour of RCC Dams in the USA for designers from China (1993-94) AGRA Earth and Environmental, Phoenix, Arizona for Mid South Design Institute.

**Egiin Hydroelectric Dam, Mongolia:** Design Review (1993) Woodward-Clyde Consultants, Denver, Colorado for Asian Development Bank.

**Jequitai Dams, Brazil:** Preliminary Design Review (1993) Engecorps, San Paulo, Brazil.

**Kroombit Dam, Australia:** RCC Mixing Equipment Evaluation (1992) Leighton Contractors, Brisbane, Australia.

**Spring Hollow Dam, Roanoke, Virginia:** Quality Assurance Proposal (1992) Schnabel Engineering Associates, Bethesda, Maryland.

**Town Wash Dam, Mesquite, Nevada:** Final Design and Construction Monitoring (1991-92) CH2M Hill, Redding, California.

**Victoria Replacement Dam, Ontonagon County, Michigan:** Consultant on preliminary and final design for an RCC replacement gravity dam for the concrete multiple arch dam that had experienced freeze-thaw deterioration and cracking (1990-1991). Stone & Webster Engineering Corporation, Denver, Colorado.

**New Victoria Dam, Australia:** Design Review (1989) Gutteridge, Haskins & Davey, Brisbane for Water Authority of Western Australia – also aid with tender for Baulderstone-Hornibrook contractor.

**Pangue Dam (115m), Chile:** Preliminary Design Review (1989) Kaiser Engineers for ENDESA, Santiago, Chile.

**Box Canyon (RCC) Dam, New Mexico:** Preliminary Design & Cost Study (1988) Morrison-Knudsen Engineers, Denver, Colorado, for the U.S. Dept. of Justice.

**SWJD Dam, Spartanberg, South Carolina:** Preliminary Design (1987-88) Black & Veatch, Greenville, South Carolina.

**Lower Wailua Diversion Dam, Kauai, Hawaii:** Preliminary and Final Design and Specifications (1987) Bingham Engineering, Salt Lake City, Utah.

### **Roller Compacted Concrete for Dam Rehabilitation and other Applications:**

**Lake White Dam, Waverly, Ohio:** Consulted to Stantec on preliminary design and specification review for RCC overtopping protection for this \$32 million dam rehabilitation that is being jointly funded by the Ohio Department of Transportation and the Ohio Department of Natural Resources (2015).

**Dull Knife Dam, Buffalo, Wyoming:** Consulted to Tetra Tech on design, cost estimate and mixture proportions for the stepped RCC portion of a replacement combined service and auxiliary spillway for this NRCS dam (2015).

**Klondike Highway Bridge Replacement, Skagway, Alaska:** Consulted to DOWL on complete RCC infill of steep canyon to replace existing Captain William Henry Moore cable-stayed bridge, for Alaska Highway Department (2015-2016).

**Cherokee Dam Raise, Jefferson City, Tennessee:** Consulted to Stantec on all phases of a 4-ft. high raise to the main dam and three saddle dams that form Cherokee Lake to prevent overtopping during a rare hydrological event. Reviewed final plans and specs, provided the basic criteria for the RCC mixture proportions, reviewed all contractor submittals and coordinated construction of the RCC test section for this TVA owned dam (2014).

**Left Hand Valley Dam, Boulder, Colorado:** Inspected RCC protected auxiliary spillway that operated for one week during the September 2013 flooding in Colorado. Prepared a report on the present



condition of the RCC overlay and expected future life of the RCC for the Left Hand Ditch Company, Niwot, Colorado.

**Sainte-Cecile Dam Upgrade, Department of Gard, France:** Served as an **international expert to Electricite de France (EDF)** on RCC overtopping alternatives to increase spillway capacity for a 131-foot high rockfill dam. Visited site and made presentation to the owner, engineer, reviewer, and regulators on RCC expertise with RCC overtopping protection on more than 100 dams in the US (2013).

**Las Animas Diversion Dam Modifications, Las Animas, CO:** Consulted to W.W. Wheeler and Associates on the RCC buttress to strengthen this century-old diversion dam located adjacent to the Arkansas River for Public Service Company of Colorado (dba as Xcel Energy). Provided input on RCC mixture proportions, suppliers of materials, reviewed final plans and specifications as well as coordinated construction of the RCC test section (2010-2011) W.W. Wheeler & Associates, Englewood, Colorado.

**Cabresto Lake Dam, Questa, New Mexico:** Consulted to RJH Consultants on RCC and concrete aspects of the new spillway and stilling basin for the rebuilt dam located at an elevation greater than 9,000 ft. Consulting also included recommendations on mixture proportions for the RCC as well as the air-entrained concrete exterior protection at this cold weather site subjected to frequent freeze-thaw cycles (2010 - 2012) RJH Consultants, Englewood, Colorado.

**Stoney Creek Dam, Bedford County, Virginia:** Reviewed and revised specifications for RCC overtopping protection (2009) Schnabel Engineering, Greensboro, North Carolina.

**Capay Dam, Yolo County, California:** Consulted on design, mixture proportions, cost estimate and specifications for stepped RCC, and extension of eroded apron of the concrete diversion dam. Provided on-site management for construction of RCC test strip. (2008-2010) Stantec, Phoenix, Arizona.

**Cobb Creek No.1 Dam Rehabilitation, Weatherford, Oklahoma:** Aided with design of new RCC chute spillway with stepped sides for 80-ft. high embankment dam that forms Lake Crowder (2009) for Schnabel Engineering for NRCS- Oklahoma.

**Yellow River Site No. 16 (Y16), Lawrenceville, Georgia:** Assisted with cost estimate and construction considerations for small volume of RCC overtopping protection for low NRCS designed dam (2007). Gwinnett County, Georgia.

**Poe Valley State Park, Centre County, Pennsylvania:** Reviewed plans and specifications for RCC overtopping protection for 40 ft high RCC dam (2006). Provided site consulting on quality control testing (2008). Pennsylvania Department of General Services, Harrisburg, Pennsylvania.

**Murchison Dam, Australia:** RCC expert on **International Review Panel** to study options including RCC overtopping protection for hydraulic upgrade of 93m high concrete faces rockfill (CFRF) dam (2004) for Hydro Tasmania, Hobart.

**Linville Dam, Morganton, North Carolina:** Consulting on preliminary design and cost estimate for 125 ft. high RCC retaining wall for dam's seismic upgrade (2003). Devine, Tarbell & Associates (Now HDR), Charlotte, North Carolina.

**Goshen Dam, Virginia:** Reviewed design for RCC overtopping protection and supervised RCC mixture proportioning study (2001-2007) for Norfolk District Corps of Engineers.

**McKinney Lake Dam, North Carolina:** Supervised construction of RCC test section and consulted on construction methods (2001) North Carolina Wildlife Resource Commission.

**Marrowbone Dam #1 Rehabilitation, Martinsville, Virginia:** Consulted on RCC overtopping protection concept and RCC test section evaluation (2005) Schnabel Engineering, Greensboro, North Carolina for NRCS-Virginia.

**Lake Tholocco Dam Rehabilitation, Ft. Rucker, Alabama:** Reviewed design and specifications for RCC overtopping protection and oversaw construction of RCC test section (1999-2000) for Mobile District Corps of Engineers.

**Pioneer Detention Basin, Henderson, Nevada:** Consulting on laboratory testing and mix proportions for RCC spillway (1999-2000), Terracon Las Vegas, Nevada.

**Anthem #2 Detention Basin, Henderson, Nevada:** Consulting on RCC spillway design,

specifications, test section and project construction (1998-2000) G.C. Wallace, Inc., Las Vegas, Nevada.

**Pueblo Dam Modification, Pueblo, Colorado:** Assistance with Bid Preparation (1998) Bradbury & Stamm Construction, Albuquerque, New Mexico.

**Tongue River Dam Modification, Decker, Montana:** Provided construction problem resolution for RCC overtopping protection cracking (1997) Barnard Construction Company, Bozeman, Montana.

**Douthat Dam rehabilitation, Clifton Forge, Virginia:** Test Section Construction (1997) Timmons Engineering, Richmond, Virginia.

**Niagara Dam rehabilitation, Roanoke, Virginia:** **Niagara Dam rehabilitation, Roanoke, Virginia,** American Electric Power Corp., Columbus, Ohio.

**North Unit Irrigation District Main Canal Lining, Bend, Oklahoma:** Final Design & Specifications & Review (1996-97) HDR Engineering, Bellevue, Washington.

**Bonneau Dam Modification, Rocky Boy, Montana:** On-site consulting on RCC overtopping protection design, (1995) Tierra Engineering Consultants, Santa Fe, New Mexico.

**Indian Bend Wash Drop Structure, Tempe, Arizona:** VE Proposal (1992) Pulice Construction Co., Phoenix, Arizona.

**Kyle Canyon Detention Basin, Northern Las Vegas, Nevada:** Final Design (1991-92) VTN-Nevada, Las Vegas, Nevada.

**Xingo Hydroelectric Project, Brazil:** (140 m - CFRF Dam) - On-Site Design and RCC and Concrete Construction Review (1992-94) PROMON Engenharia, San Paulo, Brazil.

**Coddle Creek Dam Emergency Spillway, Charlotte, North Carolina:** Construction Control (1992) HDR Engineering, Denver, Colorado.

**Upper Las Vegas Wash Detention Basin, Northern Las Vegas, Nevada:** Final Design and RCC Test Section Construction (1990-91) Black & Veatch, Las Vegas, Nevada.

**Bishop Creek Dam #2 Rehabilitation, Bishop, California:** Preliminary Design (1987) James M. Montgomery Engineers, Pasadena, California.

**Hornsby Bend Lagoons, Austin, Texas:** Construction Control (1986) Camp Dresser and McKee, Austin, Texas.

## **Concrete for Dams; etc.**

**Columbine Dam, Woodland Park, Colorado:** Inspected an 83-year old concrete gravity dam that had been repaired previously to determine its present condition to receive an additional concrete overlay. Reviewed proposed design, draft specifications and stability calculations. Prepared report for the owners – Colorado Springs Fly Casting Club (2013).

**Bear River Canal Failure, Colfax, California:** Consulted on concrete mixture proportions and placing methods on a steep slope to allow rebuilding of a failed support for a PG&E water supply canal (2011) SAGE Engineers, Granite Bay, California

**Tourist Park Replacement Dam, Marquette, Michigan:** Served as the mass concrete specialist on the FERC required owner's **Board of Consultants** for the rebuilding of this failed embankment dam caused by the failure of the upstream Silver Lakes Dam. Provided review and comments of all the consultant's reports and contract documents. He was also called upon to consult on how to proceed during construction after a severe unexpected gouge in the foundation rock was uncovered during excavation for the mass concrete spillway section (2005, 2008-2014). Marquette Light and Power Company, Marquette, Michigan.

**Salem Lake Dam Replacement, Winston Salem, North Carolina:** Consulted to Schnabel Engineering on the thermal cracking analysis and transverse joint spacing for this mass concrete replacement dam for the City of Winston Salem. Also provided peer review for the concrete specifications (2010) Schnabel Engineering, Greensboro, North Carolina

**Northern Pacific Reservoir Dam, Helena, Montana:** Analysis and recommendations for repair of old gravity arch concrete dam, (1999) Ash Grove Cement Co., Portland, Oregon.

**Xingo Hydroelectric Project, Brazil:** (140 m – CFRF Dam) - On-Site Design and Concrete Construction Review (1992-94) PROMON Engenharia, San Paulo, Brazil.

## **Soil-Cement:**

**Green River Water Reservoir, Green River, Wyoming:** Consulted to Miller Geotechnical Consultants as a sub consultant to Nelson Engineering on soil-cement testing and criteria for providing slope protection for a water supply reservoir (2015).

**Manatee Power Station Cooling Water Reservoir, Parrish, Florida:** Participated as part of AMEC Foster Wheeler team to provide an in-depth inspection of a 40-year old stair-stepped soil-cement slope protection for the nearly 9-mile long embankment. The results of the inspection were used to develop a means of estimating the remaining useful life of the soil-cement protection and developing a suggested repair method for Florida Power and Light consisting of a concrete overlay (2015).

**Lower Santa Ana River, Reach 9, Phases 4 and 5A, Corona, California:** Selected as soil-cement expert for Board of Consultants for Type II Independent External peer review for soil-cement bank protection for this Los Angeles, Corps of Engineers flood control project through Schnabel Engineering (2015).

**Lane City Reservoir, Lane City, Texas:** Served as consultant to CH2M-HILL on soil-cement slope protection design, cement content determination and specifications for a five-mile long embankment approximately 40-feet high for a water storage reservoir for the Lower Colorado River Authority (LCRA) (2014).

**C44 Reservoir, Pahokee, Florida:** Provided independent technical review of design and specifications for plating soil-cement for protecting slopes of 3,600 acre reservoir for HDR Engineering, Tampa, Florida (2012-2013).

**Tampa Bay Water Reservoir Renovation, Lithia, Florida:** Reviewed soil-cement slope protection specification and provided input on construction methods and aesthetics for placing new stair-stepped soil-cement slope protection for Kiewit Infrastructure, Tampa, Florida (2013-2014).

**Rueter-Hess Dam, Parker, Colorado:** Inspected soil cement plating slope protection that reported had not been protected against freezing temperature for one night. Recommended additional water curing to restore compressive strength, (2011) Peltz Companies, Inc. Alliance, Nebraska.

**Toledo Bend Dam, Burkeville, Texas:** Performed detailed inspection of soil-cement slope protection and provided report on conditions and remedial measures recommended for cracks and joints in the soil-cement (2010-2011), Freese and Nichols, Houston, Texas.

**Santa Maria Levees, Santa Maria, California:** Served as the **Materials Expert for the Safety Assurance Review (SAR)** for Battelle Institute for a Corps of Engineers design for soil-cement protected replacement levees along a more than 6 mile stretch of the Santa Maria River and the Bradley Canyon extension. Provided review of the Design Deficiency Report (DDR) Environmental Assessment (EA) as well as the plans and specifications. Oversaw RCC construction during three site visits (2010 - 2013).

**Aurora Reservoir Water Purification Facility, Aurora, Colorado:** Consulted on construction and performance of soil cement lining for five water and sludge storage lagoons (2008-2009) for CH2MHill, Denver, Colorado.

**Prado Dam Flood Wall, Corona, California:** Served on three person **Board of Experts** on design and construction of Corps of Engineers Los Angeles District solid soil-cement flood wall to protect the BNSF Railroad from a PMF event (2008) Parsons Brinkerhoff Quade and Douglas, Los Angeles, California.

**Peace River Reservoir, Port Charlotte, Florida:** Consulting on design, constructability, specifications and precedent for “plating” soil-cement slope protection for 640 acre reservoir for Peace River/Manasota Regional Water Supply Authority (2006-2009) MWH, Denver, Colorado.

**Ten Mile Creek Reservoir, Ft. Pierce, Florida:** Consulted on in-place specifications and acceptability and properties of completed plating soil-cement slope protection for Corps of Engineers

Jacksonville District's 600 acre reservoir that is part of the Everglades Restoration Project (2005)  
Atlantic Skanska, Atlanta, Georgia.

**Tampa Bay Water Reservoir, Lithia, Florida:** Consultation on soil-cement construction on 3H:1V slope for 1,100 acre water supply reservoir (2003), Barnard Construction Company, Inc., Bozeman, Montana. Aid with Proposal and interview for rehabilitation design criteria contract, Halcrow, Tampa, Florida (2010).

**Garfield County Airport, Rifle, Colorado:** Consulted on soil-cement laboratory test program, design and specifications review for steep 70-foot high soil-cement buttress (2007-2009) Tetra Tech, Golden, Colorado.

**Boise City, Oklahoma Waste Water Lagoons, Boise City, Oklahoma:** Expert witness on soil-cement design and construction (1999-2000) D.E. Rice Construction, Inc., Borger, Texas.

**Fish Creek Dam, (Moss Lake) Modifications, Gainesville, Texas (2002):** Expert Witness for sub contractor Entact, Inc vs. Hays Construction Inc.(Prime), on claim of defective soil-cement specifications; Strasburger and Price Attorneys, Dallas, Texas.

**Sanford Plant, Sanford, Florida:** Inspection and consulting on repair and preventive maintenance for 28-year old soil-cement slope protection for cooling water reservoir and channel, (1999-2000) Florida Power & Light Company, Juno Beach, Florida.

**Kahoolawe Island Road, Hawaii:** Consulting on soil-cement acceptance criteria mixture proportions and test section construction (1998-1999) Geolabs, Hawaii, Honolulu, Hawaii.

**Santa Margarita Flood Protection, Camp Pendleton, California (1998-2000):** Consulting on cement determination, construction methods and expert testimony, PK Contractors, Inc., Spokane, Washington.

**Shattuck Chemical Waste Stabilization, Denver, Colorado:** Assistance with Arbitration (1997) Earth Science Consultants, Export, Pennsylvania.

**Guyman, Oklahoma Sewage Lagoons, Guyman, Oklahoma:** Construction Assistance (1987) LABCO Construction, Chickasha, Oklahoma.

**Rosana and Porto Primavera Dams, Brazil:** Final Design and Construction Criteria (1985) CESP, San Paulo, Brazil.