Boyd Clark, Ph.D.

Principal In Charge

As the Vice President of Materials at CTLGroup, Dr. Clark excels in materials science, new product design, and the research and analysis of building materials. He is additionally proficient in the application and use of scanning electron microscopy (SEM), optical microscopy, X-ray diffraction (XRD), and X-ray fluorescence (XRF). With over 25 years experience as a principal investigator for a wide variety of material related failures, Dr. Clark is a leader in litigation and support for CTLGroup. Prior to joining CTLGroup, Dr. Clark worked at a major testing and consulting firm where, among other roles, he served as Director of Construction Materials Services. There, he was involved in research and problem solving analyses for materials including ceramics, metals, minerals, and building products.

Representative Project Experience

Materials Analysis & Structural Investigation

- Determined the cause of deterioration in concrete members including railroad ties, bridges and piers, parking garages, residential foundations + swimming pool plasters.
- Evaluated concrete in a building damaged as a result of the collapse of the World Trade Center Towers. The evaluation included failure analysis, appraisal of thermal effects on cementitious and metal building systems and the extent to which diesel fuel ingress compromised structural integrity.
- Evaluated and designed cementitious systems for the incorporation of simulated mixed waste (radioactive and non-radioactive) from the Hanford Reservation.
- Has overseen multiple projects for the Nuclear Industry; projects have been governed by both DOE and NRC regulations. Projects include qualifying constituents for concrete production, evaluating structural integrity and durability of concrete containing radioactive waste, and operations to evaluate concrete and mortar specimens with low levels of radioactivity, including examinations using multiple analytical techniques and physical testing.
- Evaluated concrete samples using multiple analytical techniques to determine cause of deterioration; concrete members evaluated include concrete railroad ties, bridges and piers, parking garages, stucco applications, residential foundations, and swimming pool plasters.

Laboratory Oversight

- Overseen various laboratory functions for the testing of cement, fly ash, slag, concrete, and other components related to construction materials. Testing includes wet chemical, mechanical (structural) behavior, physical parameters, microscopy, and analytical chemistry techniques, including organic and inorganic analytical techniques.

Academic Credentials

Ph.D. Intercollege Materials Program Pennsylvania State University, 2001

M.S. in Materials Science and Engineering University of California-Berkeley, 1988

B.S. in Materials Science and Engineering University of California-Berkeley, 1983

Professional Affiliations

- Need -

Contact Information

(847) 972-3348
BClark@CTLGroup.com

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Representative Project Experience (Continued)

Laboratory Oversight (Continued)

- Skilled in application of laboratory systems and quality control programs for numerous test methods in environmental and construction industry.
- Managed routine laboratory operations for environmental assessments using both organic and inorganic test procedures.
- Research and problem-solving analyses for a wide variety of materials, including semiconductors, metals, minerals, and building products utilizing multiple analytical techniques.

Nuclear Industry

- Oversaw multiple projects for the Nuclear Industry, governed by both DOE and NRC regulations. Projects included qualifying constituents for concrete production, evaluating structural integrity and durability of concrete containing radioactive waste, and research of cementitious waste forms for long term disposal. developed laboratory operations to evaluate concrete and mortar specimens with low levels of radioactivity, including examinations using multiple analytical techniques and physical testing.
- Evaluation and design of cementitious systems for incorporation of simulated mixed waste (radioactive and non-radioactive) from the Hanford Reservation. Projects involved the evaluation of physical and chemical parameters for long-term containment and/or solidification of liquid or solid waste components.

Environmental Toxins Analyses

- Managed laboratory performing environmental testing using standard analytical and wet chemistry techniques for building products, contaminated soils and water specimens.
- Evaluation of a building damaged as a result of the collapse of the World Trade Center Towers. Evaluation included appraisal of the extent of diesel fuel ingress and the extent of dust contamination on electronic components.
- Managed department evaluating dust samples for multiple industrial clients. Both bulk and air-borne dust samples were evaluated on a routine testing basis. Testing included organic and inorganic component evaluations.
- Managed projects using automated SEM and optical microscopy techniques to enhance particulate evaluation. These testing results were, in turn, used many times for source apportionment purposes. Also assisted in the development of automated techniques for project-specific purposes.
- Designed sampling programs and reporting systems for monitoring nuisance dust, respirable and bulk crystalline silica in the mining and construction industry.

Representative Project Experience (Continued)

Concrete Construction

- Evaluated concrete samples using multiple analytical techniques to determine cause of deterioration. Concrete components evaluated include concrete railroad ties, bridges and piers, parking garages, stucco applications, residential floors and foundations, and swimming pool plasters.
- Evaluation of a building damaged as a result of the collapse of the World Trade Center Towers. Evaluation included appraisal of thermal effects on cementitious and metal building systems; assessments were used to evaluate the extent of compromised concrete structural integrity.
- Managed department evaluating cementitious materials for failures and concrete mix design determinations. Testing generally employed SEM and optical microscopy techniques for projects.
- Evaluated stucco construction defects in residential applications, including mix design problems, component failures, and durability issues.

Coating Failures

- Evaluated numerous construction defects involving failures of coatings. Coating failures have included paint delamination, cementitious material finish coats, and elastomeric coatings on exterior building surfaces. Substrate materials, with coatings, have included aluminum frames, concrete, stucco, and plastics. Evaluation of construction defects included origin of coating failure, defects present in coatings (voids and foreign materials), determination of coating thicknesses, assessment of organic and inorganic constituents, and identification of specific products used for the coatings.
- Project involving the evaluation of premature deterioration of oil refinery fireproofing. Cementitious fireproofing applied to steel girders for use in an oil refinery expansion was delaminating and cracking due to outdoor exposure. Numerous analytical techniques were employed to evaluate the cause of observed yellowing of the product and correlated microstructural changes to the fireproofing. Determined that causation was directly related to the inadequate manufacturing practices employed for the pre-bagged products used in casting the fireproofing on the beams.
- Assessed numerous failure projects of coatings on architectural aluminum frames for high-rise buildings in marine environments. In these projects fluoropolymer compounds were required for the long term durability. Assessments included evaluation of component manufacturing and failure mechanisms.

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Representative Project Experience (Continued)

Metal Corrosion

- Involved with projects evaluating the corrosion of various metal components using optical microscopy, SEM, and other analytical techniques. Multiple routine investigations passed through the laboratory to characterize corrosive ionic species and to assess extent of corrosion.
- Large projects involved corrosion of household articles from chlorine gas (train derailment) and corrosion of metal components in single family residences in Southern California, Arizona, Hawaii and Florida.
- Evaluation of corrosion mechanisms of aluminum architectural frames due to marine environment.
- Assessing the service life of corroding fasteners for a building envelope system in a high-rise, multi-family building.
- Led development of new product designed to prevent corrosion of metal in concrete using chemical inhibitors. Comparisons included using existing (marketed) liquid corrosion inhibitors.

Publications

- Henocq, P., E. Samson, J. Marchand, and B. Clark. 2007. "**Determination of the Chloride Content Threshold to Initial Steel Corrosion**." 5th International Essen Workshop – TRANSCON 07 – Transport in Concrete: Nano- to Macrostructure, Essen, Germany. June 11-13.
- E. Samson, J. Marchand, and B. Clark. 2008. "**Extending the service life of an existing bridge structure using a predictive modeling software**". Concrete Bridge Conference, St. Louis, May 4-7 (presentation).
- Feng, X. and Clark, B. 2014. "**Portland-Limestone Blended Cement: Effects of Limestone Characteristics**". Portland Cement Association R+D SN3241.
- Feng, X., and Clark, B. 2012. "**Correlations between the Laboratory Test Methods for Potential Alkali-Silica Reactivity of Aggregates**." 14th International Conference on Alkali Aggregate Reaction, Austin, Texas. May.
- Cooke, G. A., L. L. Lockrem, B. A. Clark, and R. Westberg. 2008. **Cast Stone Technology for Treatment and Disposal of Iodine Rich Caustic Waste Demonstration** - Final Report. CH2M Hill, RPP-RPT-26725, Hanford Group, Richland, Washington.
- Atteridge, D., M. Avila, V. Baca, S. Stevens, R. Westberg, K. M. Bishop, G. A. Cooke, L. L. Lockrem, B. Clark, R. J. Lee, and M. Silsbee. 2005. "**Development of a Cast Stone Formulation for Hanford Tank Wastes**." Full Paper, Presented at the RemTech 2005 Symposium, CH2M Hill, RPP-RPT-27297-FP, Banff, Alberta. October 19-21.

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Publications (Continued)

- Avila, M., G. A. Cooke, L. L. Lockrem, G. L. Koci, M. D. Guthrie, K. J. Lueck, B. Clark, R. J. Lee, and M. Silsbee. 2005. "**Development of Waste Forms for the Hanford Brines Basin 42 Waste Water + WTP Secondary Wastes & Bulk Vitrification Secondary Waste**." Full Paper, Presented at the RemTech 2005 Symposium, CH2M Hill, RPP-RPT-27298-FP, Banff, Alberta. October 19- 21.
- Clark, B. A., S. Badger, N. Thaulow, S. Sahu, G. Hobbs, R. J. Lee, J. Marchand, and U. Jakobsen, 2004. "**Petrography Analysis of a Building Foundation Impacted by 9/11**." Presented at and abstract published in the Hal Taylor Cement and Concrete Conference Book, Les Diablerts, Switzerland. June 20-23.
- Brown, P. W., B. A. Clark, and R. D. Hooton. 2004. "**Microstructural Changes in Concretes with Sulfate Exposure**." Cement and Concrete Composites, 2, No. 8: 993-999. November.
- Brown, P. W., B. A. Clark, and R. D. Hooton. 2003. "**The Co-Existence of Thaumasite and Ettringite in Concrete Exposed to Magnesium Sulfate at Room Temperature and the Influence of Blast-Furnace Slag Substitution on Sulfate Resistance**." Cement and Concrete Composites, 25, No. 8:939-945. December.
- Clark, B. A., and P. W. Brown. 2002. "**Phases Formed During Hydration of Tetracalcium Aluminoferrite in 1.0 M Magnesium Sulfate Solutions**." Cement and Concrete Research, 24: 331-338. June/August.
- Badger, S. R., B. A. Clark, S. Sahu, N. Thaulow, and R. J. Lee. 2001. "**Determination of the Water to Cement Ratio of Hardened Concrete Utilizing Backscattered Electron Imaging**." Presented at the Transportation Research Board Conference, Washington, D.C. January.
- Badger, S. R., B. A. Clark, S. Sahu, N. Thaulow, and R. J. Lee. 2001. "**Backscattered Electron Imaging to Determine Water-to-Cement Ratio of Hardened Concrete**." Transportation Research Record. Concrete, Materials and Construction, 1775:17-20.
- Brown, P. W., and B. A. Clark. 2001. "**An Overview of the Roles of Ca(OH)2 in Cementing Systems**." Calcium Hydroxide in Concrete, American Ceramic Society, 73-75.
- Clark, B. A., and P. W. Brown. 2000. "**The Formation of Calcium Sulfoaluminate Hydrate Compounds from C3A, Gypsum, and NaOH Solutions - Part II**." Cement and Concrete Research, 30:233-240.
- Clark, B. A., and P. W. Brown. 2000. "**The Formation of Monosulphate From Tetracalcium Aluminoferrite and Magnesium Sulphate**." Advances in Cement Research, 12, No. 2: 71-78.
- Clark, B. A., and P. W. Brown. 2000. "**The Formation of Ettringite from Tricalcium Aluminate and Magnesium Sulphate**." Advances in Cement Research, 12, No. 4: 137-142. October.

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Publications (Continued)

- Clark, B. A., and P. W. Brown. 1999. "**The Formation of Calcium Sulfoaluminate Hydrate Compounds from C3A, Gypsum, and NaOH Solutions - Part I**." Cement and Concrete Research, 29:1943-1948.
- Clark, B. A., and P. W. Brown. 1999. "**Formation of Ettringite From Monosubstituted Calcium Aluminosulfate Hydrate and Gypsum**." Journal of the American Ceramic Society, 82, No. 10:2900-2905.
- Clark, B. A., and P. W. Brown. 1999. "**Phases Formed From Hydration of Tetracalcium Aluminoferrite and Magnesium Sulfate**." Advances in Cement Research, 11, No. 3:133-137.
- Sahu, S., B. A. Clark, and R. J. Lee. 1998. "**Delayed Ettringite Formation and the Mode of Concrete Failure**." Materials Science of Concrete - The Sidney Diamond Symposium, 379- 394.
- Ten Huisen, K S., B. A. Clark, M. Klimkiewicz, and P. W. Brown. 1997. "**A Microstructural Investigation of Calcium-Deficient and Stoichiometric Hydroxyapatite Synthesized from CaHPO4*2H2O and Ca4(PO4)2O**." Cells and Materials, 6 (1-3): 251-267.
- Thaulow, N., U. H. Jakobsen, and B. A. Clark. 1996. "**Composition of Alkali Silica Gel and Ettringite in Concrete Railroad Ties: SEM, EDX and X-Ray Diffraction Analyses**." Cement and Concrete Research, 26, No. 2:309-318.
- Skalny, J. P., B. A. Clark, and R .J. Lee. 1993. "**Alkali-Silica Revised**." Presented at the 15th International Conference on Cement Microscopy, Dallas, Texas.
- Jie, Y., D. A. Warner, B. A. Clark, N. Thaulow, and J. P. Skalny. 1993. "**Temperature Relics in Steam Cured Concrete**." Presented at the 15th International Conference on Cement Microscopy, Dallas, Texas.
- Skalny, J. P., B. A. Clark, and R. J. Lee. 1992. "**Alkali-Silica Reaction Revisited**." Proceedings of the 14th International Conference on Cement Microscopy, 309-324.
- Clark, B. A., E. A. Draper, R. J. Lee, J. P. Skalny, M. Ben-Bassat, and A. Bentur. 1992. "**Electron- Optical Evaluation of Concrete Cured at Elevated Temperatures**." Proceedings of the American Concrete Institute Symposium on How to Produce Durable Concrete in Hot Climates, San Juan, Puerto Rico.
- Clark, B. A., A. J. Schwoeble, R. J. Lee, and J. P. Skalny. 1992. "**Detection of ASR in Opened Fractures of Damaged Concrete**." Cement and Concrete Research, 22:1170-1178. November.
- Liu, J. B., B. A. Clark, and R. M. Fisher. 1990. "**Applications of Scanning Tunneling Microscopy in the Materials Characterization Laboratory**." Proceedings of the XIIth International Congress for Electron Microscopy.
- Hoyt, J. J., B. A. Clark, and D. de Fontaine. 1989. "**A Synchrotron Radiation Study of Phase Separation in Al-Zn Alloys - I. Kinetics**." Acta Metallurgica, 37, No. 6: 1597-1609.

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Publications (Continued)

- Clark, B A. 1988. "**Unmixing Kinetics in Al-Zn Alloys**." Thesis, University of California, Berkeley, California.
- Clark, B. A., D. de Fontaine, and J. J. Hoyt. 1987. "**Unmixing Kinetics in Al-Zn Alloys**." Presented at the Flume-Rothery Memorial Symposium (in conjunction with the 1987 AIME Meeting), Denver, Colorado.
- Hoyt, J. J., M. Sluiter, B. A. Clark, M. Kraitchman, and D. de Fontaine. 1987. "**Anomalous X-Ray Scattering Study of Early-Stage Precipitation in Al-Zn-Ag**." Acta Metallurgica, 35, No. 9:2315-2322.
- Hoyt, J. J., O. Lyon, J. P. Simon, B. A. Clark, B. Davis, and D. de Fontaine. 1986. "**The Determination of Partial Structure Functions in Al-Zn-Ag Alloys**." Solid State Communications, 57, No. 3:155-158.
- Lyon, O., J. J. Hoyt, R. Pro, B. Davis, B. A. Clark, D. de Fontaine, and J. P. Simon. 1985. "**Anomalous Small-Angle X-Ray Scattering on Al-Zn and Al-Zn-Ag Alloys**." Journal Applied Crystallography, 18:480-486.

Presentations

- Clark, B. 2012. "**Forensic Materials Analysis: What Analytical Approach is Needed?**" Construction Materials Seminar, University of Illinois. February 29.
- Feng, X., and Clark, B. 2011. "**Evaluation of the Physical and Chemical Properties of Fly Ash Products for Use in Portland Cement Concrete**." 2011 World of Coal Ash Conference, Denver, Colorado. May.
- Clark, Boyd A., Larry L. Lockrem, Gary A. Cooke, Marisol Avila, Richard Westberg, Michael R. Silsbee, and Richard J. Lee. 2006. "**Hanford Site Cement-Based Waste Stream Solidification Studies**." Presented at the Cementitious Materials for Waste Treatment, Disposal, Remediation and Decommissioning Workshop, CH2M Hill, RPP-31811-VA, Savannah River National Laboratory, Aiken, South Carolina. December 12-14.
- Cooke, Gary, Larry L. Lockrem, Marisol Avila, Richard Westberg, Michael R. Silsbee, Boyd Clark, Mike D. Guthrie, Gary L. Koci, and Kristi J. Lueck. 2006. "**Cement Solidification of Ammonium Sulfate Rich Basin 42 Waste Water from the Hanford Effluent Treatment Facility**." Presented at the Cementitious Materials for Waste Treatment, Disposal, Remediation and Decommissioning Workshop, CH2M Hill, RPP-31803-VA, Savannah River National Laboratory, Aiken, South Carolina, December 12-14.
- Clark, B. A., Teo Rebagay, Richard Westberg, Sandy Stephens, Vicki Baca, David Attridge, Michael Silsbee, Marisol Avila, and R. J. Lee. 2005. "**Development of a Cast Stone Formulation for Hanford Tank Wastes**." Abstract submitted to Remediation Technologies Symposium, Alberta, Canada. October 19-21.

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Presentations (Continued)

- Silsbee, Michael, Marisol Avila, Boyd A. Clark, and R. J. Lee. 2005. "**Development of Waste Forms for the Hanford Brines Basin 42 Waste Water, Waste Treatment Plant Secondary Wastes and Bulk Vitrification Secondary Waste**." Abstract submitted to Remediation Technologies Symposium, Alberta, Canada. October 19-21.
- Clark, B. A. 2003. "**The Practice and Duties of Forensic Investigators**." Presented at ACI, September 30.
- Clark, B. A., P. W. Brown, A. J. Schwoeble, Y. Jie, and R. J. Lee. 1995. "**Comparison of Ettringite Morphologies Observed on Fracture Surfaces and in Thin Sections**." Presented at The American Ceramic Society 97th Annual Meeting, Cincinnati, Ohio.
- Clark, B. A., and R. J. Lee. 1993. "**Energy Dispersive X-Ray Analysis of Cement Paste Features Resulting From Heat Treatment**." Presented at the American Ceramic Society 95th Annual Meeting and Exposition, Cincinnati, OFI.
- Clark, Boyd A. 1993. "**A Comparison of SEM and TEM Analyses of Mortars Cured at Various Temperatures**." Materials Science Candidacy Paper.
- Clark, B. A., A. M. Dailey, Y. Jie, J. P. Skalny, and R. J. Lee. 1993. "**TEM and EDS Analysis of Cement Paste in Concrete and Experimental Mortars**." Poster Session American Ceramic Society PAC RIM Meeting, Honolulu, Hawaii.
- Clark, B. A, J. P. Simon, J. J. Hoyt, R. Pro, O. Lyon, and D. de Fontaine. 1986. "**Unmixing Kinetics in Al-Zn Alloys**." Presented at The Metallurgical Society Annual Meeting, New Orleans, Louisiana.

Professional Honors, Awards, Fellowships, and Affiliations

- American Concrete Institute (ACI) Member
- Responsibility in Concrete Construction Committee 132
- Fly Ash in Concrete Committee 232
- Natural Pozzolans Committee 240
- Durability of Concrete Committee 201
- Corrosion of Metals in Concrete Committee 222
- American Society for Testing and Materials (ASTM) Member
- ASTM Cement Committee C01 and ASTM Concrete and Aggregate Committee C09.
- Honorary Member of ASTM Concrete and Aggregate Committee C09
- Subcommittee member
- Supplementary Cementitious Materials C09.24
- Aggregate Reactions in Concrete C09.50
- Petrography C09.65