

This book can be purchased through Amazon [here](#). A summary is presented below.

Slurry Trenching – History, Uses, Fundamentals, and Construction

Daniel G. Ruffing, P.E., D.GE¹ and Jeffrey C. Evans P.E., D.GE, PhD²

²Vice-President, Geo-Solutions, Inc., 1250 Fifth Avenue, New Kensington, PA 15068; E-mail: druffing@geo-solutions.com

²Professor Emeritus, Department of Civil and Environmental Engineering, Bucknell University, One Dent Drive, Lewisburg, PA; E-mail: evans@bucknell.edu

Overview:

The authors approach this text from the viewpoint of a practitioner and an academic. This combination provides a wide viewpoint on several nuanced concepts related to the subject construction method. The book is written to present a fundamental understanding of slurry trench construction and includes an introduction to slurry trenching, a short history of the method, a discussion of alternate construction techniques, detailed descriptions of slurry trench construction methods, and an overview of some of the fundamental principles needed to understand and implement the slurry trenching technique. The book is meant to be primarily a resource for practicing engineers and researchers and secondarily as a supplemental text for graduate or advanced undergraduate instruction. Practitioners engaged in the design or construction of slurry trenches are the primary users of this book. Specialized texts of this nature are challenging in that the content is meant to be comprehensive all the while the industry is constantly changing. This constant change is true of all techniques in the ground improvement industry because the industry is constantly improving as modern design, research, and construction are pushing the boundaries of the profession. As with any specialized construction technique, readers are encouraged to expand their understanding of slurry trenching by keeping up with current research and practice. Ideally, readers will come to this book with a basic understanding of geology, soil mechanics, mathematics, and natural sciences commonly provided during the first three years of an undergraduate education in civil engineering.

Chapter List

- Chapter 1 – Introduction, History, Deployment Options
What is a slurry trench?
- Chapter 2 – Types of Slurry Trenching
What slurry trenching methods are available?
- Chapter 3 – Alternate Construction Approaches
What are alternate construction approaches to slurry trenching?

Chapter 4 – Construction Procedures
How is slurry trenching performed?

Chapter 5 – Fundamental Concepts
What else should I know before I choose to implement a slurry trench?

Chapter 6 – Summary Takeaways
What are the final takeaways about slurry trenching?

Example Content from Chapter 1 (What is a Slurry Trench?):

A slurry wall or slurry trench may be broadly defined as any vertical underground feature (wall) that is installed using slurry to support the excavation. The concept of using a slurry to support the sidewalls of an excavation is a natural extension of the use of mud supported drilling wherein slurries are used to keep the borehole open. The term slurry trenching is widely used to refer to construction of non-structural walls to accomplish environmental and geotechnical objectives. In the USA, practitioners often use the term slurry wall for structural wall installations that are also commonly known as diaphragm walls. For the purposes of this book, the term slurry trench is used to describe the variety of unreinforced wall types. Hence this book is not about structural diaphragm walls where the slurry is replaced by reinforced concrete but rather those walls where the slurry is left to harden in place or replaced with materials of significantly lower strength than reinforced concrete.

Slurry trenching is a term that describes the means of construction where an excavation is made under a slurry head and the role of the slurry is to maintain trench stability. Slurry trench wall, slurry wall, vertical cutoff wall, cutoff wall, and vertical barrier are all terms that refer to the finished product. For slurry trenching, the wall may result from hardening of the slurry used to excavate the trench or from materials placed in the trench to replace the slurry. Cutoff walls installed using other methods such as soil mixing, sheet-piling, secant piling, jet grouting, and injection grouting are not slurry walls. These other methods are not based on the slurry trench construction method and are not the principal subject of this text. These alternatives to slurry trenching are, however, summarized in this book for ease of comparison.

List of Figures

Figure 1. Slurry supported trench demonstrated in the laboratory

Figure 2. Construction of a deep SB slurry wall in the 1970s

Figure 3. Slurry trenching applications

Figure 4. Circumferential slurry trench cutoff (after LaGrega et al. 2010)

Figure 5. Upgradient (a) and downgradient (b) cutoff walls (from LaGrega et al. 2010)

Figure 6. Placement of cutoff walls for dams and levees

Figure 7. Primary and secondary trenches for over-excavation and replacement

Figure 8. One-pass trencher from DeWind (left) and the TRD trench from Keller (right)

Figure 9. Auger soil mixing (from Geo-Solutions, Inc.)

Figure 10. Diaphragm wall in service (from Evans et al. 2021)

Figure 11. Schematic of vibrating beam (left) and photo of vibrating beam wall installation (right, from Geo-Solutions, Inc.)

Figure 12. Jet grouting types (from Evans et al. 2021, www.railsystem.net)

Figure 13. Simple permeation grouting tip with attached drive point (from Evans et al. 2021)

Figure 14. Secant pile walls for groundwater cutoff and earth retention (from Evans et al. 2021)

Figure 15. Sheet pile wall with tiebacks

Figure 16. Frozen ground excavation support system (courtesy of Geo-Solutions, Inc.)

Figure 17. Flow diagram of flash mixer

Figure 18. Bentonite slurry flash mixer with slurry going into storage pond (courtesy of Geo-Solutions, Inc.)

Figure 19. Bentonite slurry storage tanks (left) and storage pond (right) (courtesy of Geo-Solutions, Inc.)

Figure 20. Slurry mixing plants (batch type mixing on left, continuous mixing through density monitoring on right) (courtesy of Geo-Solutions, Inc.)

Figure 21. Slurry storage and circulation pond configurations

Figure 22. Conventional excavator for slurry trenching (courtesy of Geo-Solutions, Inc.)

Figure 23. Examples of long sticks on excavators for slurry trench excavation (courtesy of Geo-Solutions, Inc.)

Figure 24. Side by side comparison of hydraulic (left) and mechanical (right) clamshells (from Mauro et al. 2013)

Figure 25. Examples of clamshell excavators in action (courtesy of Geo-Solutions, Inc.)

Figure 26. Hydromill photo (left, Wikipedia) and hydromill schematic (right, courtesy of Keller)

Figure 27. Slurry trench excavation sequence

Figure 28. Cleaning of excavation bottom and backfill slope of sediments (not to scale)

Figure 29. Open trench

Figure 30. Movement of excavator bucket with a long stick over backfill

Figure 31. Layout details of an excavation work platform (plan view)

Figure 32. Representative cross-section to control total seepage and exit gradients at the Herbert Hoover Dike (USACE)

Figure 33. Excavator refusal

Figure 34. Desanding equipment

Figure 35. Cross-sectional schematic of excavation platform and backfill mixing area

Figure 36. Remote mixing pad with earthen dikes to confine the backfill

Figure 37. SCB mixing (left) and SCB placement in the slurry trench (right) (from Ryan and Day 2002)

Figure 38. Starter slope for backfill placement (not to scale)

Figure 39. Trench soundings to determine sediment accumulation or trench sidewall collapse (not to scale)

Figure 40. Temporary protective cover over the slurry trench

Figure 41. Schematic of Marsh funnel viscosity measurement equipment

Figure 42. Photo of sampling slurry directly into Marsh funnel

Figure 43. Mud balance for measurement of unit weight and/or density

Figure 44. Bleed test schematic (a) and photo of a completed bleed test (b)

Figure 45. Slump test on SB backfill

Figure 46. SB backfill slump measured in the laboratory and field (from Malusis et al. 2008)

Figure 47. Graphical representation of Mohr-Coulomb failure criteria

Figure 48. Mohr's circle of stress for an unconfined compression test sample

Figure 49. Typical stress-strain relationships for two types of slurry wall materials (not to scale)

Figure 50. Unconfined compression test in progress

Figure 51. Grain size distributions from an SB cutoff wall constructed in Montandon, PA (Barlow 2018)
Figure 52. Phase diagram
Figure 53. Mechanisms of slurry & soil interaction at the filter cake (modified after Coughenour et al. 2023)
Figure 54. Effectiveness of backfill made of excavated soils
Figure 55. Dispersion of contaminants from a point source
Figure 56. Photograph of sedimentation tests with control (left) and CaCl₂ (right)
Figure 57. Desiccation test (cracking pattern test) results.
Figure 58. Filter press setup for modified filter press testing (side by side samples)
Figure 59. Plot of filter cake permeability ratio from modified filter press test (GW = groundwater, MW = municipal / tap water)
Figure 60. Permeation of SB backfills with aniline and carbon tetrachloride (redrawn from Evans et al. 1985)
Figure 61. Photo of self-hardening slurry immersion test

List of Tables

Table 1. Relative costs of slurry trench walls
Table 2. Relative costs of Alternates
Table 3. Pore fluid increases effect on bentonite swelling (after Evans et al. 1983)
Table 4. Long term permeability testing variables and their impact (modified from Evans and Fang 1988)
Table 5. Key properties of materials in slurry trenching

References:

API 13A (2019). "Drilling Fluids Materials", American Petroleum Institute Recommended Practice, Washington D.C.
ASTM C143M-15. Standard Test Method for Slump of Hydraulic-Cement Concrete), ASTM Standards, ASTM International, West Conshohocken, PA, www.astm.org
ASTM C150-07. Standard specification for portland cement. ASTM International, West Conshohocken, PA, 2012, www.astm.org
ASTM C595-08a. Standard specification for blended hydraulic cements. ASTM International, West Conshohocken, PA, 2010, www.astm.org
ASTM C989-10. Standard specification for slag cement for use in concrete and mortars. ASTM International, West Conshohocken, PA, 2012, www.astm.org
ASTM D7100-11, Standard Test Method for Hydraulic Conductivity Compatibility Testing of Soils with Aqueous Solutions, ASTM International, West Conshohocken, PA, 2011, www.astm.org
Barlow, L. C. (2018). Experimental study of hydraulic conductivity of a soil-bentonite cutoff wall. Thesis submitted in partial fulfillment of requirements for an MSCE, Bucknell University, Lewisburg, PA.
Bellew, G. M., Koirala, A. K., Dillon, J. C., & Mathews, D. L. (2012). Tuttle Creek Dam Seismic Remediation with High Strength CB Slurry Walls. In *Grouting and Deep Mixing 2012* (pp. 291-300).
Boyes, R. G. H. (1975). Structural and cut-off diaphragm walls.

- Burland, J.B. (1965). Some aspects of the mechanical behaviour of partly saturated soils. Moisture equilibria and moisture changes in soils beneath covered areas, (pp. 270-278).
- Bye, G. C. (1999). *Portland cement: composition, production and properties*. Thomas Telford.
- Cao, B., Zhang, Y., & Al-Tabbaa, A. (2022). SEBS-Polymer-Modified Slag–Cement–Bentonite for Resilient Slurry Walls. *Sustainability*, 14(4).
- Card, G.B. (1981). A study of the properties and performance of bentonite-cement slurries for use as hydraulic cutoffs. Ph.D. thesis, King's College, University of London.
- Cermak, J., Evans, J., & Tamaro, G. J. (2012). Evaluation of soil-cement-bentonite wall performance-effects of backfill shrinkage. In *Grouting and Deep Mixing 2012* (pp. 502-511).
- Coughenour, N., Ruffing, D., and Evans, J. (2023). Sampling and Laboratory Testing of Soil-Cement from Soil Mixing and Slurry Trenching. DFI 5th International Conference on Grouting and Deep Mixing, New Orleans, LA, January.
- Day, S. R., O'Hannesin, S. F., & Marsden, L. (1999). Geotechnical techniques for the construction of reactive barriers. *Journal of hazardous materials*, 67(3), 285-297.
- Day, S. R., Ryan, C. R., & Fisk, G. (2001, September). Innovative slurry trench methods for the rehabilitation of small dams. In *Annual meeting of the association of state dam safety officials* (Vol. 12).
- Day, S., & Schindler, R. (2004, May). Construction methods for the installation of permeable reactive barriers using the biopolymer slurry method. In *Proceedings of the International Conference on Remediation of Chlorinated and Recalcitrant Compounds, 4th..*
- Du, Y. J., Fan, R. D., Liu, S. Y., Reddy, K. R., & Jin, F. (2015). Workability, compressibility, and hydraulic conductivity of zeolite-amended clayey soil/calcium-bentonite backfills for slurry-trench cutoff walls. *Engineering Geology*, 195, (pp. 258-268).
- Donohoe, J. F., Corwin, A. B., Schmall, P. C., & Maishman, D. (2001). Ground freezing for Boston Central Artery contract section C 09 A 4, jacking of tunnel boxes. In *2001 Rapid Excavation and Tunneling Conference* (pp. 337-344).
- Erto, A., Lancia, A., Bortone, I., Di Nardo, A., Di Natale, M., & Musmarra, D. (2011). A procedure to design a Permeable Adsorptive Barrier (PAB) for contaminated groundwater remediation. *Journal of environmental management*, 92(1), (pp. 23-30).
- Evans, J. C., & Dawson, A. R. (1999, December). Slurry walls for control of contaminant migration: A comparison of UK and US practices. In *Geo-engineering for underground facilities* (pp. 105-120). ASCE.
- Evans, J. C., & Opdyke, S. M. (2006). Strength, permeability, and compatibility of slag-cement-bentonite slurry wall mixtures for constructing vertical barriers. In *5th ICEG Environmental Geotechnics: Opportunities, Challenges and Responsibilities for Environmental Geotechnics: Proceedings of the ISSMGE's fifth international congress organized by the Geoenvironmental Research Centre, Cardiff University and held at Cardiff City Hall on 26–30th June 2006* (pp. 118-125). Thomas Telford Publishing.
- Evans, J. C., Kugelman, I. J. and Fang, H. Y. (1983, June). Influence of industrial wastes on the geotechnical properties of soils. In *15th Mid-Atlantic Industrial Waste Conference*, Lewisburg, PA(USA), Jun 1983 (Vol. 1983).
- Evans, J. C., Fang, H. Y., & Kugelman, I. J. (1985, May). Organic fluid effects on the permeability of soil-bentonite slurry walls. In *Proceedings of the National Conference on Environmental Emergencies* (pp. 267-271). The Hazardous Materials Control Research Institute: Cincinnati, OH.
- Evans, J. C., Ruffing, D. G., & Elton, D. J. (2021). *Fundamentals of Ground Improvement Engineering*. CRC Press.

- Evans, J. C., Larrahondo, J. M., & Yeboah, N. N. N. (2021). Fate of bentonite in slag–cement–bentonite slurry trench cut-off walls for polluted sites. *Environmental Geotechnics*, 40(XXXX), 1-13.
- Evans, J. C., Trast, J. M., & Frank, R. L. (2004). Lessons learned from the Macon County slurry wall. In *Proceedings, Fifth International Conference on Case Histories in Geotechnical Engineering* (pp. 13-17).
- Evans, J. C., & Garbin, E. J. (2009). The TRD method for in situ mixed vertical barriers. In *Advances in Ground Improvement: Research to Practice in the United States and China GSP188* (pp. 271-280).
- Evans, J. C., Prince, M. J., & Adams, T. L. (1997). *Metals attenuation in mineral-enhanced slurry walls* (No. CONF-970208-Proc.). US Department of Energy (USDOE), Washington DC (United States).
- Evans, J. C., Ororbia, M., Gutilius, J., Ruffing, D. G., Barlow, L., Malusis, M. A. (2017, September). Soil-bentonite slurry trench cutoff wall lateral deformations, consolidation, stress transfer and hydraulic conductivity. In *Proceedings of the 2nd Symposium on Coupled Phenomena in Environmental Geotechnics (CPEG2), Leeds, UK*.
- Evans, J.C. and Jefferis, S.A. (2014). "Volume Change Characteristics of Cutoff Wall Materials, *Proceedings of the 7th International Congress on Environmental Geotechnics*, Melbourne, AU, November 10-14.
- Evans, J. C. and Ruffing, D., (2019) Stresses in soil-bentonite slurry trench cutoff wall. In *Geo-Congress 2019: Geoenvironmental Engineering and Sustainability* (pp. 177-184). Reston, VA: American Society of Civil Engineers.
- Fang, H. Y. and Evans, J. C. (1988). Long-term permeability tests using leachate on a compacted clayey liner material. *ASTM STP 963*, (pp.397-404).
- Filiz, G. M., Adams, T. and Davidson, R. R. (2004). Stability of long trenches in sand supported by bentonite-water slurry. *Journal of geotechnical and geoenvironmental engineering*, 130(9), (pp. 915-921).
- Fox, P. J. (2004). Analytical solutions for stability of slurry trench. *Journal of geotechnical and geoenvironmental engineering*, 130(7), (pp. 749-758).
- Freundlich, H. (1927). The structure and formation of colloidal particles. *Transactions of the Faraday Society*, 23, (pp.6 14-623).
- Glass, P. and Stones, C., (2001). Construction of Westminster Station, London. *Proceedings of the Institution of Civil Engineers-Structures and Buildings*, 146(3), (pp. 237-252).
- Grim, R.E. (1968). *Clay Mineralogy*. McGraw Hill Book Company, New York, NY.
- Guner, A. (1978). Properties and behaviour of bentonite-cement slurries. *University of London PhD thesis*.
- Hong, C. S., Shackelford, C. D., & Malusis, M. A. (2012). Consolidation and hydraulic conductivity of zeolite-amended soil-bentonite backfills. *Journal of Geotechnical and Geoenvironmental Engineering*, 138(1), 15-25.
- Jefferis, S.A., (1981, June). Bentonite-cement slurries for hydraulic cut-offs. In *Proceedings, Tenth International Conference on Soil Mechanics and Foundation Engineering, Stockholm, Sweden* (Vol. 1, pp. 435-440).
- Jefferis, S. A., (1993). In-ground barriers. *Contaminated land-problems and solutions*, (pp. 111-140).
- Jefferis, S. A., (1997). *The origins of the slurry trench cut-off and a review of cement-bentonite cut-off walls in the UK* (No. CONF-970208--PROC).

- Jefferis, S. A., 2012. Cement-bentonite slurry systems. In *Grouting and Deep Mixing 2012* (pp. 1-24).
- Joshi, K., Kechavarzi, C., Sutherland, K., Ng, M. Y. A., Soga, K., & Tedd, P. (2010). Laboratory and in situ tests for long-term hydraulic conductivity of a cement-bentonite cutoff wall. *Journal of geotechnical and geoenvironmental engineering*, 136(4), (pp. 562-572).
- Kramer, H. (1946) Deep cut-off trench of puddled clay for earth dam and levee protection, *Engineering News Record*, June 27, (pp. 986-990).
- LaGrega, M.D., Buckingham, P.L. and Evans, J.C., (2010). *Hazardous waste management*. Waveland Press.
- Lam, C., & Jefferis, S. A. (2018). *Polymer support fluids in civil engineering*. London: Ice Publishing.
- Malusis, M. A., Evans, J. C., McLane, M. H., & Woodward, N. R. (2008). A miniature cone for measuring the slump of soil-bentonite cutoff wall backfill. *Geotechnical Testing Journal*, 31(5), (pp. 373-380.)
- Mauro, M., Morales, C., & Taylor, J. (2013). Self Hardening Slurry Wall Installation by Hydromill at The Herbert Hoover Dike—An Innovative Solution. Seventh International Conference on Case Histories in Geotechnical Engineering, Chicago, IL, USA.
- Mitchell, J. K., & Soga, K. (2005). *Fundamentals of soil behavior*. New York: John Wiley & Sons.
- Nash, J. K. T. L., & Jones, G. K. (1963). The support of trenches using fluid mud. *Proc., Grouts and Drilling Muds in Engineering Practice*, (pp. 177-180).
- Owaidat, L.M., Andromalos, K.B., Sisley, J.L. and Civil Engineer, U., (1999, October). Construction of a soil–cement–bentonite slurry wall for a levee strengthening program. In *Proceedings of the 1999 Annual Conference of the Association of State Dam Safety Officials, St. Louis, Mo* (pp. 10-13).
- Powell, R.M., Blowes, D.W., Gillham, R.W., Schultz, D., Sivavec, T., Puls, R.W., Vogan, J.L., Powell, P.D. and Landis, R., (1998). Permeable reactive barrier technologies for contaminant remediation. *US EPA*, 600: (pp 1 -1 64).
- Puller, M. (2003). *Deep excavations: A practical manual*. Thomas Telford.
- Ressi di Cervia, A.L., (1992). History of slurry wall construction. *ASTM Special Technical Publication*, 1129, (pp. 3-15).
- Roscoe, K.H., Schofield, A. and Wroth, A.P., (1958). On the yielding of soils. *Geotechnique*, 8(1), (pp.22-53).
- Ruffing, D. G., Evans, J. C., & Malusis, M. A. (2010). Prediction of earth pressures in soil-bentonite cutoff walls. In *GeoFlorida 2010: Advances in Analysis, Modeling & Design* (pp. 2416-2425).
- Ruffing, D. G., & Evans, J. C. (2010, November). In situ evaluation of a shallow soil bentonite slurry trench cutoff wall. In *Proceedings of the 6th International Congress on Environmental Geotechnics* (pp. 758-763).
- Ruffing, D. G. and Evans, J. C., (2020). Design and Specification Considerations for Environmental Cutoff Walls. In *Proceedings of DFI Conference* (pp. 514 to 523).
- RWE Power International, (2011). Diaphragm Containment Walls using PFA at Bedfont Lakes, Middlesex, Generation Aggregates Electron, Windmill Hill Business Park, Whitehill Way, Swindon, Wiltshire SN5 6PB, United Kingdom.
- Ryan, C. R. (1987). Vertical barriers in soil for pollution containment. In *Geotechnical practice for waste disposal '87* (pp. 182-204). ASCE.
- Ryan, C. R., & Day, S. R. (2002). Soil-cement-bentonite slurry walls. In *Deep Foundations 2002: An International Perspective on Theory, Design, Construction, and Performance* (pp. 713-727).

- Ryan, C., Ruffing, D., & Evans, J. C., 2022. Soil Bentonite Slurry Trench Cutoff Walls: History, Design, and Construction Practices. In *Geo-Congress 2022, GSP 335*, (pp. 89-99).
- Schmall, P., & Dawson, A. (2017). Ground-freezing experience on the east side access Northern Boulevard crossing, New York. *Proceedings of the Institution of Civil Engineers-Ground Improvement*, 170(3), (pp. 159-172).
- Schofield, A. N., & Wroth, P. (1968). *Critical state soil mechanics* (Vol. 310). London: McGraw-hill.
- Sherard, G.E., (1969). Slurry trench method for deep foundation construction. MSc thesis, Oklahoma State University.
- Soga, K., Joshi, K., and Evans, J.C. (2013). Cement bentonite cutoff walls for polluted sites, *Proceedings of the International Symposium on Coupled Phenomena in Environmental Geotechnics*, (pp. 149-165).
- Tallard, G. R. (1988). *Self-hardening slurry mix* (Patent No. US 4726713).
- Tallard, G. R. (1997). *Very low conductivity self-hardening slurry for permanent enclosures* (No. CONF-970208-Proc.). USDOE, Washington, DC (United States).
- Tamaro, G. J. (2002). World trade center" bathtub from Genesis to Armageddon. *Bridge*, 32(1), (pp.11-17).
- Taylor, D. W. (1948). *Fundamentals of soil mechanics*. Vol. 66, No. 2, p. 161. LWW.
- Terzaghi, K., & Peck, R. B. (1948). *Soil mechanics in Engineering Practice*. John Wiley and Sons, Inc., New York.
- Tong, S., Wei, L. L., Evans, J. C., Chen, Y. M., & Li, Y. C. (2022). Numerical analysis of consolidation behavior of soil-bentonite backfill in a full-scale slurry trench cutoff wall test. *Soils and Foundations*, 62(5), 101188.
- Van Genuchten, M. T., & Parker, J. C. (1984). Boundary conditions for displacement experiments through short laboratory soil columns. *Soil Science Society of America Journal*, 48(4), (pp. 703-708).
- Veder, C. (1963). Excavation of trenches in the presence of bentonite suspension for the construction of impermeable and load-bearing diaphragms. *Grouts and Drilling Muds in Engineering Practice*, Butterworths, London, (pp.181-188).
- Xanthakos, P. (1979). *Slurry Walls*, McGraw-Hill Book Co., New York, New York.
- Yang, L., Jiang, G., Shi, Y., Lin, X., & Yang, X. (2017). Application of ionic liquid to a high-performance calcium-resistant additive for filtration control of bentonite/water-based drilling fluids. *Journal of Materials Science*, 52, (pp. 6362-6375).
- Yang, Y. L., Reddy, K. R., Du, Y. J., & Fan, R. D. (2018). Sodium hexametaphosphate (SHMP)-amended calcium bentonite for slurry trench cutoff walls: workability and microstructure characteristics. *Canadian Geotechnical Journal*, 55(4), (pp. 528-537).
- Yang, Y. L., Reddy, K. R., Zhang, T., Fan, R. D., Fu, X. L., & Du, Y. J. (2022). Enhanced contaminant retardation by novel modified calcium bentonite backfill in slurry trench cutoff walls. *Construction and Building Materials*, 320, 126285.

Index

active
adsorption
advection
aggregate
alignment

arching
attapulgite
Atterberg limits
backfill segregation
bathtub
Bingham fluids
bio-polymer
bleed
borrow materials
breaker
breaking slurry
breakthrough
budget
clamshells
clay
colloids
compaction
compatibility
compressibility
concrete
consolidation
contaminant
cost
curvature
Darcy's law
density
desanding
desiccation
desilters
desilting
development (trench)
dewatering
diaphragm wall
diffuse double layer
diffusion
dispersion
DNAPL
drainage
electrolyte
embedment
factor of safety
filter cake
filters
fines content
flocculation
fluids
freezing

friction angle
gel strength
gradient
grain size distribution
gravel
grouting
guar gum
hanging wall
hydration
hydraulic conductivity
hydromill
impermeable
incompatibility
interlayer
key
laydown
leakage
long stick
loss on ignition
Marsh funnel
minerology
modified filter press
Mohr's circle
moisture content
mud balance
NAPL
nonaqueous phase liquids
one phase
open cuts
organic
pathways
permeability
pH
piano key
piping
polymer
porosity
portland cement
principal stress
project goals
pumping
refusal
retardation
saline
salt
sand
secant pile walls

sedimentation
self-hardening
semifluid
sepiolite
shear strength
silos
silt
slag
slope
slump
slurry breaker
slurry pond
sorption
spoils
staging
suspended solids
suspension
swelling
termination
thixotropy
trench stability
UCS
unsuitable soils
venturi
venturi mixer
viscometers
viscosity
void ratio
water content
water source
window
work platform
workability