CIGMAT

CENTER FOR INNOVATIVE GROUTING MATERIALS AND TECHNOLOGY, UNIVERSITY OF HOUSTON

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NEWS AND LITERATURE REVIEW

CIGMAT CONFERENCE

A one day conference and exhibition sponsored by the Center for Innovative Grouting Materials and Technology (CIGMAT) and the Department of Civil and Environmental Engineering on "Construction and Rehabilitation Activities Related to the Greater Houston Area" was held on March 8, 1996 at the University Hilton, Houston, Texas. The conference focused on design, construction and maintenance of highways and various other service facilities including sewer system in a big city environment.

The slate of speakers consisted of personnel from the State of Texas, Harris County, Los Angeles County (CA), City of Houston, National Science foundation (NSF) and Industry. The presentations included current projects and proposed projects for 1995-96 in the Greater Houston area and Los Angeles County. Speakers also discussed the use of some of the state-of-the-art technologies to solve the problems in the Greater Houston area and around the country. Research project funded by the NSF under the Civil Infrastructure System (CIS) program was also discussed. The poster session of the conference included current research projects at the University of Houston and Rice University. Also several companies participated in the exhibition. More than 180 people attended the conference.

C. Vipulanandan (Director, CIGMAT) of the University of Houston delivered the welcome address. In his address Vipu emphasized the fact that the construction and rehabilitation activities in the Houston area could be a model to rest of the country. The three keynote speakers during the first session at the conference were Hilda Garza Scott, Deputy Director, Capital Projects, City of Houston; Steve Simmons, Deputy District Engineer, Texas Department of Transportation; and John M. Sadlak, Assistant General Manager, Metropolitan Transit Authority. Other keynote speakers for the day were Steve Fitzgerald, Harris County Flood Control District, John Redner, Sewerage System Superintendent, Los Angeles County (CA) and Gary Ordat, Manager, Wastewater Design, City of Houston. The keynote speakers discussed some of their operational difficulties with new environmental regulations. Also several new projects planned for the Houston area were discussed. John Redner discussed in length their experiences in rehabilitating concrete sewer pipes in Los Angeles county.

Priscilla Nelson, Program Director, NSF, was the Luncheon Speaker. She discussed the CIS program in detail and emphasized the need for interdisciplinary research programs to address the complex problems in the rehabilitation of big city infrastructure. Weiher and Vipulanandan from the University of Houston, discussed their research projects on community renewal and evaluating coating materials for rehabilitating concrete pipes respectively which were jointly funded by the CIS program (NSF) and the City of Houston. Douglas Ivor-Smith, Project Engineeer, City of Houston, discussed the design and construction of tunnels and pipelines in fault zones. Industrial speakers included, Jeff Wells, Insituform Technologies Inc.; Richard M. Berry, Rembco Engineering; Richard Croxton, Kinsel Industries; and Chuck Mooney, CSR Hydro Conduit. Jeff Wells discussed an effective method to rehabilitate service laterals. Dick Berry showed how grouts can be used to control flow within the sewer trench. Richard Croxton discussed the important soil parameters in pipe bursting. Art Kidder, City of Houston; M. W. O'Neill, University of Houston; David Magill, Avanti International; and Shondeep Sarkar, S. E. Coleman Associates were among the moderators of the sessions.

In this issue....

New Publications and Announcements:

(i) Verification of Geotechnical Grouting: A Report from the ASCE Committee on Grouting of the Geotechnical Engineering Division, Geotehnical Special Publication No. 57, Edited by Micheal J. Byle and Roy H. Borden.

Geotechnical Speciality Conference "Uncertainity-96", August 1-3, 1996, Madison, Wisconsin, Sponsored by ASCE.

I. SOIL GROUTING

(i) Steel fiber reinforced piles at horse mesa dam; *Bayasi, Z., and Downey, K., Concrete International, Vol. 17, No. 6, June 1995, pp. 32-36.*

The Horse Mesa Dam project was a pioneer project for steel fiber reinforced concrete. The existence of steel fibers improved the material characteristics of the plain grout considerably so that it could help extend the application fields of concrete. This project was just one more stepping stone to the popularity of fiber reinforced concrete. The presented reinforced pile wall after a major flood that kept the road accessible proved the project a success.

Keywords: *grout curtain, reinforced piles.*

(ii) Design of Katse dam; *Tardieu, B., International Water Power and Dam Construction, Vol. 47, No. 4, April 1995, pp. 16-20.*

Central to the Lesotho Highlands Water Project (South Africa), undertaken to augment the water supply of the Vaal Dam, is a 185 m high concrete arch dam. Geological investigations of the dam site revealed several horizontal planes of discontinuity caused by water pressure within the joint where displacement may be localized. To alleviate the undesirable effects of uplift pressures acting along the joint, the foundation excavation of the arch was modified and a preformed 'open' joint that permits water pressure to maintain a positive compressive load along the concrete rock interface was constructed. A second line of defense is provided by further galleries with grout and drainage curtain.

Keywords: *preformed joint, Londe method, concrete construction.*

(iii) Treating contaminated, cracked and permeable field clay with grouts; *Vipulanandan, C. and Leung, M., Geotechnical Special Technical Publication, No. 46/1, 1995, ASCE, New York, NY, pp. 829-843.*

A method to reduce the hydraulic conductivity of a field clay and a clay-sand mixture with plasticity indices of 40 and 15 respectively were investigated. Methanol, used as the contaminant, made the clay non-plastic and increased the hydraulic conductivity of the clay and clay-sand mixture to above 10^{-6} cm/s. Remolded field clay and clay-sand mixture with and without cracks and methanol contamination were permeated with dilute solution and suspension grouts to reduce their hydraulic conductivities. Lean grouts included a 8% sodium silicate solution grout and a suspension grout with 0.3% bentonite. The duration of treatment was very much dependent on the level of contamination and the permeability of soil before treatment and the type of grout used. The hydraulic conductivity of the contaminated and permeable clay and clay-sand mixture was reduced from over 10^{-5} cm/s to far less than 10^{-7} cm/s by permeating with a 8% sodium silicate solution grout. But the 0.3% bentonite suspension grout was not effective in reducing the hydraulic conductivity of the clay-sand mixture. Changes in effluent pH during and after treatment were also verified.

Keywords: *suspension grouts, sodium silicate solution grout, clay-sand mixtures.*

Did you know!!!

The first tunnel ever constructed under water is beneath the River Thames in London. This was constructed between 1825 and 1842 (Brittanica Encyclopedia).

(iv) DSM saves the dam; *Walker, A. D., Civil Engineering (New York), Vol. 64, Dec. 1994, pp. 48-51.*

In view of the aging and deterioration of U.S. dams, these dams must be upgraded in order to meet new regulations and factors of safety. Current dam-safety regulations require that the existing dam core must be extended to the crest level to guard against potential failure from seepage at the maximum flood. This core extension project was specifically undertaken at Lockington dam in Ohio. To extend the core, a cutoff wall using deep-soil mixing (DSM) method was used. DSM was seen to reduce successfully the risk of liquefaction in dam foundations, although this project is among the earliest application of the technique to construct a conventional cutoff wall on an existing dam.

Keywords: *deep soil mixing, cutoff wall, flood control, safety regulations.*

II. TUNNEL GROUTING

(i) Investigation of grouting effects to improve strength and water-proof of ground in shallow tunnel excavation by NATM; *Fukushima, S., Mochizuki, Y., Hatayama, K., and Aoki, T., Proceedings of the Japan Society of Civil Engineers, No. 505, Pt. 3-29, Dec. 1994, pp. 319-327.*

Face stability is one of most important factors to excavate safely a shallow tunnel by NATM in a sandy ground under water level. The results of an investigation aimed at evaluating the improvement effect of a sandy ground in tunnel improved by chemical grouting are presented herein. In this investigation, the permeability test and the triaxial compression test in triaxial cell were used to determine the permeability and the strength of the undisturbed specimens obtained by the block sampling method from the improved sandy ground in tunnel face. The results showed the following: (1) The grouting had sufficiently improved the strength and the waterproof of the sandy ground under the water level. (2) The laboratory tests of the undisturbed specimens gained by block sampling in this report were useful to evaluate the grouting effect.

Keywords: *shallow tunnels, face stability, chemical grout*

(ii) Basic study on characteristics of urethane material for grout forepoling applied for tunneling; *Higo, M., Maki, H., Furukawa, K and Nakagawa, K., Proceedings of the Japan Society of Civil Engineers, No. 504, Pt. 6-25, Dec. 1994. pp. 117-126.*

Considering actual applicability and effectiveness at the site, two different urethane grout materials currently used in forepoling were tested in a laboratory. And following test results were obtained: 1) Urethane materials are effervesced after grouting, and its cohesiveness and rising time which influence on workability are effected by temperature. 2) Concerning reinforcement of ground, quick reinforcing effect is achieved, and not only compressive strength but also tensile strength and adhesive tensile strength of material after grouting were found good enough.

Keywords: *urethane materials, cohesiveness, thermal effects, compressive and tensile strength.*

III. SEWER GROUTING

(i) San Francisco CSO; *Edgerton, W., Berti, D.J., and Wong, M.M., Civil Engineering (New York), Vol. 65, No. 5, May 1995, pp. 68-71.*

A major problem in the Islais Creek Basin area is the excess combined sewage discharged into the Islais Creek about 46 times per year. To minimize these occurrences, construction of an extensive 900 mi. long combined-sewer-overflow (CSO) control system that comprises of a series of underground reinforced concrete box sewers, tunnels, pipes and pumping stations to store the combined sewage until it can be pumped to a treatment plant. The Islais Creek transport/storage system is about 11,000 ft. long, adding 32 million gal. of storage volume, and will depreciate overflows to an average of fewer than ten per annum.

Keywords: *pipelines, sewage pumping plants, combined sewers.*

(ii) Construction of extension shield tunnel using ground freezing method; *Suzuki, S., Mizuno, R and Kimura, K., Proceedings of the 7th International Symposium on ground Freezing, 1994, pp. 289-293.*

This paper describes the construction of the extension tunnel for the major telephone artery (GL - 44m, outer diameter of the segment diameter 4450 mm) owned by Nippon Telegram and Telephone Corporation (NTT) using ground freezing method. The existing shield tunnel links Kasumigaeseki to Higashi-Ginza in Tokyo, Japan. The extension tunnel was constructed to connect the existing tunnel with the NTT Ginza office which was located on the route of the existing tunnel. At the junction, pneumatic caisson (diameter 4750 mm) was buried to a depth 2 m right above the existing tunnel. The ground around the caisson and the shield tunnel (very fine sand, water pressure 0.294 MPa) was placed in order to increase the cohesion between the caisson structure and the surrounding ground, preventing the caisson from settling. Under the frozen condition, the shield tunnel segment (1200 ton) at the junction was demolished, from where a rectangular widening was excavated upward in order for the caisson structure to be extended to the shield tunnel. After completion of the extension tunnel construction, the ground was forced to thaw and the chemical grout was injected.

Keywords: *ground freezing method, chemical grouts, extension shield tunnels.*

IV. STRUCTURAL GROUTING

(i) Grouting Specifications; *Anon., Concrete (London), Vol. 27, No. 4, July-Aug. 1993, pp. 23-28.*

As part of a work on post-tensioned concrete bridges, a working party of the Concrete Society's Design Group prepared this article which contains background information, a specification for grouting together with different draft clauses, and an appendix covering grouting trials, protection of tendons, and the supervision of prestressing operations.

Keywords: *post-tensioned concrete bridges, grouting, specifications.*

(ii) Ultimate strength and fatigue resistance of grouted tabular joints; *Le Meur, G., Falcimaigne, J., and Ozanne, P., Proceedings of the 13th International Conference on Offshore Mechanics and Arctic Engineering - OMAE, Vol. 3, 1994, ASME, New York, NY, pp. 249-256.*

Several authors have pointed out the interest of combining steel with a cement or concrete grout for designing efficient tubular connections, both for static strength and fatigue resistance. However, the designers are faced with a lack of published data to be able to assess and implement this technique. Applications are thus relatively rare and limited principally to repairing or strengthening existing structures. A 4-year research project has recently been completed to improve the understanding of the behavior of the grouted connections. Principal achievements include the testing of 14 large scale grouted prototype joints, finite element analyses and an improvement of the grouting material. The paper presents an overview on the main results of the project, with special attention to the validation of numerical models. Numerical modelling of composite joints can complement experiments but analyses are complex and lengthy. Simplified design method or design formulae are still useful.

Keywords: *strength and fatigue of materials, mathematical models.*

*(iii) **Structural Performance of cavity walls constructed with units containing saw dust and shear connected to the brick veneer;** Goyal, A., Rashwan, M., Hatzinikolas, M.A., and Zervos, S., Canadian Journal of Civil Engineering, Vol. 21, No. 4, Aug. 1994, pp. 576-584.*

A series of experiments were conducted to investigate the behavior of walls constructed using newly developed masonry saw dust blocks. Full-scale cavity walls consisting of the new masonry block backup and burnt clay brick veneer, connected together using metal connectors, were tested under lateral loads. The effects of block unit size, height of wall, reinforcement, grout, and cavity width on the behavior of the wall were studied. The test results showed behavior similar to that of walls constructed with lightweight concrete masonry units. A summary of the results is presented in this paper.

***Keywords:** cavity walls, lightweight masonry concrete, saw dust.*

*(iv) **Permeability and microstructure of plain and polypropylene fiber reinforced grouts;** Allan, M.L., and Kukacka, L.E., Cement and Concrete Research, Vol. 24, No. 4, 1994, pp. 671-681.*

Cementitious grouts with and without polypropylene fibers were evaluated for use as containment barriers around waste landfills located in an arid environment. Viscosity, flow time, water permeability and microstructure of the grouts were investigated. Low permeabilities of the order of 10^{-11} to 10^{-10} cm/s were measured on cement-sand grouts. Permeability was influenced by curing time and water/cement ratio. Variation of sand/cement ratio by mass from 1 to 1.2 and addition of 0.1 to 0.2 % volume fraction of fibers did not affect the permeability significantly.

***Keywords:** fiber reinforced materials, permeability, cementitious grouts.*

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Journals Reviewed

The articles for inclusion in the CIGMAT News and Literature Review are selected on the basis of their usefulness and applicability in the field of grouting technology, and are geared towards practicing professionals in the field. Recent issues of the following publications were reviewed.

1. American City and County
2. American Concrete Institute
3. Civil Engineering (ASCE)
4. Civil Engineering (London, England)
5. Concrete Construction
6. Concrete International (ACI)
7. Civil and Structural Engineering Abstracts
8. Engineering News Record
9. Environmental Geology
10. Electrical World
11. Geotechnique
12. Indian Geotechnical Journal
13. Canadian Geotechnical Journal
14. Ocean Engineering
15. Soil Dynamics and Earthquake Engineering
16. Foundation Facts
17. Geodex Retrieval System for Geotechnical Abstracts
18. Geotechnical Abstracts
19. Journal of Geotechnical Engineering (ASCE)
20. Journal of Structural Engineering (ASCE)
21. Soils and Foundations
22. Soil Technology
23. Series on Rock and Soil Mechanics
24. Public Works
25. New Scientist
26. Military Engineer
27. Oceanus
28. Pipelines and Utilities Construction
29. Pipes and Pipelines Manual
30. Pipes and Pipelines International
31. Tile and Brick International
32. Composite Materials Series
33. Mexican Society for Soil Mechanics Meeting
34. Tunnels and Tunnelling