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CENTER FOR INNOVATIVE GROUTING MATERIALS AND TECHNOLOGY, UNIVERSITY OF HOUSTON.

News and Literature Review

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Polyurethanes: Materials for the Future ?

During the past three decades, polyurethane chemistry and technology have matured into a sophisticated industry despite the initial slow-start, which is typical of so many ultimately successful materials except asbestos. Nearly 14 years elapsed before suf ficient commercial interest developed to invest capital in the diisocyanate polymerization reaction first discovered by German chemist Otto Bayer in 1937. Only in 1954 polyurethane chemistry with innovative methods of "tailor making" plastics, gels and foams was transferred to the U.S.

Following a brief technical battle against the more stable latex foam, urethane chemistry and technology began on a victory procession that has no parallel in the polymer industry Cost effectiveness, high performance and versatility have made this family of polymers to be widely accepted around the world. Changing markets, applications and uses for urethanes continues to challenge the chemists and engineers to modify and develop necessary urethane chemistry making and placing technologies and testing standards to economically meet the increasing performance requirements. Polyurethane production in the U.S. is estimated to be over 6 million metric tons and is steadily growing.

Polyurethane is also used in coatings, adhesives, concrete repair materials and joint sealants in civil engineering applications. Polyurethane is also increasingly used in waste treatment and containment technology. The construction/repair market for polyurethane is expect to grow even further in the coming years. CIGMAT researchers are investigating several polyurethane coatings in their ongoing research program funded by the National Science Foundation, City of Houston and Industries(abstract under Coatings).

Polyurethane grouts (concrete repair, joint sealant) are being also characterized in CIGMAT Laboratory. Studies are focused on evaluating current test methods and develop new test methods if necessary to better characterize these grouts used for concrete repair and joint sealants. American Concrete Institute (ACI), International Concrete repair Institute (ICRI) and ASCE have publications/ committees on polyurethane grouts. It should be noted thatASTM has no standard for testing polyurethane grouts and most of the data reported in the literature/supplier brochure are standards developed for various other materials and applications. Some of the tests adopted for polyurethane grouts for concrete repair are summarized below and none of these tests were developed for repair application.

Standard Number	Scope of the Test	Committee and Subcommittee
D 93-96	Test Method for Flash Point by Pensky-Martens Closed Cup Tester	D-2 on Petroleum Products and Lubricants and D02.08 on Volatility
D 756-93	Practice of Determination of Weight and Shape Changes of Plastics Under Accelerated Service Conditions	D-20 on Plastics and D20.50 on Permanence Properties
D 1623-78	Test Method for Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics	D-20 on Plastics and D20.22 on Cellular Plastics
D 2842-94	Test Method for Water Absorption of Rigid Cellular Plastics	D-20 on Plastics and D20.22 on Cellular Plastics
D 3574-95	Test Methods for Flexible Cellular Materials-Slab, Bonded, and Molded Urethane Foams	D-20 on Plastics and D20.22 on Cellular Plastics

In this issue.....

Announcements

Grouting Sessions ASCE National Convention, Boston, Oct 18-21, 1998.

CIGMAT -99 Conference will be held on March 5, 1999 in Houston, Texas

Literature Review

(I) Geotechnical Grouting

i) Long-term test of compaction grouting for liquefaction mitigation, *Mejia, Lelio H.and Boulanger, Ross W. Earthquake-Induced Movements and Seismic Remediation of Existing Foundations and Abutments Geotechnical Special Publication No. 55,1995, ASCE, New York, NY, USA. p 94-109*

An overview of a recent case history of compaction grouting to mitigate liquefaction potential at a proposed building site is presented. The case history involved a test section to densify a medium stiff clayey silt and a medium dense silty sand. Quality control testing included SPT, CPT, and DMT tests, and shear wave velocity measurements. CPT soundings one week, one month, and 18 months after treatment were used to evaluate the effects of time on the penetration resistance of the treated soils. A large increase in the penetration resistance of the silt and sand was observed one week after treatment. However, up to about 30% of the average increase was lost within the following 18 months. Thus, this case history underscores the need to carefully consider time effects following compaction grouting for liquefaction mitigation

Keywords: *Compaction grouting, Standard penetration test, Cone penetration test, Soil liquifaction.*

ii)Jet grouting to support historic buildings*, Drooff, Eric R.; Furth, Allen J.and Scarborough, Jessee A. Foundation Upgrading and Repair for Infrastructure Improvement Geotechnical Special Publication No. 50 1995,ASCE, New York, NY, USA. p 42-55*

Jet grouting technology is becoming increasingly accepted by geotechnical engineers in the United States, and has developed a particular niche in its application to sensitive historic structures. The technique involves the use of high pressure jets of air, water, and grout to simultaneously erode and replace soil with cement grout, producing a final product known as soilcrete. Interconnected columns of soilcrete can be installed and used for underpinning and excavation support. Recently several notable historic structures have been underpinned and supported by the use of jet grouting.

Keywords: *Jet Grouting, Cement grouts, Underpining.*

iii) Instrumentation and measurements of a type-a insert wall, *Brown, Dan and Wolosick, John, Foundation Upgrading and Repair for Infrastructure Improvement Geotechnical Special Publication No. 50 ,1995, p 27-41.*

A slope failure in northwest Alabama has been stabilized using a system of grouted 'Insert' piles to provide load transfer across the failure surface of the slide. This system, referred to as a 'Type A' wall, includes small diameter grout piles reinforced with a high strength steel pipe as well as permanent earth anchors. A program of instrumentation was installed in an attempt to both verify the performance of this system and measure the axial, shear and bending forces in the key elements. This paper describes the Insert Wall repair of the slide as well as the plan and installation of the instrumentation. Initial measurements suggest that the majority of the instrumentation are providing reliable data and that the Insert Wall system has arrested the movement of the slide. The instrumentation is to be monitored over the next few years to verify long term success of the repair.

Keywords: *Steel pipe, Slope stability*

iv) Introduction to micropiles: an international perspective *Bruce, D.A.; DiMillio, A.F. and Juran, I. ,Foundation Upgrading and Repair for Infrastructure Improvement Geotechnical Special Publication NO. 50 ,1995, p 1-26.*

A major study of micropile technology has recently been funded by the Federal Highway Authority and completed by the authors. The subject is defined as a drilled and grouted, cast-in-place, reinforced pile of nominal diameter less than 300 mm. Micropiles have exceptional qualities not least of which are their relatively high axial load holding performance and their ability to be installed in very difficult locations and geologies. The bulk of the FHWA study relates to design, construction and performance. However, this paper provides an overview of the technology with respect to characteristics, definitions, historical development and applications, in order to establish common background for other publications on the subject.

Keywords: *Micropile, Axial load*

v) Liquefaction, and dynamic properties of grouted sand *Maher, M.H. and Gucunski, N., Soil Improvement for Earthquake Hazard Mitigation Geotechnical Special Publication, No.49,1995, p37-50*

This paper reviews the response of sand treated with chemical grouts to high strain dynamic loads. The effect of chemical grouting is evaluated in terms of liquefaction potential and dynamic soil properties (shear modulus and damping) of the sand. The liquefaction potential is measured, in the laboratory, in terms of flow failure and cyclic mobility using a series of undrained triaxial (cyclic) compression tests. The dynamic shear modulus and damping of grouted sand are determined using laboratory resonant column and cyclic triaxial tests. The effect of chemical grouting on dynamic soil properties is then evaluated under high strain dynamic loads similar to those encountered during earthquakes. The important parameters considered were shearing strain-amplitude, and grout type.

Keywords: *Chemical grouts, Shear modulus, Cyclic triaxial tests*

(II) Tunnel Grouting

i) Semi-empirical method for the design of support systems in underground openings *Singh, B., Viladkar, M.N.and Samadhiya, N.K., Tunnelling and Underground Space Technology vol.10, No. 3 July 1995, p 375-383*

A semi-empirical method has been developed for the design of support systems consisting of rock bolts/anchors, shotcrete/fibre-reinforced shotcrete, steel ribs and grouted arches to support tunnels and caverns, especially in poor rack conditions. The empirical relations for mobilizing factors of shotcrete and bolts/anchors have been deduced on the conservative side from extensive data of the Norwegian Geotechnical Institute (NGI) tables and charts for support systems presented by Barton et al. (1974). There is a reasonably acceptable correlation between the empirical approach and the proposed theory of estimating the support capacity except for

abnormal cases. The proposed method is simple to apply in the field. Special designs have been suggested for complex geological conditions for which the assumptions are not valid, such as in thick shear zones.

Keywords: *Shotcreting, Underground opening*

(III) Environmental Grouting

i) Barrier technology is waxing for recalcitrant sites
Wilson, David D. Ground Water Monitoring & Remediation vol.15, No. 3, Summer 1995. p 86-87

Tests on subsurface barrier technology using montan wax grouts have demonstrated the effectiveness of such a technique in encapsulating contaminated sites. Montan wax grout, which is based on bituminous wax found in brown or lignite coals, offers lower viscosity for injection; chemical, radiological, and biological resistivity; variable plasticity; and wide geological application. Results from tests conducted in the US and Germany are presented.

Keywords: *Contamination, Bituminous wax, Barrier technology*

(IV) Structural Grouting

i)Shear key performance in multibeam box girder bridges *Huckelbridge, A. A., El-Esnawi, H. and Moses, F., Journal of Performance of Constructed Facilities, vol. 9, No. 4, Nov.1995, p271-285*

This report describes a series of field tests of multibeam prestressed box girder bridges. The objective of the test was to investigate the in-situ performance of the grouted shear keys, located at the longitudinal joints between adjacent girders. The longevity of these joints can be a problem with this type of bridge; failure of the joint will typically not only compromise the load-sharing mechanism between adjacent girders, but also lead to the failure of the deck waterproofing system, with attendant corrosion problems. The tests consisted of monitoring relative displacements occurring across the intergirder joints, as well as bending strains in the girders themselves during passes of a preweighted tandem-axle dump truck, with axle loads typically in the range of 84.7 kN (19 kips). Relative displacements were measured with an especially designed transducer, having a resolution on the order of .00254 mm (0.1 mil), which was bonded to the underside of the bridge across the intergirder joints. Bending strains in the girders were measured with conventional foil strain gauges, having a gauge length of 38 mm (1.5 in.). All bridges tested exhibited relative displacements across at least some of the joints, which indicated a fractured shear key.

Key words: *Box girder, Grouted shear keys, Testing*

ii)Cement grout containing precipitated silica and superplasticizers for post-tensioning *Bastien, J., Dugat, J. and Prat, E., ACI Materials Journal, vol. 94 ,No. 4 ,Jul-Aug, 1997, p 291-295*

The purpose of this study is to investigate the applicability of an amorphous precipitated silicate in a low water/cement ratio grout formulation. The rheological and mechanical properties of the proposed grout are very interesting since, from a practical point of view, it exhibits no bleeding or segregation and reaches high compressive strength. This grout could therefore be a cost-effective alternative to traditional silica fume grout. Afield injection program indicates that the proposed grout formulation could be adequate for post-tensioning usage. This grout investigation has led to a European patent.

Keywords: *Cements, Rheology, Superplasticizers*

iii) Grout-filled pipe splices for precast concrete construction *Einea, A., Yamane, T. and Tadros, M. K. PCI Journal vol.40 ,NO. 1, Jan-Febr 1995, p 82-93*

The effect of confining entire members or parts of members, such as beams and columns, is known to strengthen the bond between the concrete and reinforcement. In this paper, the effect of confining the grout that surrounds isolated, single reinforcing bars on the bond strength between the bar and the grout is investigated. Grout-filled steel pipe splices with different parameters and geometrical design were prepared and loaded in axial tension until failure. The test specimens are described and the test results are presented, with discussion and analysis in light of existing theory. The experimental results show that a generic and inexpensive reinforcing bar splice for field connection of precast concrete members can be achieved using grout-filled standard steel pipe.

Keywords: *Precast concrete, Bond strength*

iv)Study on the joint strength of lap splices for precast concrete structures *Marcos, M., Yamaguchi, T. and Imai, H. , Transactions of the Japan Concrete Institute vol 18,1996, p 309-314*

Forty eight pullout specimens were tested in an objective to determine the changes in the joint strength of the lap splices while varying the lapping lengths. The results obtained are compared with calculated values from existing bond strength equations. It is also the aim of the experimental program to evaluate the effect of the presence of voids in the grout on the efficiency of the sheath-grout-main bar system in precast concrete structures. It was concluded that the presence of 20% void in the grout reduced the strength of the connection by about 12-16 percent.

Keyword: *Bond strength, Joints*

v) Post-tensioned prestressing cables in ducts *Clark, G., Concrete (London) vol. 29 No. 4 July-Aug, 1995, p 27-28*

Grouting specifications has been developed in order to protect post-tensioning steel tendons against corrosion. This process is effective if thegrouted tendons are not exposed to moisture and replenishment of oxygen. To improve its effectiveness, four suggested measures are given, namely the use of a protective barrier with sealed joints, reduction of the maximum water/cement ratio to a level that will require the use of admixtures; full-scale trials to establish the effectiveness of the procedures and viewing the grouting process as a specialist operation.

Keywords: *Prestressing, cement grouting*

Did you know?
The breakthough discovery of the reaction for polyurethane was found on March 26, 1937 by a German chemist named Otta Bayer.

(V) Sewer Grouting

i) Save money, seal service laterals with chemical grout *Anon, Public Works ,vol. 128 No. 11 ,Oct 1997, p 60-62*

Reducing groundwater infiltration by sealing laterals with chemical grout can be a cost-effective way to stop leaks in structurally sound pipeline. Commonly used lateral packer systems can be accurately positioned in the main line by remote control so that the center section of the packer aligns with the lateral line. At this point, an inflatable tube can be inserted a prescribed distance into the lateral line. When the two ends of the packer are inflated in the main line, a T-shaped area is effectively isolated from the rest of the rest of the sewer system and can be tested again. If a leak is found, chemical grout can be applied to seal it. After the grout has been applied, the connection is pressure tested again until the connection is sealed.

Keywords: *Chemical grout, Service laterals*

(VI) Masonry Grouting

i) Accurate estimation of interface shear stresses in composite masonry walls *Anand, S. C.and Rahman, A. M., Journal of Structural Engineering vol.120 , Mar 994, p998-1015*

A composite masonry wall consists of a concrete-block wythe, a clay-brick wythe and a cavity (collar joint) between the two wythes that is filled with mortar or grout. The in-plane loads on a composite wall due to gravity and/or wind are generally applied on the block wythe and can produce large interface shear stresses in the collar joint. The composite action of the wall is ensured only if these shear stresses are less than the shear strength of the interfaces. A refined finite element procedure based on interface shear stiffness and considering stress singularity, which can accurately predict collar-joint interface shear stresses in composite masonry walls, is proposed in this paper. This paper shows that there is no need to consider reduced shear stiffness for the interface elements.

Keywords: *Shear stress, Finite element method*

(VII) Dam Grouting

i) Mind over matter *Moxon, S., International Water Power and Dam Construction vol. 49, No. 8 Aug,1997, p26-28*

Immediately after the first sinkhole was confirmed on WAC Bennett dam in June 15, 1996, a round-the-clocksurveillance program was implemented. Over the next few months, around 90 piezometers, weirs, turbidity gauges and similar devices had been automated and alarmed to detect any changes. To ensure dam safety, Williston Reservoir was lowered by partially opening spillway gates and maximizing flow through the turbines. Twelve months after the first alert to the presence of the crest sinkhole, remediation work was completed and WAC Bennett dam is now all systems go.

Keywords: *Sinkholes, Compaction grouting*

ii) Grouting in a karst environment *Williams, B. E. and Robinson, R. Proceedings of the International Conference on Hydropower - Waterpower, vol. 1, 1997, p 814-818*

Logan Martin Dam is owned and operated by Alabama Power Company. Since the completion of the dam in 1964, control of the underseepage through the karstic foundation has been a continuous challenge. Several attempts have been made to establish a cutoff through the foundation by grouting. However, recent hydrogeological investigations indicate that the original and the remedial curtains did not extend deep enough to intercept the predominate seepage paths. The original curtain extended to an average depth of 30 meters (100 feet) into bedrock. Highly permeable zones have been found at depths reater than 122 meters (400 feet). This paper presents the drilling and grouting techniques utilized for the most recent grouting program.

keywords: *Seepage, Karstic foundation, Grout curtain*

iii) Deep leakage through the karstic foundation at Logan Martin dam *Robinson, R. and Williams, B. E., Proceedings of the International Conference on Hydropower - Waterpower, vol. 1,1997, ASCE, New York, NY, USA, p 806-813*

The dam and reservoir are built on an intensely deformed, karstic foundation which allows considerable underseepage to pass beneath the dam. Since completion of construction in 1964, a number of remedial measures have been taken to improve the foundation. While these measures have certainly improved dam safety, the foundation continues to suffer leakage in excess of 18 m**3 s (650 cfs). This continuing leakage presents long-term safety concerns for the dam, water quality problems immediately downstream and lost revenues from generation. Much of the present leakage is passing beneath the dam at considerable depths and exiting near the downstream toe of the embankments. In 1991, an intensive deep grouting program was initiated to address this leakage. An important result of this program was definitively characterizing the nature
of the leakage.

Keywords: *Embankment dams, Karstic foundation*

iv) Restoration of Rideau Canal historical locks *Narduzzo, L.and Naudts, A., Concrete International: Design and Constnuction ,vol. 16, No. 3, Mar, 1994, p29-34*

A state-of-the-art grouting approach was used for the rehabilitation of the historical locks on the Rideau Canal, located in Ontario, Canada. Grouting reduces permeability of the structures, increases their structural integrity, and preserves their historical character.

Keywords: *Dam seepage, Permeability*

(VIII) Rock Grouting

i) Numerical model for rock bolts with consideration of rock joint movements *Marence, M. and Swoboda, G. Rock Mechanics and Rock Engineering, vol. 28,No. 3, Jul,1995, p 145-165*

The stability of any underground structure during and after excavation is the most important question for designers, because any king of collapse may destroy large parts of a finished tunnel, causing major repairs and time loss. Preliminary calculations are therefore of great importance. A calculation is only useful, however, when the underlying numerical model correctly describes natural behavior. The rock bolts used in tunnel excavations are mostly untensioned grouted bolts, and this type of bolt is the main focus of this work. From the model of the grouted bolt, other types of rock bolts can also be modelled by the theory presented herein. Bolt behavior in intact rock mass is so different from behavior when a bolt intersects a joint, that a model with two different

elements is suggested for a numerical calculation; one element for the bolt in the rock mass and one as a bolt intersecting with a joint. The model for both elements is verified by the experimental results. The numerical results correspond favourably with the experimental work. A variation of the parameters important for the behaviour of the bolt in intersection with the joint is shown. As an implementation of the bolt model, the numerical simulation of excavation and stabilisation of one road tunnel is presented.
Keywords: *Computer simulation, Numerical model, Rock bolts*

ii) Load bearing behavior of fully grouted anchors under shock loading *Hagedorn, H. and Borm, G. , Soil Dynamics and Earthquake Engineering, vol. 13, No. 2,1994, p 89-95*

The load bearing behavior of fully grouted fiber reinforced polyester and epoxy rock anchors under shock loading was investigated using a special facility for dynamic tests. Two concrete blocks were connected with the anchor. With a constant acceleration three loading blocks with different weights were used to produce various dynamic forces on the anchor and the grout material. Of special interest were the length of exceeded bond strength in the grout material and the load capacity of the fiber reinforced anchors. The residual resistance of the anchors was tested by push-out tests of specimens to estimate the loss of bond strength and its distribution over the anchor length. The results refer to a realistic scale.
Keywords: *FRP anchors, Dynamic loads, Bond strength*

(IX) Biomedical Grouting

i) Total joint replacement: Biomechanics and biomaterials *Liu, Y. K., Bioengineering American Society of Mechanical Engineers, Petroleum Division (Publication) PD vol. 64, NO. 4, 1994. Publ by ASME, New York, NY, USA. p 15*

Total hip joint replacement is a major success in orthopedic surgery and biomedical engineering. To a slightly less extent, so is total knee replacement. For the load-bearing joints, two methods are employed for the fixation of implants to the musculoskeletal system: (1) use of grouting materials, e.g., polymethylmethacrylate (PMMA), as bone cement between bone and prosthesis; (2) direct apposition of bone tissue onto porous or nonporous implant surfaces. The use of PMMA as a grout between living bone and the metallic prostheses, with many improvements added over the years, remains the gold standard today. The main advantages of cement fixation are: fast fixation time and surgically forgiving. The chief disadvantages are: complications arising from uneven cement polymerization; maldistribution and the inherent material-property mismatch between implant, cement and bone giving rise to interfacial stress concentrations; and the potential for crack initiation and crack propagation. The cemented total joint replacement lasts, on an average, a decade under in-vivo weight-bearing conditions. Cracking of the cement mass is the most common mode of failure. Conventional surgical wisdom is to use cemented prosthesis in older patients, where revision is highly unlikely. In the younger patient, where revision is likely, the cementless implant is the method of choice. To achieve purchase between the bone cement and concellous and/or cortical bone, a relatively large amount of bone cement is forced into the to intermedullary canal. The interdigitation of the bone cement and bone creates a good-sized composite. When revision becomes necessary, this composite mass must be destroyed, thus, leaving little bone for the second purchase. One way of resolving the dilemma of revision is to make it unnecessary altogether. Towards this end, several investigators have mixed resorbable particles with the polymer phase of the bone cement to increase the endurance limit of the impregnated composite as well as allow living bone to resorb the particles and deposit new bone into its vacated spaces. Thus, the bone cement/bone interface becomes an interconnected and viable one.
Keywords: *Hip prostheses, Joints, PMMA*

(X) Coatings

i) Quantitative nondestructive in-service evaluation of stay cables of cable-stayed bridges: methods and practical experience *Weischedel, H. R. and Hoehle, H.W., Proceedings of SPIE - The International Society for Optical Engineering vol. 2456 1995. p 226-236.*

Stay cables of cable-stayed bridges have corrosion protection systems that can be elaborate. For example, such a system may simply consist of one or several coats of paint, or - more complex - of plastic pipes that are wrapped with tape and filled with grout. Frequently, these corrosion protection systems prevent visual inspections. Therefore, alternative nondestructive examination methods are called for. For example, modern dual-function electromagnetic (EM) instruments allow the simultaneous detection of external and internal localized flaws (such as external and internal broken wires and corrosion pitting) and the measurement of loss of metallic cross-sectional area (typically caused by external or internal corrosion or wear). Initially developed for mining and skiing applications, these instruments have been successfully used for the inspection of stays of cable-stayed bridges, and for the inspection of guys of smoke stacks, flare stacks, broadcast towers, suspended roofs, etc. As a rule, guys and bridge cables are not subjected to wear and bending stresses. However, their safety can be compromised by corrosion caused by the failure of corrosion protection systems. Furthermore, live loads and wind forces create intermittent tensile stresses that can cause fatigue breaks of wires. This paper discusses the use of dual-function EM instruments for the detection and the nondestructive quantitative evaluation of cable deterioration. It explains the underlying principles. Experiences with this method together with field inspection results will be presented.
Keywords: *Nondestructive examination, Electromagnetic waves, Stay cables*

ii) Concrete repairs and coatings *Shaw, J., Concrete (London), vol. 31, No. 8, Sep. 1997, p23-25*

Removing deteriorated concrete cover, patching and then coating the whole structure with anticarbonation coating are time-consuming and costly. In recent years less costly repair techniques that retard or arrest reinforcement corrosion have been developed and applied. The service life of reinforced concrete structures, where the cover is fully carbonated, can be increased by applying high-performance coatings capable of bridging any cracks in the concrete and thus providing a weatherproof membrane to the exposed surface. These protective coatings for concrete could provide a cost effective way of reducing or eliminating corrosion of

reinforcement by helping to dry out the concrete cover or preventing ingress of chloride ions.
Keywords: *Carbonation; Chloride; Corrosion protection.*

iii) Evaluating coatings for concrete wastewater facilities
Vipulanandan, C., Ponnekanti, H., Umrigar, D.N. and Kidder, A.D., Materials for the New Millennium Proceedings of the Materials Engineering Conference, vol. 1, 1996. ASCE, New York, NY, USA. p 851

Microbial corrosion in concrete sewer facilities requires rapid in situ rehabilitation of the concrete structural elements. Coating concrete is one method currently being adopted, but there is no systematic method for evaluating the performance of these coating materials under wet and dry conditions. The aim of this study was to develop a testing program to evaluate the performance of polymeric and cementitious coating materials on concrete substrates. A comprehensive testing program has been developed with a combination of prototype and laboratory tests. Full scale pressure chambers were designed and built to evaluate the application and performance of the coating materials on concrete substrate under a hydrostatic pressure of over 10 m (32 ft.) of water simulating the groundwater conditions. Coated concrete with holidays (pinholes) was used to study the chemical resistance under acidic environment. To quantify bonding strength between the coatings and concrete substrate two standard testing methods were adopted. The performance of coating materials were being studied for a period of at least one year. Preliminary results based on the first round of coating tests are discussed to evaluate performance of coatings and the sensitivity of the testing program.
Keywords: *Hydrostatic test, Bonding, Holiday test.*

Industrial Contacts and Sponsoring Members :

Berry, R., Rembco Engineering, Knoxville, Tennessee.
Bandimere, S., Denver Grouts, Denver, Collorado.
Fiest, G., 3M Construction, St. Paul, Minnesota.
Magill, D., Gulf Coast Trenchless Association (GCTA).
Magill, D., Avanti International, Webster, Texas.
Wells, J., InsituformTechnologies, Chesterfield, Missouri.

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, other related topics 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. *Canadian Geotechnical Journal*
4. *Civil Engineering Magazine (ASCE)*
5. *Civil Engineering (London, England)*
6. *Civil and Structural Engineering Abstracts*
7. *Composite Materials Series*
8. *Concrete Construction*
9. *Concrete International (ACI)*
10. *Engineering News Record*
11. *Engineering and Mining Journal*
12. *Foundation Facts*
13. *Geodex Retrieval System for Geotechnical Abstracts*
14. *Geotechnical Abstracts*
15. *Geotechnique*
16. *International Journal of Rock Mechanics and Mining Sciences and Geomechanics Abstracts.*
17. *Japan Society of Civil Engineers.*
18. *Journal of Geotechnical Engineering (ASCE)*
19. *Journal of Structural Engineering (ASCE)*
20. *Journal of Protective Coatings and Linings.*
21. *Materials Performance*
22. *New Scientist*
23. *Ocean Engineering*
24. *Pipes and Pipelines Manual*
25. *Pipes and Pipelines International*
26. *Pipelines and Utilities Construction*
27. *Rock Mechanics and Rock Engineering*
28. *Series on Rock and Soil Mechanics*
29. *Soils and Foundations*
30. *Soil Technology*
31. *Trenchless Technology Magazine*
32. *Tunnelling and Underground Space Technology*
33. *Waste Management*

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