ABSTRACTS

4th Annual Technical Forum

Geohazards in Transportation in the Appalachian Region

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Nick J. Rahall, II
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Appalachian Coalition

Chair: Dr. Tony Szwilski, P.E. ***Co-Chair: Kirk Beach***

DAY 1

Opening Session

Chair: Kirk Beach

Synthesis Study of State DOTs and the UK geotechnical Data Systems

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There is little doubt that a functioning standardized distributed geotechnical database system would benefit the geotechnical community. There are any numbers of examples that can be cited to provide emphasis to this point, as many of the participants at this conference are well-aware. One example, and the one that will be focused in this presentation, includes the geotechnical engineers and geologists from the various state Departments of Transportation (DOTs) across the country. These agencies have historically collected (and continue to collect) a tremendous amount of geotechnical and geologic information during the execution of highway construction projects. Unfortunately, there are currently no standardized guidelines for collecting, storing, or managing these data. While many of the DOTs have developed some form of a geotechnical management system that works for their respective state, very few have developed systems that treat geotechnical information as "data".

Historically, many DOTs have looked to the Federal Highway Administration (FHWA) for guidance related to technical issues, particularly the issues that are common to and affect virtually all agencies, regardless of the geologic or geographic setting. The issue of geotechnical data management is one of these areas where FHWA involvement and guidance would be beneficial to several agencies. Although there has not necessarily been a formal "request for guidance" to the FHWA from all of the DOTs, a few of the states have either solicited FHWA assistance or taken the initiative to develop state-specific data management systems. The Ohio DOT has developed a long-term data management vision for managing geotechnical information from across the state. One of the initial steps in the implementation is to minimize "reinventing the wheel" by learning what has been developed by DOTs across the country. Together the Ohio DOT and the FHWA have authorized a study to compile and synthesize the geotechnical data management practices by the state DOTs and within the geotechnical community in the United Kingdom (UK). This presentation provides the results of the state-by-state and the UK survey.

As part of the synthesis study, geotechnical engineers and/or geologists from each state were interviewed and their responses have been compiled into a database. The results of the study highlight the pressures placed on the geotechnical engineers at the DOTs to assist in the construction of major projects, but suffering from the lack of funding to hire and retain sufficient personnel to meet many of their data management goals. In the majority of states, there are no existing protocols for tracking or managing information regarding geotechnical boring logs or laboratory/field test results. The majorities of the states, however, have developed procedures to catalogue and manage

geotechnical reports that contain the boring logs and test results. There is strong interest among the state DOTs to adopt a system, but many of the survey participants are skeptical of claims that such a system will, in fact, help them do their jobs better. Interestingly, the UK recognized the challenges and the potential opportunities of a geotechnical data management system several years ago and currently has developed standards that have been incorporated into current practice. The results of the synthesis survey coupled with the UK results present a unique challenge to the US geotechnical and geological community, but the authors feel that if the challenges are accepted, the rewards will be significant.

Overview of Geological Hazards that may Impact Ohio's Transportation Network

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Unlike west-coast states that experience major geologic hazards like large earthquakes and active volcanoes, Ohio has subtler, more infrequent, and less visible geologic hazards that can still cause severe damage, especially to the transportation network. Geologic hazards may be classified as those due to geological materials or those due to geological processes. In the materials category, reactive minerals pose the greatest threat to Ohio highways, and those include swelling soils and reactive aggregates in concrete. In the geologic processes category, landslides, subsidence, and floods pose the greatest threats to the transportation network. Identification of landslide hazards can be minimized in highway construction by geologic mapping of landslide-prone bedrock units like the Kope Formation in the greater Cincinnati region. Mapping of landslide-prone colluvium is also important. Subsidence can be due to abandoned underground mines, karst features, and sinking earth in glacial deposits. Again, detailed geologic mapping can help to predict occurrence of these hazards. Floods are a function of both weather and geologic conditions. The capability of bedrock and surficial materials to contain water partly controls the occurrence of flooding. Detailed geologic mapping and characterization of subsurface conditions helps to predict this capability. Earthquakes in Ohio are another geologic hazard that can affect the transportation network. Although generally of small magnitude, Ohio earthquakes do have the potential to trigger landslides and threaten bridges. Maintenance of the Ohio Seismic Network allows for the collection of seismic data and mapping of deep basement faults.

Session 2: GeoHazards Investigations

Chair: John Keifer

Geologic Hazards Investigation for MUS-93-4.69

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The MUS 93- 4.69 project is the proposed new construction of a 5-mile connector between US 22 and US 40 in Muskingum County on the west side of Zanesville, Ohio. The project is in the initial stages of Step-6 of the Ohio Department of Transportation 14-Step Major Project Development Process. Step-6 involves the development and investigation of Feasible Alternative Alignments. The project corridor is located in the non-glaciated portion of the Allegheny Plateau Section of the Appalachian Plateau Physiographic Province. The topography is moderate to steep and cuts near 100 vertical feet will be required. Bedrock is generally shallow and consists of the middle and lower members of the Allegheny Group. This group includes the Middle Kittanning Coal which has been extensively mined using both surface and underground methods for approximately ½ of the project length. BBC&M's work has identified the following geologic hazards within the project corridor: underground mines; surface mines; landslides; and rockfalls. Considerations and possibly corrections will need to be made for each of these geologic hazards as part of the project design. This paper will present the methods and sources used to identify the geologic hazards and the work proposed to characterize and potentially correct for the hazards.

Integrated Geotechnical Data Management for Working Engineers and Geologists

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A geotechnical data management application is being developed to facilitate better sharing and exploitation of investigation data. GIS integration will facilitate enterprise-wide access to logs, diagrams and soil and rock data for more economical utilization and decision-making. The geotechnical data management application will facilitate complete systems integration, supporting activities such as research, operations and maintenance, instrumentation, and production. The state of management of geotechnical data typical amongst government agencies varies from isolated computer software packages to disorganized boxes of paper logs that are hardly managed at all. Some agencies have implemented software and systems to collect investigation data, archive testing data, and produce logs and reports electronically. Conversely, in others, there is no effective use and management of electronic data at all.
An engineer in a federal agency said, "The department is truly archaic when dealing with records. It is my understanding that the [department] only uses hard copies of log and

testing data. The information is stored in warehouses at different places throughout [city to remain anonymous]." In addition to supporting engineering design and hazard management, web-based GIS access to investigation data will allow simplified, intuitive access to report summaries, borehole logs, and laboratory test data. This software will integrate the open-architecture database backend with commonly used logging, modeling, design and GIS applications resulting in more efficient design and better decision-making.

Arresting Subsidence Using Low Cost Pozzolan Materials

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Various geophysical survey techniques are being investigated to locate abandoned mine and solution cavities. The Maryland Department of Natural Resources and U.S. Department of Energy have entered into a Cooperative Research and Development Agreement to explore the potential of arresting mine and karst formation subsidence using low cost pozzolan stabilized materials prepared from power plant combustion products. Subsidence in Maryland's five coal basins is an increasing hazard as abandoned mines approach 160 years of age. Natural subsidence in Maryland's karst belt is a growing hazard, particularly to linear facilities, as the Baltimore/Washington metropolitan areas spread into the Carroll, Frederick and Washington Counties. The results of geophysical surveys supporting mine, road, and stream investigations are presented.

Session 3: GIS Applications in Geotechnical Issues

Chair: Steve Brewster

Development of Abandoned Underground Mines (AUM) GIS Applications

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The Ohio Division of Geological Survey, with funding from the Ohio Department of Transportation (ODOT), has created a GIS of abandoned underground mines that will help mitigate the hazard that mines present to lives and property. Current activities on the project involve steps that will make the GIS more useful to the public and ODOT. Some of these steps include adding mine attribute information, adding and editing newly discovered mines and mine extensions to the GIS, and georeferencing the detailed mine-map images. Applications have been developed for ODOT and the public. The georeferenced mine-map images are used along with the ODOT road system to identify locations where the roads intersect the mines. ODOT field crews then use the intersections, roads, and mine outlines for detailed site investigations. An ArcIMS website has been developed. The public can access the website to determine whether a mine is located underneath their property.

Application of GIS in Reducing Impact of Landslides on Highway Routes in West Virginia

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Highways in West Virginia run close to the bottom of the mountains. These mountains are mostly of shale, limestone, and sandstone and are susceptible to weathering. The seasonal freeze and thaw circle also affects the stability of these mountains. During heavy rainfall, mudslides are common closing down roads and causing unexpected interruption to traffic flow. Interruption to traffic causes inconvenience, delay and increases user cost. To inform highway users ahead of time for possible interruption to traffic, this paper proposes a web based geographic information system (GIS) that indicate segments of highway vulnerable to traffic interruption due to mudslides. Based on rainfall data, hydrologic, geologic and road maps, vulnerable regions and their threat will be rated on a composite scale. Segments of highway which fall under vulnerable region would be identified for future interruptions. Historic data would also be incorporated in forecasting future cases of interruption. In case of a mudslide, GIS maps would also be used to identify alternative routes and direct the driver to routes that are not interrupted by mudslides. This system when fully developed would also have the potential to direct drivers when their may be road closures due to other traffic problems e.g. spilled loads or other hazardous material on a highway, traffic incidents.

GIS/GPS Applications for a Geotechnical Corridor Review

Ed Bennet and Kirk Beach, Ohio Dept. of Transportation

US-30 is designated as a major through corridor in northern Ohio. Several projects have been undertaken by the Ohio DOT to upgrade US-30 into a limited access 4-lane highway running from the Indiana border to the Pennsylvania line as a major east-west route. The Ohio DOT recently conducted a comparative assessment of two 35-mile alternative alignments for the eastern end of the corridor in Stark, Carroll, and Columbiana Counties. The assessment included, in part, a review of landslides, surface and underground mines, wetlands, lactustrine deposits, surface and groundwaters. Field verification of geohazard features involved two (2) teams. To provide a measure of quality control, both field teams jointly evaluated the first section of the corridor before proceeding, independently, along the alternative north and south alignments. In order to assess the corridors, geo-reference layers were used in the planning stages to identify areas of potential concern. These areas were then field reviewed during the site reconacciance. GPS units were used for navigation to identify the centerline of the proposed alignments while recording any geotechnical features encountered along the way. All information was compiled into GIS layers for final evaluation and assessment. The use of GPS and GIS in the planning stage of design is a valuable tool in adjusting alignments to minimize impacts to environmental features and to avoid costly geotechnical hazards.

Grid Analysis of Landslide Hazards Impacting Transportation Systems

Sean Davies, Intergraph Corporation & Matt West, Keigan Systems

Grid based Geographic Information Systems (GIS) are an effective analysis tool for the study of geologic hazards as they pertain to transportation systems. Grid GIS is ideal for identifying potential landslide hazards because they collect, store, retrieve, and analyze spatially-distributed data representing the multiple factors contributing to landslides. Grid GIS has tools that can be used to extract, extrapolate, interpolate, correlate, visualize, analyze, and cross tabulate point, line, area, and continuous data. In Grid GIS, complex landslide hazard models can be created, run, evaluated, and improved by refining criteria and variables or adding new factors and layers. A general landslide hazard model can easily be modified for specific regions and conditions. Risk of landslide can be assessed for an entire transportation system at once rather than location by location. Grid based landslide hazard maps have been constructed for many highly distinct regions using a multi-criteria analysis that takes local factors, standard and non-standard models, and data availability into account, such as: geology, hydrology, topography, landslide frequency, soil and rock properties & mechanics, precipitation & infiltration, piezometry, vegetation cover, surface gradient, surface aspect, and surface curvature. Analysis can be customized to local triggers such as blasting, earthquakes, snowmelt, or precipitation events.

Session 4a: Ground Stabilization Issues

Chair: James Fisher

US 35/I 64 Interchange Embankment and MSE Wall Design and Construction Using Lightweight Backfill

James C. Fisher, West Virginia DOT

US Route 35 in Putnam and Mason counties is currently being upgraded from two lanes to four lanes. As a part of this upgrade a new relocated Route 35 intersection with existing Interstate 64 is being constructed in Putnam County. The construction of the project is within the valley of the ancient Teays River. The Teays River was an ancient stream, comparable in size to the modern Ohio River that once drained much of the east central U.S., including nearly two-thirds of Ohio. It was destroyed by the glaciers of the Pleistocene Ice Age about 2 million years ago. The edge of the glacier created a massive dam that blocked the northward-flowing Teays and created a major lake in southern Ohio eastern Kentucky and western West Virginia. The focus of this paper is the investigation and design consideration for construction of exit Ramp 5. This ramp required the most detailed geotechnical considerations for construction of the interchange. Due to the project geometric requirements, a large amount of fill was required on this ramp. An abutment for a flyover bridge over I-64 is to be located on top of the fill. Several design alternatives were considered, ultimately two Mechanically Stabilized Earth (MSE) walls were designed to meet the ramp's right of way, utility and geometric requirements. Special consideration was required for designing and constructing the embankment fill and backfill of the MSE walls over a thick and relative low strength soils deposits. Alternatives were studied in order to construct the fill and backfill and maintain stability considering the weak material that would be at the base of the embankment and MSE walls. It was decided to use a lightweight fill material in order to maintain stability of the embankment and MSE walls. Bottom ash, which is a waste product obtained from coal burning power plants, was chosen as the light weight material for inclusion in the fill and backfill.

Mine Shaft Grouting Using CCPs

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The Kempton Man Shaft Project is one of several projects sponsored by the Maryland Department of Natural Resources Power Plant Research Program, and funded by the US Department of the Interior Office of Surface Mining, to demonstrate the replacement of concrete with coal combustion products (CCPs) from nearby coal-fired power plants. The Kempton Mine complex was an active deep mine during the period 1912 – 1950. The mine tunnels, varying in depths of 130 feet to 420 feet below grade, lie beneath an area of approximately 12 square miles spanning portions of West Virginia and Maryland. Most of the tunnels are flooded by surface water intrusion or from local aquifers. The presence of residual coal in the tunnels acidifies the water and causes environmental

damage when it discharges into nearby Laurel Run, a tributary of the Potomac River. The Man Shaft, which lowered miners to the mine tunnel entrances, is 420-feet below grade. Exploratory boreholes drilled around the Man Shaft revealed horizontal fractures in siltstone bedrock at depths between 120 feet and 140 feet. The project objective was to reduce the amount of ground water lost to the mine pool by installing a grout curtain to a depth of 160 feet around the shaft using a cementitious grout prepared from coal combustion products from nearby power plants. Because the available coal fly ash was a Class F ash (low Calcium) ash from a fluidized bed furnace, which mixes the coal with limestone prior to burning, was added to ensure proper hardening. Grout was injected into 28 6-inch holes, cased to 20 feet and filled to 150 – 160 feet using a tremie line. Because the number fluidized-bed furnaces in the vicinity of Western Maryland are limited, the supply of fluidized-bed ash may be insufficient for large volume projects. Laboratory test results suggest that the more plentiful lime kiln dust may be suitable replacement for the fluid-bed ash. Future projects to test this substitution on a large volume scale are under consideration.

Use of Expanded Polystyrene (EPS) In Slope Stabilization

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Innovative foundation treatments and embankment construction have been used to mitigate slope stabilization on landslide and Rock fall containment areas throughout the United States. The use of EPS have reduces the settlement and expedite construction on soft, clayey, unstable foundation soils. Another use of geofoam is to reduce settlements and improve the stability of embankment/wall systems, by using a “vertical face geofoam backfill” instead of mechanically stabilized earth “MSE” walls. In some areas, relatively high MSE walls (ranging from 10 to 14 meters) have been constructed. A comparison of MSE type stabilization will be analyzed as well as slope stability and alternatives relative to EPS fills. An MSE wall system, with time allowance for foundation preparation, construction, and settlement completion, required more time before the pavement could be placed atop the system. In a handful of cases, mainly due to schedule constraints, Contractors have elected to use geofoam walls, instead of MSE wall construction. A geofoam system has been constructed in about one month, or less, without significant stability or settlement issues. This paper will present a background on geofoam use in the United States as well as instrumentation and monitoring results of past projects.

Session 4b: GIS Analytical Tools and Karst

Chair: Steve Brewster

Internet GIS Tools for Site Analyses in Kentucky

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The Kentucky GIS community has developed several tools to assist in site development evaluations. The KYGeoNet is a "one-stop-shop" for geographic data resources related to the Commonwealth of Kentucky. A wide range of datasets can be located and accessed, static map products can be downloaded, and several Internet Mapping solutions are accessible via the site. The KGSGeoPortal is an Internet service that links users to a variety of Web-based information about Kentucky's landscape, environment, resources, and infrastructure through Internet maps, tabular databases, and online publications. The collection of Internet maps, developed by a variety of state and local agencies, are tightly linked by the KGSGeoPortal tools, so that a user can move from an area of interest on one map, say soils and geology, to the same area of interest on another, say abandoned mine areas, with two clicks of a mouse.

A Geospatial Analysis for an Environmental Restoration Feasibility Study of the Monday Creek Watershed

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The Monday Creek Watershed, located in southern Ohio, primarily in Athens, Hocking, and Perry counties is an area of abandoned and inactive mines. As a result, the watershed has a high concentration of abandoned mine land (AML) features, as identified in the U.S. Army Corps of Engineer AML inventory, including subsidence's, portals, ponds, seeps, gob piles, slumps, remaining structures and refuse. In addition, pH checkpoints were collected that exposed varying levels of acidity. Totaling an area of more than 74,000 acres, the Monday Creek Watershed provides drainage to the Hocking River from the Little Monday Creek, Monday Creek Mainstream, and the Snow Fork basins. Through a partnering agreement with the U.S. Forest Service, ODNR, the Monday Creek Restoration Group, and the U.S. Army Corps of Engineers a feasibility study is being develop to propose treatment methods for restoring the watershed to its biological habitat and as a resource for public recreation. In order to provide information for the feasibility study to determine restoration measures, the functionality of GIS was employed. ArcGIS (Environmental Systems Research Institute, 2002) software was utilized for compiling the large quantities of data from the AML inventory, identifying and locating the proposed treatment site locations, and combining all other additional data needed for a comprehensive feasibility study. The flexibility of ArcGIS allowed multiple data sources in varying projections and coordinate systems to be converged into one database and displayed spatially.

Karst Inventory and Vulnerability for I-66, Somerset to London, KY

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This study evaluated potential interstate alignments traversing Kentucky's Eastern Pennyroyal karst region in Pulaski and Laurel Counties. The principal carbonate stratigraphic units in the study area are the St. Louis, St. Genevieve, and Kidder Limestones. The inventory and assessment consists of three main components: karst terrain features; karst hydrology; and karst fauna. This paper principally reports on the karst terrain aspects. The study was conducted in three phases; literature search, field reconnaissance, and vulnerability assessment. The field reconnaissance covered over 25 miles along three 1000-foot wide bands. Over 1100 karst features were located by GPS, photographed and described. Field data was entered into a database and plotted on the project mapping. The vulnerability assessment and ratings are being developed based on *Karst Inventory Standards and Vulnerability Assessment Procedures for British Columbia.* The vulnerability potential will be based on a qualitative evaluation of the following attributes: epikarst development; surface karst feature density; subsurface karst potential; surficial material character; and bedrock type and proportion. The presence of unique fauna or habitat may be used to increase potential vulnerability rating. Results of the assessment will be used to present karst impacts in the Environmental Impact Statement for the project.

Session 5: Landslides and Rockfalls

Chair: Tony Szwilski

Determining the Validity and Effectiveness of Landslide Susceptibility Maps, Using Cincinnati, Ohio as an Example - A Study in Progress

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The 1980 Landslide Susceptibility Map of Cincinnati, Ohio, is used as a model, to determine the most practical methods for evaluating the validity, reliability and effectiveness of landslide susceptibility maps. The 1980 study used a multivariate statistical analysis with weighted factors assigned to the parameters of slope, geology, soil type and proximity to an inventoried landslide to delineate areas of Low, Moderate, Moderately High and High landslide susceptibility. The current study inventories all recorded landslides that have occurred within the City of Cincinnati. Information describing the landslides is being entered into a GIS interactive database along with shapefiles of their boundaries. To date 173 landslides identified in the original study and an additional 325 landslides have been entered into the GIS database along with theme layers depicting slope, bedrock and surficial geology and soil type. Additional landslides that occurred prior to 1980 but omitted from the original study and landslides that occurred after 1980 will be statistically analyzed to determine how successful the 1980 Landslide Susceptibility Map identified potentially unstable areas.

Rockfall Control Measures In ODOT District 11

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This presentation will summarize the author's 18 years of experience in dealing with rockfall hazards in Eastern Ohio. Preventing and controlling rockfall will be broken down into three primary areas: design, construction, and maintenance. The design discussion will include considerations useful to avoid creating a problem. Using tools such as the Colorado Rockfall Simulation Program (CRSP), the Oregon DOT Rockfall Catchment Area Design Guide, and the Ritchie Criteria will be discussed. Examples of poor slope designs are compared to State-of-the-Art slope designs. During construction, the protection of traffic is of utmost concern and various methods will produce dramatically different results. Several methods are discussed. Dealing with rockfall from existing slopes requires a "street wise" approach. Innovative control and cleanup methods are discussed.

Landslide Investigation on State Route 7 along the Ohio River

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A mile long section of State Route 7 just south of Gallipolis has an extensive history of landslides. Records maintained by the Ohio Department of Transportation indicate that many landslide remediation projects have been performed in the area, starting in 1937, yet the roadway is still affected by slide movement. An investigation of the area was performed which included a detailed field reconnaissance, borings, and an instrumentation program. The soils in the area consisted mainly of colluvial soils (landslide debris) with some alluvial deposits and the bedrock consisted of Conemaugh Group formations, including weak red claystone. The investigation identified multiple slides above bedrock interacting with one another along the slope, and relatively shallow landslides occurring within larger landslide masses. The rate of slide movement was generally ½ to 1-inch per year over a 2-year period and increased immediately after a sudden rise and fall of the water in the Ohio River.

Exploring Construction on Sites Underlain by Colluvial Deposits in the Eastern Kentucky Coal Fields

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In planning transportation projects in most areas of the Southern Allegheny Plateau Region of Kentucky, geologic conditions are fairly predictable due to the U. S. Geological Survey mapping. Principal geotechnical concerns are typically the slake durability of shales in cut situations and the compressibility of soft alluvium underlying embankments in major stream valleys. Residual soils on hill slopes are typically of insignificant thickness. Latent deposits of thick colluvium on hill slopes, however, are of significant concern in design and construction. Colluvial deposits started as ancient rock slides caused by the surface erosion that carved the valleys. Over time the slide rock has weathered and turn into soil with some small rock fragments. Due to its form of deposition, colluvial deposits are metastable and can undergo displacement or fail with minimal disturbance. Explorations and design of projects located in the Eastern Kentucky coalfields provide some insight on the methodology needed to construct transportation systems intersecting the colluvium. However, each deposit is unique and requires site specific exploratory and construction measures. This paper presents background information and discusses actual conditions encountered and methodology implemented in constructing several projects underlain by colluvial deposits