

# Format Conference

**Electronic Transmission and Storage of Data:  
Site Investigation to Piling  
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## **THE STATE OF DATA INTERCHANGE IN GEOTECHNICAL PRACTICE IN THE US**

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**SYNOPSIS:** Unlike the UK, common practice in the US is for geotechnical consultants to carry out the site investigation. Therefore, the need to transfer data between the SI contractor and the consultant is minor. The demand for data transfer is predominantly driven by government agencies. This paper surveys how this is being currently handled. It looks at the current methodologies with their advantages and disadvantages.

### **1. INTRODUCTION**

Geotechnical data interchanges generally follow the following broad routes:

- Site Investigation Contractor to Consultant
- Consultant to Client
- Public Agency to Public Agency
- Public Agency to the Public Domain
- Internal Exchanges

Overall electronic geotechnical data interchange in the US currently represents a small percentage of the data collected. Generally consultants collect the data and few clients demand data is electronic format. Where there is exchange of data most is still limited to paper and electronic paper generally in the form of PDF and CADD files.

There are a significant number of notable exceptions to the above description which will be covered in this paper. However, the electronic exchanges are generally specific to a particular organisation and data generators that need to deal with multiple such organisations must format their data in different manners for each client.

This paper is certainly not exhaustive but endeavours to illustrate the general, current practice.

### **2. SI CONTRACTOR TO CONSULTANT**

#### **2.1. Geotechnical Laboratories**

Whether a lab is internal or external to a consultant's organisation, there is little electronic data exchange. Commonly the lab transfers the test results in paper or PDF format. Those results are included with the final report unchanged or the data are rekeyed into the consultant's database.

With a significant number of consultants, the lab and the engineers are working with the same database software so that the engineers have access to the lab data electronically. However, this is not data exchange it is merely two groups entering data into the same database.

## **2.2. CPT Data**

Not too many years ago CPT contractors in the US transferred the results of the soundings via paper and electronic format was an extra cost or not available. Today consultants have access to the electronic data as a matter of general practice.

Every CPT manufacturer has a different data format thereby making the transfer difficult. One product on the market in the US for some time from Dataforensics (Rapid CPT) has facilities for importing CPT data from a number of CPT manufacturers. This makes the job easier but it doesn't cover all formats and manufactures have been known to change formats.

## **2.3. Bechtel: A Special Case**

Bechtel is currently the only consultant/client in the US that requires data in AGS format from at least some its data providers.

## **3. CONSULTANT TO CLIENT**

### **3.1. State Departments of Transportation (DOTs)**

#### **3.1.1 General**

Most DOTs obtain their geotechnical data, either partially or fully, from consultants. However, when consultants are used, most DOTs still require data either in paper, PDF, and/or CADD format.

In the 2005 study by GeoSyntec for the Ohio DOT, "...few [DOTs] have [data management] systems focused on geotechnical data management." Without such an electronic system, electronic data from consultants has little or no benefit.

Our own phone survey of DOTs found that about half of the respondents did require at least some of the data electronically. The most common method of exchange was via Excel<sup>®</sup>. The remaining methods of transfer require specific programs (generally gINT) into which the data will be entered and the data files submitted. This works very well for the DOT but makes life difficult for the consultant who must alter their work process specifically for each DOT for which they work. Even if they only work for one DOT, their practice for non-DOT clients is generally quite different, even when using the same software for both types of clients.

Two states where the process is significantly different than this general description are listed below.

#### **3.1.2 Texas DOT**

The Texas DOT has created its own program, WinCore, which is freely available from their Web site. The site investigation data can be typed directly into the program, the logs are generated, and the final file submitted back to the DOT at the end of the project. Many of our clients did not wish to use WinCore for their Texas DOT work and gINT for the rest. We have added a WinCore export feature which allows the consultant to use their own database structure and then create a WinCore file for submittal. Under these conditions WinCode acts as a software non-specific data exchange format since the WinCore is ASCII.

#### **3.1.3 Florida DOT**

The Florida DOT has developed a series of Excel<sup>®</sup> spreadsheets in which geotechnical data providers can input their field, laboratory, and piling data and upload, via an XML file, to the DOT data repository on the Web. Excel macros and an accompanying DLL perform calculations, validation, the conversion to XML, and the upload. Data generators can:

- Manually input into the spreadsheets.
- Transfer their data from their own database to the spreadsheets.
- Convert their data to the requisite XML format and directly upload to the Web repository using the supplied DLL.

While this system is set up, it is currently not implemented but will be soon.

### **3.2. US Army Corps of Engineers**

Since 2002 the Jacksonville district has required the use of a specific gINT project structure for submittal of data by consultants. Currently, on both the Sacramento River and New Orleans levee studies, the Corps is requiring specific gINT project files for data submittal from all entities involved: Corps districts, consultants, and other agencies. Currently 18 Corps districts have signed on to use the file structures developed for the New Orleans levee project and others are expected to join soon.

### **3.3. US Bureau of Reclamation**

Much of the site investigation work is done in-house but a significant amount is subcontracted to consultants. To date, geotechnical data exchange from consultants is only in the form of paper, PDF, and CADD files.

### **3.4. US Air Force**

The US Air Force has required electronic data submission for site investigations for many years. Although the bulk of the data is environmental in nature, significant amounts of geotechnical data are also transmitted. The format, Environmental Restoration Program Information Management System (ERPIMS; formerly IRPIMS) is quite mature, is updated periodically, and is well supported with documentation and software tools.

### **3.5. US Department of Agriculture**

The USDA has geologists and engineers to look after various infrastructure assets on lands under the USDA jurisdiction such as roads and dams. Much of the site investigation work is done in-house but a significant amount is subcontracted to consultants. To date, geotechnical data exchange from consultants is only in the form of paper and PDF files.

### **3.6. Health Departments**

Many health departments require borehole log information for water wells and, in many cases, any holes that are drilled deeper than a certain depth. To our knowledge none require electronic data submission. Some even require that their sequentially numbered forms be used directly so that they cannot even be generated electronically from an existing database.

### **3.7. Florida Department of Environmental Protection**

In 2005, the Florida DEP, through their consultant URS, set up an Oracle<sup>®</sup> database system to store the results of all offshore investigations for sand for use in beach replenishment. This system is named ROSS: Reconnaissance Offshore Sand Search. All investigations for sand borrows have to submit data to the DEP in the form of a specific ACCESS<sup>®</sup> file which is then uploaded to the ROSS database. gINT has created a mechanism for generating this file from a gINT project thereby allowing the data generator to work with their database structure. To date no other software vendor has supported this format.

### **3.8. Wisconsin Department of Natural Resources**

The DNR requires many forms when holes of certain characteristics are drilled. These include borehole logs and details of well construction, well development, and abandonment. The forms can be submitted on paper or, optionally, via an ACCESS file. Both the forms and the database can be generated through a free program available on the DNR Web site. The DNR encourages submittal of the data by giving those who do so the ability to request records from any area of the state from the central database.

Discussions with the DNR indicate that the vast majority of the submitted electronic data are from drinking water well drillers, not from geotechnical or geoenvironmental engineers. Within the water well drilling group the DNR estimates that the data from only 1 in 10 drilled water wells are submitted electronically.

### **3.9. Clark County Nevada**

In 2007 Clark County (includes Las Vegas) implemented the requirement that subsurface data be submitted for any project that requires a geotechnical report. The Electronic Submittal of Geotechnical Information (ESGI) requires submittal of an ACCESS<sup>®</sup> file with the requisite data. The file does have an interface for manually keying the data. gINT clients had the subsurface data within project structures of their own design and did not wish to rekey the information. Instead those project structures were mapped to the ESGI format.

## **4. PUBLIC AGENCY TO PUBLIC AGENCY**

Our experience is limited in this process but discussions with our public agency clients indicate that most public agency geotechnical data exchange takes place through paper records or PDF and CADD files.

## **5. PUBLIC AGENCY TO THE PUBLIC DOMAIN**

### **5.1. COSMOS/PEER-LL**

The Consortium of Organisations for Strong-Motion Observations Systems (COSMOS) and the Pacific Earthquake Engineering Research Centre Lifelines Program (PEER-LL) sponsored a series of meetings and conferences starting in 2002 which culminated in the creation of the Geotechnical Virtual Data Centre (GVDC).

Currently Pacific Gas & Electric (power supplier for Northern California), Caltrans (California Department of Transportation), the California Geological Survey, and the US Geologic Survey link their data via a web-based system. The ultimate goal is to link many more data sets through the Internet. The work done in this project to date helped in the formation of the DIGGS committee and the current plan is to adopt DIGGS for the GVDC interchange format.

### **5.2. National Geotechnical Experimentation Sites (NGES)**

In 1992 the National Science Foundation and the Federal Highway Administration began sponsorship of a series of geotechnical test sites throughout the US and the storage of the data from these sites. NGES is no longer funded but the database of results from 40 sites can still be obtained from the Web site.

As an interesting side note, the data from the test sites were submitted to the central repository via a modified version of the AGS format. The table and field naming in the final ACCESS file also closely follows AGS group and variable naming.

### **5.3. Wisconsin Department of Natural Resources**

The DNR maintains a number of databases on-line which can be queried by the public. These contain a significant amount of data that would be of interest to geotechnical engineers. Besides displaying query results, data can also be downloaded.

### **5.4. Virginia Department of Transportation**

The VDOT Geotechnical Database Management System (GDBMS) Framework is on a Web site with a GIS interface. Currently, subsurface data from two large projects are stored there. Data are from VDOT and US Army Corps of Engineers gINT projects. The site allows retrieval of data for specific boreholes, querying of data, and generation of fence diagrams (sections) to a PDF file.

## **6. INTERNAL EXCHANGES**

Exchanges of geotechnical data internal to an organisation, whether public or private, occur every day:

- From one office or department to another.
- Between different database, presentation, analysis, and design programs.
- Between working databases and archives.
- Conversion of database structures to updated formats.

Even when electronic data exists, most times the format of the data will not work with different software. The only choice then becomes writing conversion programs to transfer data from one system to another or to manually rekey information.

We have seen common practice to give the paper logs to drafting for rendering in CADD, data rekeyed from the logs and lab results into Excel for plotting, rekeyed again for tabular summaries, and again in analysis programs, etc.

For some time there has been a big push in many organisations to standardise on their database structures. This has gone a long way to reduce data replication and inconsistency and improve data access. However, without an interchange standard common to all software, there are always awkward exchanges that must be performed.

## **7. SUMMARY**

The bulk of geotechnical data in the US is still stored mainly on paper or its electronic equivalents and are rarely exchanged in reusable electronic format. Significant efforts have been, and are being, made to change this. Most of the data exchange today is via proprietary database or spreadsheet files, usually through the required use of specific software. Use of software non-specific file formats such as structured ASCII or XML is rare but hopefully will be more common in the future.

## 8. REFERENCES

### 8.1. Web Pages

Air Force Centre for Engineering and the Environment

<http://www.afcee.af.mil/resources/restoration/erpims/index.asp>

National Geotechnical Experimentation Sites <http://www.unh.edu/nges/>

Dataforensics (Rapid CPT) [www.dataforensics.net](http://www.dataforensics.net)

Texas DOT (WinCore) [http://www.dot.state.tx.us/services/technology\\_services/engineering\\_software.htm](http://www.dot.state.tx.us/services/technology_services/engineering_software.htm)

Florida DEP (ROSS) <http://ross.urs-tally.com/>

gINT Software (Government Agency Reports) [www.gintsoftware.com/support\\_reports\\_agency.html](http://www.gintsoftware.com/support_reports_agency.html)

Clark County, Nevada (electronic data submittal)

[http://dsnet.co.clark.nv.us/dsweb/building\\_services/letters\\_inspections/electronic\\_submittal\\_esgi.pdf](http://dsnet.co.clark.nv.us/dsweb/building_services/letters_inspections/electronic_submittal_esgi.pdf)

COSMOS/PEER-LL (GVDC) <https://geodata.cosmos-data.org/index.asp>

Virginia DOT (GDBMS) [http://gis.viriniadot.org/GDBMS\\_menu.asp](http://gis.viriniadot.org/GDBMS_menu.asp)

Florida DOT <http://fdot.ce.ufl.edu/>

Wisconsin Department of Natural Resources:

Required paper forms <http://www.dnr.state.wi.us/org/water/dwg/gw/forms.htm>

Software for producing forms and submitting data <http://dnr.wi.gov/org/water/dwg/gw/software.htm>

Groundwater and Environmental Monitoring System (GEMS)

[http://prodoasext.dnr.wi.gov/inter1/gems\\$.startup](http://prodoasext.dnr.wi.gov/inter1/gems$.startup)

Groundwater Retrieval Network (GRN) [http://prodoasext.dnr.wi.gov/inter1/grn\\$.startup](http://prodoasext.dnr.wi.gov/inter1/grn$.startup)

### 8.2. Publications

Unpublished telephone survey by gINT Software, Inc. of State Departments of Transportation, May 2008.

Stepp, et. al. (2006). "Overview of The COSMOS/PEER-LL Geotechnical Virtual Data Centre (GVDC) and Data Provider Perspectives", *JTC2 workshop conducted during the 10<sup>th</sup> IAEG Conference at Nottingham University*, 9 September 2006.

Robert Bachus, GeoSyntec Consultants (2005). "Geotechnical Management System Information Synthesis", *Unpublished draft study presented to the Ohio Department of Transportation*, June 2005.