GEOTECHNICAL PRACTICE PUBLICATION NO. 5

GEO-VELOPMENT

THE ROLE OF GEOLOGICAL AND GEOTECHNICAL ENGINEERING IN NEW AND REDEVELOPMENT PROJECTS

Edited by
Christoph M. Goss, Ph.D., P.E.
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GEO INSTITUTE

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PROCEEDINGS OF THE 2008 BIENNIAL GEOTECHNICAL SEMINAR

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Preface

Across all lands and time, engineers have developed their environment to obtain housing, water, transportation, mineral resources, and protection. As structures wore out or societal needs changed, the environment would be redeveloped. Inevitably, the development would start from the ground up, in the realm of the geotechnical engineer, who would make the foundation of the dam, building, or canal strong and clean. Geotechnical engineering in Colorado began around the 8th Century A.D. at Mesa Verde, when the first reservoir was constructed by the Ancestral Puebloans. In the 19th Century, geotechnical engineering was focused on mining and irrigation. As cities grew in the 20th Century, the development focus shifted to large buildings, roads, airports, bridges, and dams. Today, Colorado's geo-community continues its work to develop new areas and re-develop the old. We hope that this collection of seminar papers, presenting Colorado's geotechnical practice and experience related development and re-development, will be of value to others worldwide.

Since 1984, the ASCE Colorado Section's Geotechnical Group, in collaboration with the Rocky Mountain Section of the Association of Environmental and Engineering Geologists and the Colorado Association of Geotechnical Engineers, has organized a biennial series of geotechnical seminars on a wide variety of themes that have been attended by as many as 270 civil/geotechnical engineers, geologists, and other geo-professionals. The geotechnical seminars have been held at area universities or hotels and have offered the opportunity for sharing ideas and experiences among Colorado's diverse geo-disciplines. Since 2004, ASCE's Geo-Institute has published the papers of these seminars in Geotechnical Practice Publications, allowing the experiences to be shared with a worldwide audience.

The GEO-velopment Steering Committee convened in August 2007 and held monthly meetings to plan for the 2008 Biennial Geotechnical Seminar. The Steering Committee members included Joels Malama (Conference Chair), Dr. Christoph Goss, Mark Brooks, Dr. Bill McCarron, Minal Parekh, Becky Roland, Mark Vessely, Leslie Jansen, Steve Bryant, Jere Strickland, Keith Seaton, Melanie Longi, Joe Kerrigan, Chris Wienecke, and Richard Wiltshire.

Christoph Goss, Richard Wiltshire, Joels Malama, and Minal Parekh

Acknowledgements

The GEO-velopment Steering Committee wishes to take this opportunity to thank all of the authors and reviewers of our papers, which are herein presented as Geotechnical Practice Publication No. 5. The authors have spent many hours in preparing and finalizing their papers, which will be presented at the 2008 Biennial Geotechnical Seminar on November 7, 2008. These papers have been reviewed by a volunteer group of Denver area geo-professionals who put in their valuable time and helped make these papers even better. The Geo-Institute's Committee on Technical Publications completed its review of our GEO-velopment papers in a very timely manner and their adherence to our aggressive publication schedule is greatly appreciated. We would also like to acknowledge the assistance of Donna Dickert of ASCE's Book Production Department for putting this publication together.

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Downtown Redevelopment with Complex Site Constraints

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ABSTRACT: When a developer selected a site in Denver for a new office building, there were numerous challenges to be faced. Due to zoning and height restrictions, the 8 story building required 4 levels of below grade parking, extending over 6 meters (20 feet) below the water table in coarse sand. On the northwest and southwest sides of the site, an existing basement wall was present at the property line, supporting critical utilities in the backfill zone. On the northeast side of the site, a portion of a newly completed building was supported on shallow footing foundations located about 6 meters (20 feet) above final proposed grade at the property line. As the new building was to extend to the property line, there was no room for a temporary excavation bracing system. All of these factors dictated a creative approach to site preparation and building construction. The ultimate approach to construction involved the installation of a secant wall around the entire periphery of the site, extending into bedrock to cut off the majority of the groundwater, provide lateral and vertical support for the adjoining building, protect adjoining utilities and serve as the final basement wall for the office building.

INTRODUCTION

During the past few years, the Lower Downtown section of Denver, Colorado has experienced a period of significant development and redevelopment. Once a predominantly commercial/warehouse district, the area now includes Coors Field (a major league baseball park), as well as numerous shops, restaurants, condominiums, and offices.

While older buildings dating to the 1800's largely have been refurbished and converted to new use, a few more recently constructed buildings with less historical significance have been razed to make way for new development. One such building was the former United States Post Office Processing Center located within the city block bordered by 15th , Wynkoop, 16th and Wewatta Streets at the western extreme of the Lower Downtown District. This large, utilitarian structure was constructed in the middle part of the 20th Century and included one to two basement levels and 4 levels above grade (Figure 1). Following acquisition of the property by a national developer,

the building was demolished to street level and the basements were filled with the resulting demolition debris.

Figure 1: Post Office Processing Center

Due to the large size of the site, it was subdivided into two parcels. The northeastern half was developed first, with an 8 story office building, currently housing the Denver Office of the Environmental Protection Agency (EPA). This entire parcel incorporated 2 levels of below-grade parking. The overlying 8-story office has a slightly smaller footprint, leaving an at grade access drive along the southwestern property line. This office building is primarily supported by drilled pier foundations extending into the Denver Formation bedrock. However, the exterior wall of the parking deck running along the shared southwestern property line was supported by a strip footing foundation bearing at a depth of about 7 meters (22 feet) below adjacent street grades.

Following substantial completion of the EPA building, plans were developed for construction of a second office building on the remaining parcel of land. This was also to be an 8-story office building to house a prominent local insurance company. Due to local building height restrictions and tenant requirements, plans called for the building to incorporate 4 levels of below-grade parking. This requirement would ultimately create significant complications for the project and necessitate innovative approaches to both design and construction.

PROJECT CHALLENGES

The 1515 Wynkoop Project, as it was ultimately designated, faced a number of significant challenges including high groundwater, the presence of existing structural elements, and the need to protect adjacent sensitive utilities and structures during and after construction.

The subsurface profile in the project site area consists of Quaternary-aged alluvial sands and gravels extending to depths of about 13 to 14 meters (40 to 45 feet) below

grade atop the Denver Formation (Niehoff, 2006). The bedrock consists of weakly to moderately cemented sandstone/claystone which extends to a depth of over 100 meters (300 feet). The Denver Formation materials are relatively impervious, and as a result, support aerially extensive perched groundwater. The system is recharged locally by the infiltration of surface water through the pervious surficial sands and by Cherry Creek, which is located two blocks to the south of the site. While fluctuations in the water table occur seasonally, groundwater is typically found about 8 to 9 meters (24 to 27 feet) below the level of the surrounding streets. Given that the parking levels would need to extend to a depth of 13 to 15 meters (40 to 45 feet) below street level, groundwater would need to be considered both during and after building construction.

The post office building that had previously occupied the site had been supported by a system of footing foundations bearing in dense sand strata at the approximate level of the groundwater system. The foundations around the periphery of the building extended to the property line and supported a thick reinforced concrete basement wall. The foundations and basement walls had been left in-place during building demolition and the open basement areas had been filled with construction debris. New construction would require excavations to depths of over 6 meters (20 feet) below the bearing elevations of the existing foundations and the base of this wall. Due to the presence of critical utilities, including fiber optic cables, water and gas lines within 1 to 2 meters (3 to 5 feet) of the existing basement walls, it would not be possible to install a new excavation bracing system at the property line to allow for the removal of these basement walls.

The new structure was also designed to extend to the site's northeastern property line. This would require a cut extending to a depth of over 6 meters (20 feet) below the footing foundations supporting the exterior wall of the EPA building parking structure. A section through the site presenting this geometry is presented on Figure 2, below.

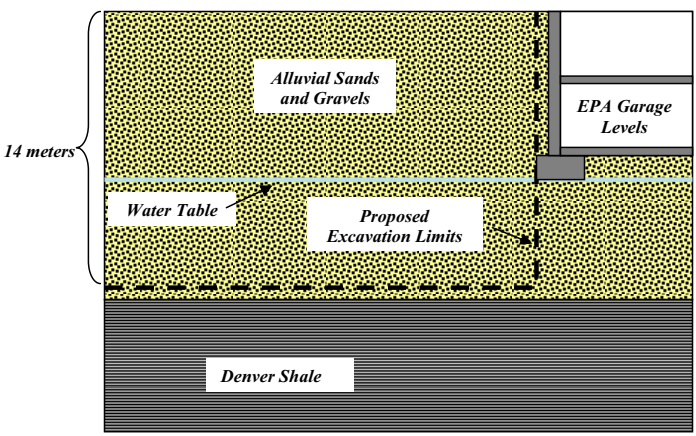

Figure 2: Section though the site presenting project geometry