



## Innovative Foundation Design at Complex Urban Sites

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Complex urban sites involving the presence of extensive foundations from prior construction may require innovative foundation design for successful completion of new structures on the same site. This paper presents the authors' views on the requirements for innovative foundation design at such complex urban sites. These requirements include the necessity for the structural engineer and geotechnical engineer to work as a team from the conceptual stage of the project. Teamwork involves confidence in each other's competence and experience.

The requirements include adequate ground investigation, including appropriate in-situ testing, to make possible reliable prediction of ground response to new building loads. The paper describes how with confidence in the ability to predict ground deformation response under imposed loading, it is possible to mix foundation systems for maximum substructure performance at minimum cost and acceptable risk. The paper describes two case histories that the authors believe illustrate innovative foundation design and some of the issues involved including two tower projects in Chicago: The Dearborn Center and 111 South Wacker Drive.

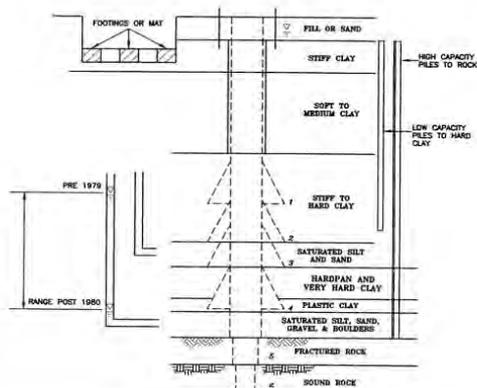


FIG. 1 TYPICAL SOIL PROFILE FOR DOWNTOWN CHICAGO - (3)



## Introduction

Historically, structural engineers have been reluctant to mix foundation type or foundation levels on the same structure for fear of potential differential settlement and their lack of confidence in settlement predictions.

This paper describes several highlights of early pressuremeter use in Chicago and then presents two selected case histories to further illustrate the paper objective. Since the selected case histories have been published elsewhere (see reference list) only the portions of the papers necessary to illustrate the objective are available here. For simplicity and consistency, the figure numbers in the referenced papers are maintained. The typical downtown Chicago soil profile is shown in Figure 1 with the typical potential foundation types indicated on the profile.

## Dearborn Center Tower Case History

Dearborn Center (Reference 3) is a case history that illustrates a mixed foundation system in which existing caissons which previously supported an 11 story building (and had been demolished down to street level) share the load with a mat constructed in the lowest basement level on top of the existing caissons to support a new 38 story office building.

## 111 South Wacker Tower Case History

The second Case History (Reference 4) illustrates the mixing of old and new foundations in a high rise office building and the predicted and observed performance. The site was formerly occupied by the 18-story US Gypsum (USG) building which was completed in 1962. The building was founded on a forest of belled caissons bearing at elevation -56 feet CCD. For reference, the ground surface at Upper Wacker Drive is approximately elevation +20 feet CCD. The bearing material was a hard silty clay, locally described as Chicago Hardpan. The foundation caissons were designed using an allowable bearing pressure of 16 ksf (770 kPa) based on unconfined compression tests. In 1996, the USG superstructure was razed, and the three-level basement was converted to an underground parking structure with ramps used a diaphragm for lateral earth support.

The new structure was a 51-story high-rise building completed in 2005 with a structural height of 681 feet (208 m). The structure had a full height concrete core and steel exterior frame. The existing basement walls were used to support neighboring streets.

To reduce the cost of foundations, the new building was supported on 26 new belled caissons, supplemented by the reuse of 25 caissons from the USG foundation. The new caissons were designed to bear at a depth approximately 10 feet (3 m) below the existing caissons.