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**General Services Administration Should Do More To Avoid Foundation Construction Problems. LCD-78-334; B-161027. September 19, 1978. 19 pp. + appendix (1 pp.).**

**Report to Joel W. Solomon, Administrator, General Services Administration; by Richard W. Gutmann, Director, Logistics and Communications Div.**

**Issue Area: Do Fed. Construction Agencies' Control Construction Costs, Life Cycle Costs, Apply New Techniques? (712).**

**Contact: Logistics and Communications Div.**

**Budget Function: General Government: General Property and Records Management (804).**

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**Congressional Relevance: House Committee on Public Works and Transportation; Senate Committee on Environment and Public Works.**

**Problems during site excavation and foundation construction for Federal buildings have troubled the General Services Administration (GSA) since the early 1960's. Since 1973, GSA has paid contractors over \$16 million for extra costs caused by site excavation and foundation construction problems. Outstanding claims against GSA for similar problems total \$6.8 million. Years of project delays and millions of dollars in additional leasing and administrative costs have resulted from these problems. Findings/Conclusions: Until recently, GSA had placed little emphasis on reducing the severity of or avoiding foundation problems. A geotechnical expert had been hired in 1967, but the position was abolished in 1968 despite a 1967 report recommending hiring such an expert. A March 1976 report cited recurring deficiencies and recommended revisions to GSA's foundation construction criteria, specifications, and guidelines. Not all of the recommendations have been implemented, and improvements are still needed in the crucial areas of site selection and inspection during foundation construction. GSA needs a staff geotechnical engineer participating in site selection to prevent risks associated with foundation construction. More emphasis on data obtained in soil tests is needed, and frequent testing and inspection during foundation construction are vital. Recommendations: The GSA should: (1) require staff geotechnical experts to participate in foundation construction inspections when appropriate; and (2) evaluate ways to obtain geotechnical expertise at the regional office level, including getting geotechnical experts from other Federal agencies to participate in foundation construction inspections when appropriate. (RRS)**

7702

REPORT BY THE U.S.

# General Accounting Office

## General Services Administration Should Do More To Avoid Foundation Construction Problems

Since 1973 General Services has paid contractors over \$16 million for extra costs caused by foundation construction problems. Claims pending amount to \$6.8 million.

Many of these problems could have been avoided if the agency had a soil and foundation expert on its engineering staff. In 1967 GAO recommended that the agency acquire such an expert. One was hired, but his position was soon abolished. In March 1976, a consulting firm made a recommendation similar to GAO's, and, in March 1978, General Services said it again had plans to hire an expert.

GAO believes that further improvements are needed in site selection and inspection during foundation construction.



LCD-78-334  
SEPTEMBER 19, 1978



**UNITED STATES GENERAL ACCOUNTING OFFICE**  
**WASHINGTON, D.C. 20543**

**LOGISTICS AND COMMUNICATIONS  
DIVISION**

B-161027

The Honorable Joel W. Solomon  
Administrator of General Services

Dear Mr. Solomon:

This report addresses the need for General Services to do more to avoid foundation construction problems. Although General Services has acted to reduce these problems, improvements are needed in two areas--(1) site selection and (2) inspection during foundation construction.

We made this review because of the sizable extra costs to the Government caused by foundation construction problems experienced by the agency.

This report contains recommendations to you on page 9. As you know, section 236 of the Legislative Reorganization Act of 1970 requires the head of a Federal agency to submit a written statement on actions taken on our recommendations to the Senate Committee on Governmental Affairs and the House Committee on Government Operations not later than 60 days after the date of the report, and to the House and Senate Committees on Appropriations with the agency's first request for appropriations made more than 60 days after the date of the report.

We are sending copies of this report to the Director, Office of Management and Budget; the House Committees on Appropriations, on Government Operations, and on Public Works and Transportation; the Senate Committees on Environment and Public Works and on Governmental Affairs; and the Subcommittee on Treasury, Postal Service, and General Government, Senate Committee on Appropriations.

Sincerely yours,

A handwritten signature in cursive script, appearing to read "R. W. Gutmann".

R. W. Gutmann  
Director

GENERAL ACCOUNTING OFFICE  
REPORT TO THE ADMINISTRATOR  
OF GENERAL SERVICES

GENERAL SERVICES ADMINISTRATION  
SHOULD DO MORE TO AVOID FOUNDATION  
CONSTRUCTION PROBLEMS

D I G E S T

Problems during site excavation and foundation construction for Federal buildings have troubled the General Services Administration since the early sixties. In 1967, GAO reported that 15 of 28 Federal buildings that cost over \$2 million each had such problems. Settlements of contractor claims in those cases ranged from \$2,500 to \$4.1 million. Upon GAO's recommendation, General Services hired a geotechnical engineer (soil and foundation expert), but his position was abolished about a year later when the agency reorganized.

Problems have continued. Since 1973, the General Services Administration has paid contractors over \$16 million in additional costs because of site excavation and foundation construction problems. Such problems have caused years of project delays and millions in additional leasing and administrative costs. Claims pending amount to \$6.8 million. (See pp. 1 and 3.)

A consulting firm, hired to examine General Services' foundation construction problems, filed a report in March 1976 which:

- Cited recurring deficiencies which could be avoided in the future.
- Recommended that General Services hire a geotechnical engineer.
- Suggested revisions to General Services' foundation construction criteria, specifications, and guidelines.

Implementation of the consultants' recommendations was delayed. The decision to hire a staff geotechnical expert was made after GAO completed its investigation for this report.

Even though General Services had upgraded its foundation design and construction procedures as suggested by the consulting firm, improvements are still needed in the areas of site selection and inspection during foundation construction.

Poor site selection, according to a construction management official, has led to many foundation problems. GAO believes some of these problems could have been avoided if personnel with appropriate backgrounds had been assigned to site selection teams.

Because of increased contract costs on projects with these problems, more emphasis on data obtained in soil tests seems in order. Usually, this information has not been examined by experts nor has sufficient weight been given to soil test findings in site selections.

Frequent testing and inspection during foundation construction are vital. General Services has issued new guidelines requiring the architect's geotechnical engineer to participate in foundation construction inspections. Past problems, however, indicate that a staff expert representing General Services' interests should both monitor and participate in the inspection process.

General Services is planning to hire a geotechnical expert for its headquarters staff. But because one person may not be sufficient, more experts should be hired or trained for its regional staffs.

GAO found that two other Federal agencies with major construction programs have organizations in their field offices devoted to geotechnical engineering. (See p. 7.)

General Services should:

--Require staff geotechnical experts to participate in foundation construction inspections.

--Evaluate ways to obtain geotechnical expertise at the regional office level, including getting geotechnical experts from other Federal agencies to participate in foundation construction inspections when appropriate. (See p. 9.)

General Services officials generally agreed with the conclusions and recommendations in this report. They said that hiring a geotechnical expert for the headquarters staff will take care of immediate needs, but acquiring experts for regional offices is not currently justified, based on projected construction levels.

GAO believes that geotechnical expertise is needed at the regional level to protect the Government's interests and that General Services should evaluate ways of getting such expertise. GAO recognizes that hiring experts for each of the regional offices may not be justified based on present and planned construction volume. (See p. 9.)

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### ABBREVIATIONS

GAO	General Accounting Office
GSA	General Services Administration

## CHAPTER 1

### INTRODUCTION

Problems during site excavation and foundation construction for Federal buildings have troubled the General Services Administration (GSA) since the early sixties. In 1967 we reported that 15 of 28 construction projects costing over \$2 million each had such difficulties. Settlements of contractors' claims against GSA in those cases ranged from \$2,500 to \$4,100,000.

Problems have continued. Since 1973, GSA has paid contractors over \$16 million for extra costs caused by site excavation and foundation construction problems. Outstanding claims against GSA for similar problems total \$6.8 million. Years of project delays and millions in additional leasing and administrative costs have resulted.

Before site excavation and foundation construction begin, tests to accurately determine soil conditions must be made. Results of these tests indicate the types of foundations suitable for the site. However, some problems--stemming from adverse soil or water conditions--are unavoidable because actual conditions occasionally differ from what is revealed in even the best soil tests.

Because of the numerous problems that can develop during foundation construction, GSA must have qualified staff experts who can

- understand soil conditions and their potential for problems;
- thoroughly evaluate soil reports, excavation schedules, and foundation designs; and
- act quickly to resolve a problem, thus reducing costs and delays.

In 1974, the American Society of Civil Engineers adopted the phrase "geotechnical" engineer to replace other phrases, like "soils," "rock," or "foundation" engineer. One geotechnical expert describes his discipline as a combination of elements from civil and geological engineering.

## SCOPE OF REVIEW

We examined GSA's (1) foundation construction problems and actions taken to avoid them and (2) guidelines and procedures for foundation design and construction. Other Federal agencies involved in major construction were also visited.

We reviewed studies, memorandums, and other documents related to each agency's foundation design and construction procedures. Claims files and contract change orders identified problems encountered. Data gathered was supplemented by interviews with agency and private geotechnical experts and construction management personnel.

Our review was conducted at the central and selected regional offices of GSA, the Army Corps of Engineers, the Naval Facilities Engineering Command, and the Veterans Administration.

## CHAPTER 2

### GENERAL SERVICES ADMINISTRATION SHOULD DO

#### MORE TO AVOID FOUNDATION CONSTRUCTION PROBLEMS

Until recently, the General Services Administration had placed little emphasis on reducing the severity of or avoiding foundation problems. A geotechnical engineer had been hired in 1967. However, GSA abolished the position in 1968 during a reorganization, despite the fact that a 1967 GAO report had recommended hiring such an expert, citing his following possible functions:

- Review proposed foundation designs and specifications.
- Interpret soil tests.
- Recommend solutions to problems arising during foundation construction.
- Review contractor claims on changed site conditions.

GSA has had many costly foundation problems since then. Staff geotechnical experts representing GSA's interests might have reduced the cost of or prevented these problems. Difficulties occurred even though each project's architect had a geotechnical engineering consultant.

In a July 1977 report (LCD-76-333), we stated that agencies seldom take legal or out-of-court action against architects and engineers for construction deficiencies. Costs caused by architect/engineer negligence can be recovered, but, since agencies do not determine who is responsible, the Government cannot recover potential costs in cases of negligence.

#### PROBLEMS WHICH MIGHT HAVE BEEN AVOIDED

##### Social Security Program Center, Chicago- Illinois

In early 1974, a massive landslide during excavation damaged piles already driven into the ground. Expensive repairs and a different excavation technique were required. GSA's consulting firm concluded in 1976 that, because no one served as a geotechnical consultant during construction, the technical feasibility of the excavation schedule was not reviewed and failure occurred. The consultants added that

similar occurrences could be avoided by having a geotechnical engineer evaluate foundation construction while in progress.

Federal Office Building and Courthouse,  
Honolulu, Hawaii

In our January 1977 report, "Settlement of Contractor Claims for Construction of a Federal Building in Hawaii" (LCD-77-311), we stated that ineffective water removal during site excavation delayed foundation construction. GSA had redesigned the foundation to reduce costs but had not made additional site tests recommended by the architect. Had GSA made those tests, its vulnerability to \$11.8 million of contractors' claims would have been reduced.

Because the project site had an average elevation of 5-1/2 feet before excavation and was close to the ocean, water problems during construction were anticipated. Yet, pad foundations (which are difficult to construct if a lot of water is present) were used in addition to piles. Also, the original contract required that the contractor hire an expert in site draining. This provision was eliminated to reduce costs.

Federal Office Building,  
Roanoke, Virginia

Piles with special tips to penetrate rock comprised the foundation. Many piles were deflected during installation and many more than originally anticipated had to be used. According to the GSA consulting firm, no one tried to solve these problems, even though they became obvious early in construction.

PROBLEM AVOIDED BY STAFF  
GEOTECHNICAL ENGINEER

We found an example which shows the value of having staff geotechnical engineering expertise. After analyzing the Seattle Federal Office Building soil report in early 1968, GSA's former staff geotechnical engineer suggested that the architect change the foundation design. According to the engineer, the soil conditions made a deep foundation too risky and costly. The foundation was redesigned. GSA's consulting firm characterized this project as a positive example of how GSA should deal with potential geotechnical problems.

## CONSULTANTS' RECOMMENDATIONS

Because of recurring costly foundation design and construction problems, GSA hired a group of nationally known consultants to analyze selected projects and recommend improvements. The consultants met with regional office personnel to discuss conclusions and recommendations before a report was issued. Even though the GSA staff raised no major objections, few of the consultants' recommendations were quickly implemented. GSA officials said that delays were caused by insufficient administrative support.

The consultants' (March 1976) report, "Geological, Design and Construction Aspects Associated With Building Substructures":

- Prescribed more exact roles and responsibilities for GSA, architects, contractors, and geotechnical engineers during foundation design and construction.
- Provided guidance on monitoring site selection and foundation design/construction.
- Recommended revisions to GSA's foundation-related criteria and guide specifications.
- Recommended that GSA acquire geotechnical expertise.

GSA is implementing some of the above, although a bit slowly. Its "new" guidelines for various roles and responsibilities during foundation design and construction were taken verbatim from the consultants' report. It took 19 months to issue those guidelines and, as of early May 1978, guidelines for site selection and foundation design/construction monitoring had not yet been issued.

As far as acquiring expertise, GSA at first rejected the idea; in October 1977, a GSA construction management official told a trade journal that a geotechnical expert was not needed because the prospective workload was low. GSA has since reconsidered and, in March 1978, after our review was largely completed, decided to hire an expert.

## ADDITIONAL EFFORTS NEEDED

GSA's adoption of the consultants' recommendations regarding roles and responsibilities has partially upgraded the agency's foundation design and construction procedures. However, further improvements are needed in site selection

and foundation construction inspection. In addition, GSA should use the geotechnical experts available in other agencies that have major construction programs.

Geotechnical expert needed during site selection

According to an official in GSA's Office of Construction Management, many of GSA's foundation problems have been caused by poor site selection. One reason for poor choices was that personnel with appropriate backgrounds were not assigned to site selection teams. This can be remedied, in part, by the presence of a geotechnical engineer. In its 1976 report, GSA's consulting firm said that site selection, more than any other phase of construction, should include staff geotechnical specialists.

Under current procedures, the site selection team examines various sites within an area. The team then submits a report containing recommendations on the three most promising sites to the Administrator or to the Commissioner of the Public Buildings Service for review and approval. Physical, sociological, and environmental factors are evaluated before one of the three sites is designated as a primary site. More thorough soil tests are done on this site before it is purchased.

The economic feasibility of construction is determined from these tests. If potential soil problems (making foundation construction risky or excessively costly) are found, GSA is supposed to consider another site. We were told that no site has been rejected because of unsuitable soil conditions.

The costs associated with site-related foundation problems indicate that geotechnical data should be given more priority in selection decisions. GSA's procedures appear adequate, but the site selection teams still need a GSA geotechnical expert. The geotechnical expert should (1) be part of the site selection team and (2) monitor and review the soil tests done on primary sites. According to a GSA Office of Space Management official, soil reports on primary sites have not been (1) reviewed by geotechnical experts and (2) given sufficient weight in site selection deliberations.

Geotechnical expert also needed during foundation construction inspections

GSA has admitted that many foundation problems occurred because no staff geotechnical engineer oversaw construction.

To improve this situation, GSA adopted guidelines requiring the design architect to participate during foundation construction. His responsibilities will include:

- Monitoring conditions during construction and adjusting the design to fit these conditions.
- Inspecting work performed during foundation construction.

If properly implemented, these guidelines should provide more continuity between design and construction, something GSA projects have lacked.

We believe that GSA should not totally rely on the architect for geotechnical inspections. GSA's consulting firm highlighted the importance of frequent testing and inspection during foundation construction. Too often, the firm said, inspection reports and test records were simply filed away without examination or review.

Geotechnical experts should participate in foundation construction inspections. GSA plans to hire one for the Washington, D.C., headquarters staff. However, experts may also be needed in GSA's field offices, which are responsible for inspecting all phases of construction.

#### WHERE TO GET EXPERTISE

As part of its long-range plans, GSA can (1) have the headquarters geotechnical expert train field-construction engineers or (2) hire engineers with strong geotechnical backgrounds as structural or civil engineer positions open.

According to GSA, the staff geotechnical engineer to be hired will be a nationally recognized authority who will be able to develop and provide geotechnical training to regional construction engineers. He will also oversee GSA's soil and foundation programs.

Until such a person is hired, however, GSA should consider using geotechnical experts from other Federal agencies. Even though they usually construct smaller buildings than GSA, two other Federal agencies have geotechnical staffs in various field offices throughout the country. The Army Corps of Engineers' Baltimore District, for example, employs eight geotechnical specialists in its Foundations and Materials Branch. The district has four soil test teams and a laboratory for soil testing and analysis. Also, the Atlantic

Division of the Naval Facilities Engineering Command has a Soil Mechanics and Paving Branch employing 10 full-time geotechnical experts. In addition, two division employees have doctorate degrees with a concentration in geotechnical engineering. We were told they are consulted when foundation-related problems or questions arise.

GSA has used another agency's expertise once. In the mid-sixties, GSA's New England Region asked the Corps of Engineers to perform soil tests and provide expert testimony after a contractor filed a large claim for differing site conditions. Corps services were provided on a reimbursable basis. A construction management official in the regional office said the Corps was brought in because it had the expertise, the equipment, and the laboratory facilities readily available.

### CONCLUSIONS

GSA has had costly and repetitive site excavation and foundation construction problems since the early sixties. A group of consultants hired to examine these problems produced a March 1976 report containing recommendations based on an analysis of eight troubled projects. Not all the recommendations have been implemented. Improvements are still needed in two crucial areas: site selection, and inspection during foundation construction.

GSA needs a staff geotechnical engineer participating in site selection. He should present an evaluation of any risks associated with foundation construction to the selecting official before a site is purchased so that, if soil conditions warrant, another site can be considered. GSA decisionmakers should give a higher priority to soil data from primary sites.

GSA now requires the design architect to participate in foundation construction. This will provide continuity between design and construction, but we believe a GSA staff geotechnical expert should also participate during foundation construction. Depending on workloads, one headquarters expert may not be able to inspect all construction projects. GSA should consider adding experts to its regional staffs. This could be done by

- having the staff geotechnical engineer train regional personnel or
- filling structural or civil engineering positions with personnel having strong geotechnical backgrounds.

Either method will take time. Meanwhile, since both the Army Corps of Engineers and the Naval Facilities Engineering Command have their own geotechnical experts, GSA should consider using them on a reimbursable basis.

### RECOMMENDATIONS

We recommend that the Administrator of General Services:

- Require staff geotechnical experts to participate in foundation construction inspections.
- Evaluate ways to obtain geotechnical expertise at the regional office level, including getting geotechnical experts from other Federal agencies to participate in foundation construction inspections when appropriate.

The report was discussed informally with GSA officials, who generally agreed with the conclusions and recommendations. They said that plans to hire a geotechnical expert for the headquarters staff will take care of immediate needs but that acquiring experts for regional offices is not currently justified, based on projected construction levels.

We believe that geotechnical expertise is needed at the regional level to protect the Government's interest. Hiring experts for each regional office may not be justified because of limited construction volume, but GSA should evaluate ways of providing such expertise at the regional level when needed.

APPENDIX I

APPENDIX I

CONTRACT INCREASES AND CLAIMS (\$20,000 AND OVER)

RESULTING FROM FOUNDATION

PROBLEMS ON GSA CONSTRUCTION PROJECTS SINCE 1973

<u>Project</u>	<u>Change orders, negotiated settlements, and awards upon appeal</u>	<u>Claims pending</u>
Federal Building, Post Office and Courthouse, Batesville, Arkansas	\$ 61,039	
Federal Building and Courthouse, Payetteville, Arkansas	84,460	
Denver Federal Center Building, Denver, Colorado	51,080	
Denver Federal Center Building, Denver, Colorado	22,207	
Hirshhorn Museum, District of Columbia	80,000	
Federal Building and Courthouse, Ft. Lauderdale, Florida	74,630	\$ 471,316
Federal Building and Post Office, Augusta, Georgia	59,450	
Federal Building and Courthouse, Honolulu, Hawaii	a/5,200,000	
Great Lakes SSA Program Center, Chicago, Illinois	b/3,500,000	4,969,838
SSA District Office, Kansas City, Kansas	28,380	
IRS Center, Andover, Massachusetts		1,274,812
Federal Building, Ann Arbor, Michigan	55,941	
Federal Building, Hattiesburg, Mississippi	57,283	50,000
U.S. Animal Meat Research Center, Clay City, Nebraska	94,341	
Federal Building and Courthouse, Lincoln, Nebraska	c/93,304	
Federal Building and Courthouse, Syracuse, New York	30,000	
Federal Building, Portland, Oregon	51,673	
Federal Building and Courthouse, Philadelphia, Pennsylvania	d/6,000,000	
Federal Building and Courthouse, San Juan, Puerto Rico	25,968	
Federal Building, Roanoke, Virginia	375,000	
Federal Building, Beckley, West Virginia	205,000	
Federal Building, Elkins, West Virginia	20,000	
	<u>\$16,169,756</u>	<u>\$6,765,966</u>

a/Adjusted to include only foundation-related problems.

b/Number provided by GSA reflects cost for repairs and use of consultants.

c/\$15,000 was the foundation-related portion paid from a claim, and \$78,304 was paid in change orders.

d/Estimate provided by GSA.

(945139)