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# REPORT TO THE CONGRESS



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Strengthen Concrete Inspections  
And Testing Requirements  
In The Construction Of Low-Rent  
Public Housing Projects *B-118718*

Department of Housing and Urban  
Development

BY THE COMPTROLLER GENERAL  
OF THE UNITED STATES

MAR 24, 1970

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COMPTROLLER GENERAL OF THE UNITED STATES  
WASHINGTON, D.C. 20548

B-118718

To the President of the Senate and the  
Speaker of the House of Representatives

This is our report on the need for the Department of Housing and Urban Development to strengthen concrete inspections and testing requirements in the construction of low-rent public housing projects. Our review was made pursuant to the Budget and Accounting Act, 1921 (31 U.S.C. 53), and the Housing Act of 1954 (42 U.S.C. 1435).

Copies of this report are being sent to the Director, Bureau of the Budget, and to the Secretary of Housing and Urban Development.

A handwritten signature in cursive script that reads "James B. Stacks".

Comptroller General  
of the United States

## C o n t e n t s

	<u>Page</u>
DIGEST	1
CHAPTER	
1 INTRODUCTION	4
Inspection responsibilities of the LHA	5
Inspection responsibilities of HUD	6
2 NEED TO STRENGTHEN CONCRETE INSPECTIONS AND TESTING REQUIREMENTS	8
Need to enforce contract provisions regarding concrete testing	10
Need for contracts to specify minimum testing frequencies for concrete	16
3 PROPOSALS, AGENCY COMMENTS, AND OUR EVALUATION AND RECOMMENDATIONS	18
Proposals, agency comments, and our evaluation	18
Recommendations	21
4 SCOPE OF REVIEW	22
APPENDIX	
I Explanation of concrete and concrete testing	25
II Letter dated December 1, 1969, with enclosure, from the Assistant Secretary of Renewal and Housing Assistance to the General Accounting Office	28
III Principal officials of the Department of Housing and Urban Development responsible for the administration of activities discussed in this report	31

D I G E S T

WHY THE REVIEW WAS MADE

The Department of Housing and Urban Development (HUD) furnishes financial assistance to local housing authorities for developing and constructing low-rent public housing projects.

During each of the past few years, local housing authorities have awarded contracts totaling more than \$300 million for the construction of low-rent public housing projects.

Because concrete represents a significant cost and structural factor in the construction of low-rent housing projects and involves unique problems of quality control over materials and workmanship, effective surveillance of concrete construction operations by the local housing authority is of considerable importance. HUD, which is responsible for protecting the Government's interest in federally assisted projects, assigns HUD construction representatives to periodically observe and review local housing authorities' construction activities, including their inspection practices.

GAO examined into HUD's controls for ensuring that local housing authorities were requiring compliance with contract specifications related to the uses of concrete in construction projects.

FINDINGS AND CONCLUSIONS

HUD construction representatives and local housing authority inspectors did not enforce construction contract requirements regarding concrete testing to determine whether the concrete used in the construction of low-rent public housing projects complied with contract specifications. (See pp. 10 through 15.)

For some projects the frequency of concrete compressive-strength tests was not specified in the construction contracts. HUD did not require local housing authorities to adhere to generally accepted concrete-testing standards, even though concrete of a specified strength was required by the construction contracts. (See pp. 16 and 17.)

GAO believes that HUD needs to place greater emphasis on evaluating and strengthening local housing authority on-site inspections of construction projects to better ensure that contractors provide material and workmanship of the quality specified and paid for and to help ensure the durability and economy of maintenance of the project buildings. (See p. 14.)

Visits to project construction sites by HUD construction representatives were relatively infrequent and of short duration. HUD regional officials stated that the construction representatives sometimes did not have sufficient time during their visits to local housing authority construction projects to make all the checks and evaluations required under HUD procedures. (See pp. 13 and 14.)

HUD regional officials informed GAO that much of the construction representatives' time during such visits was spent in checking various paper work. GAO found that some of the paper work was not related to the adequacy of local housing authority inspections of construction materials and workmanship; in GAO's opinion, this paper work could have been performed by the local housing authority. (See pp. 14 and 15.)

GAO believes that HUD's controls relating to the construction of low-rent housing projects could be strengthened through a redirection of HUD's construction representatives' responsibilities to make more of their time available for evaluating the adequacy of local housing authorities' inspections of the quality of the construction materials and workmanship being furnished. (See p. 14.)

#### RECOMMENDATIONS OR SUGGESTIONS

GAO recommends to the Secretary of Housing and Urban Development that:

- HUD's proposed revision to its construction procedures (see below) require that more effective use be made of HUD's construction representatives during their periodic visits to low-rent housing construction projects by having them place greater emphasis on determining whether the on-site inspections by the local housing authorities are adequate to ensure compliance with contract specifications.
- HUD internal auditors schedule reviews of HUD regional office activities and controls relating to low-rent housing construction projects as an aid to management in protecting the Government's interest in such projects.
- In the absence of specific contractual requirements for the testing of concrete, local housing authorities be required to adhere to generally accepted concrete-testing standards, unless advanced approval has been obtained from HUD for justifiable deviations from such standards.

AGENCY ACTIONS AND UNRESOLVED ISSUES

HUD informed GAO that it recognized that certain administrative failures had occurred, that it would advise its regional offices to be more alert to such inspection failures, and that it would insist that greater attention be given to enforcing construction contract requirements. (See pp. 18 and 19.)

HUD also advised GAO that revised construction procedures to be issued shortly would impress upon the local housing authorities and their architects the importance of carrying out all of their responsibilities and of fully enforcing all contract obligations, including inspections, which HUD considers to be of primary importance. (See p. 19.)

HUD believes that many of the paper-work functions performed by HUD construction representatives are of considerable program and statutory importance. (See p. 19.)

GAO does not question the importance of the paper work but believes that some of it could be performed by the local housing authorities, which would free HUD's construction representatives for the more critical work of determining whether inspections are adequate to ensure compliance with contract specifications. (See p. 19.)

HUD did not agree that it should require local housing authorities to adhere to generally accepted testing standards for structural concrete. HUD informed GAO that the final determination as to the need for specific testing requirements is made by the local housing authority's architect after fully evaluating the particular conditions. (See p. 20.)

GAO believes, however, that HUD should not permit the local housing authorities to deviate from the generally accepted standards for testing concrete unless such deviations can be fully justified. (See pp. 20 and 21.)

HUD informed GAO that full consideration would be given to regional office activities, including those activities discussed in our report, during the preparation of its fiscal year 1971 audit programs. (See p. 20.)

MATTERS FOR CONSIDERATION BY THE CONGRESS

GAO is reporting this matter to the Congress because of its continuing interest in the construction of low-rent public housing and to illustrate the need for improved inspection controls by HUD to protect the Government's interest in housing construction projects.

## CHAPTER 1

### INTRODUCTION

The General Accounting Office has made a review of the practices of the Department of Housing and Urban Development relating to inspections of concrete used in the construction of federally assisted low-rent public housing projects at which concrete either was one of the main structural materials or had important uses for structural support purposes. The significance of concrete from a cost and structural standpoint and the unique problems involved in maintaining quality control of concrete and workmanship make it important that close surveillance be maintained over the concreting operations. The scope of our review is described on page 22 of this report.

The United States Housing Act of 1937, as amended (42 U.S.C. 1401), authorizes HUD to conduct a program of housing assistance under which local governments establish independent legal entities--known as local housing authorities (LHAs)--to develop, own, and operate low-rent public housing projects.

HUD conducts its low-rent public housing program activities primarily through its headquarters office in Washington, D.C., and its seven regional offices located at Atlanta, Chicago, Fort Worth, New York, Philadelphia, San Francisco, and San Juan (Puerto Rico).

The development and administration of federally subsidized low-rent public housing projects is primarily the responsibility of the LHAs. HUD provides financial and technical assistance to the LHAs in the development of low-rent public housing projects and reviews the administration of the projects after construction is completed to determine whether the projects are being operated and maintained in conformance with statutory requirements and in a manner which promotes efficiency, economy, and serviceability.

Financial assistance is furnished by HUD in the form of loans for development and in the form of annual contributions (subsidies) made pursuant to contracts with the

LHAs. The contracts provide for contributions by HUD which, if made in the maximum allowable amount, will be sufficient to pay the principal and interest on bonds and notes sold by the LHAs to the public or, in some cases, to HUD, to obtain funds to pay the costs of developing the projects. The contracts provide also for reducing the maximum allowable contributions by the residual receipts, if any, from project operations.

During fiscal year 1968, HUD's annual contributions to all LHAs operating projects under the conventional low-rent public housing program amounted to about \$275 million, or about 91 percent of the maximum allowable annual contributions. The major cost incurred in developing a low-rent housing project usually is the cost of construction. Therefore, when the cost of construction is minimized, HUD's maximum liability for annual contributions is also minimized.

HUD statistical information showed that, during each of the past several years, LHAs awarded contracts totaling more than \$300 million, nationwide, for the construction of low-rent public housing projects.

#### INSPECTION RESPONSIBILITIES OF THE LHA

HUD regulations require LHAs to administer contracts for the construction and equipment of low-rent public housing projects in accordance with the requirements, procedures, and principles prescribed in HUD's low-rent housing manual. In carrying out this responsibility, LHAs are required to exercise diligence, judgment, and control to ensure that low-rent housing projects are constructed as promptly and efficiently as practicable and in accordance with contract plans and specifications.

HUD's annual contributions contract with an LHA requires the LHA to provide for competent and adequate architectural and engineering inspections of a housing project during its construction. Under HUD procedures, the LHA generally provides for such inspections through a contractual agreement with the architectural firm that drew up the project specifications. The contractual agreement generally



requires the architectural firm to employ inspectors, approved by the LHA, to make continuing on-site inspections during the construction of the project. The primary function of the inspectors is to ensure the construction of the project in accordance with the contract plans and specifications.

#### INSPECTION RESPONSIBILITIES OF HUD

HUD regulations require its regional offices to observe and review project construction activities of an LHA and its architects and inspectors to ensure compliance in the administration of contracts and the inspection of construction work performed under the contracts. In this regard, a HUD regional office construction chief serves as the direct channel of communication between the regional office and the LHA on all construction matters and is responsible for giving advice and assistance to the LHA regarding any problem that may arise during the course of construction. The HUD construction chief is aided by a group of regional office construction representatives who are required to make periodic visits to projects being constructed to observe and report on the construction work.

HUD, in its annual contributions contract with an LHA, reserves the right for HUD construction representatives (1) to review and evaluate the adequacy of the LHA's inspections of a housing construction project and to request that corrective action be taken when deemed appropriate and (2) to inspect all construction work, materials, equipment, and records and to demand that the LHA require the contractor to correct any work involving contract noncompliance disclosed by their inspections.

HUD's construction representatives are also responsible for protecting the Government's interests in low-rent housing projects. They have a direct influence in ensuring that contract requirements are met, that specified standards approved by HUD for materials and workmanship are met, and that construction operations are performed in the most expeditious and acceptable manner.

Principal officials of the Department of Housing and Urban Development responsible for the administration of activities discussed in this report are listed in appendix III.

## CHAPTER 2

### NEED TO STRENGTHEN CONCRETE INSPECTIONS

#### AND TESTING REQUIREMENTS

Our review showed certain weaknesses in LHA on-site inspection practices relating to concrete used in the construction of low-rent public housing projects. These weaknesses involved instances of noncompliance with contract requirements for testing concrete which were not detected by HUD construction representatives during their visits to LHA construction projects. Our review showed also that some LHA construction contracts approved by HUD did not include specific requirements as to the minimum frequencies for testing the compressive strength of structural concrete.<sup>1</sup>

We found that one or the other of the weaknesses cited above existed at nine of 17 projects where we reviewed concrete operations. Since visits to project sites by HUD construction representatives are made to protect the Government's interest in the development of low-rent public housing projects, it is important that the duties of HUD's representatives be effectively carried out to ensure that construction materials and workmanship comply with the specifications and other requirements of the construction contracts. Also, HUD regional offices must depend largely upon the observations and reporting of their construction representatives as a basis for taking actions and making decisions with regard to matters involving contract non-compliance and indicated weaknesses in LHA on-site inspections.

Our review showed that visits to project sites by HUD construction representatives were relatively infrequent and of short duration. In many cases, HUD construction representatives made visits to an LHA construction project only once a month or less frequently, and the length of the visits ranged from a few hours to 2 days.

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<sup>1</sup> Explanatory data on concrete and concrete testing is included in appendix I. (See pp. 25 through 27.)

HUD regional officials advised us that HUD construction representatives sometimes did not have sufficient time during their visits to LHA construction projects to make all the checks and evaluations required under HUD procedures. We were also informed that much of the construction representatives' time at a construction project was spent in checking various paper work matters. We found that some of the paper work was not related to the adequacy of LHA inspections of construction materials and workmanship and, in our opinion, could have been performed by the LHA.

On the basis of our review, we believe that HUD construction representatives should make more effective use of their technical knowledge and experience in determining whether LHA on-site inspections of construction projects are adequate to ensure that the projects are being constructed in accordance with contract specifications. In our opinion, this aspect of HUD's controls had a bearing on the inadequate inspection practices that we found at some of the projects included in our review. We believe that HUD's controls over the construction of projects could be strengthened by making more of the construction representatives' time available for the more critical and technical duties of evaluating the adequacy of the inspections provided by LHAs.

The results of our review are discussed in the following sections of the report.

NEED TO ENFORCE CONTRACT PROVISIONS  
REGARDING CONCRETE TESTING

We found that, at six low-rent public housing projects, HUD construction representatives and LHA inspectors had not enforced construction contract requirements regarding concrete testing as a means of determining whether the concrete used in the construction of the projects complied with the contract specifications. Our examination of contract documents, available concrete truck delivery tickets, and laboratory test reports showed that an average of only 33 percent of the required concrete compressive-strength tests had been made to determine whether concrete of the proper strength was being used in the six projects. Although the results of the small percentage of tests that were made indicated that the tested concrete complied with the contract specifications, we believe that such limited compliance with the testing requirements did not provide adequate assurance that all the concrete used in the projects met the applicable strength requirements for its designed use.

The contracts for the six housing projects required that concrete cylinder specimens be made and tested at specified frequencies to determine whether the compressive strength of the hardened concrete complied with the contract strength requirements. The specified frequencies of required testing generally were in line with those prescribed by the American Concrete Institute in Bulletin 318.

The contracts also provided that, if compressive-strength tests indicated that concrete cylinder specimens did not meet the contract strength requirements, the LHA could require other types of tests to be made, at the contractor's expense, to determine the strength of the in-place concrete. If the additional tests showed that the in-place concrete did not meet the contract strength requirements, the LHA could, under the terms of the contract, require the contractor to remove the low-strength concrete and replace it with concrete of the required strength.

One of the responsibilities of HUD construction representatives and LHA inspectors is to ascertain whether all required tests have been made to determine that construction materials comply with contract specifications. For

the six projects, we found that the HUD construction representatives and LHA inspectors apparently were not aware that the contractors were not having concrete compressive-strength tests made, although such tests were required by the contracts.

For example, at one high-rise project under construction at the time of our field review, we found that only about 20 percent of the required compressive-strength tests had been made. The contract required that at least four concrete cylinder specimens be made and tested for each 100 cubic yards of concrete poured and that, in any case, not less than four cylinders be made and tested for any 1 day's operations.

On the basis of these criteria and an examination of truck delivery tickets showing the amounts of concrete delivered to the project site on 113 days, we determined that a total of at least 452 cylinder specimens of the concrete placements should have been made and tested. However, the laboratory reports submitted to the LHA showed that tests had been made of only 96 of these cylinders. Moreover, we noted that no compressive-strength tests were made during a 2-month period when more than 600 cubic yards of concrete were delivered and placed in the project.

Our review showed that, during construction of this project, three different HUD construction representatives were assigned at different times to review the construction operations. We found that, during a 3-month period, HUD construction representatives visited the project site on 7 different days when no concrete cylinder specimens were made although concrete was being poured on the days of their visits.

Since the construction representatives' trip reports covering these visits indicated that all required tests of materials had been timely made and that the material met the contract specifications, it appears that the HUD representatives assumed that the concrete was being tested in accordance with the contract requirements without actually examining into this aspect of contract compliance. One of the three HUD construction representatives told us that he did not have sufficient time during his visits to the

construction project to determine whether all the required concrete strength tests were being made.

The LHA's architect for this project informed us that he had delegated to his on-site inspectors his contractual responsibility for seeing that concrete tests were made in accordance with contract requirements. The architect stated that his inspectors could not explain why the contract requirements regarding concrete testing had not been enforced.

Since concrete is one of the main structural materials for this project, we believe that the HUD construction representatives and the LHA inspectors should have been particularly concerned as to whether the contractor was complying with the contract specification requirements regarding concrete testing.

We brought this matter to the attention of HUD's acting regional chief of construction, and a regional construction official contacted the LHA regarding the in-place concrete that had not been tested. The LHA's architect subsequently advised the regional construction official that, in his professional opinion, the project was structurally sound.

At another project--a multibuilding complex of two-story homes for low-income families and of apartments for elderly citizens--that was substantially completed at the time of our field review, we found that only 10 percent of the required concrete strength tests had been made. The contract for the project required that three concrete cylinder specimens be made and tested for each day of concreting operations. On the basis of this criterion, 228 concrete cylinder specimens should have been made and tested for concrete placements on 76 days. Our review showed, however, that tests were made of only 24 cylinder specimens. Although the results of the tests of these specimens were acceptable, they covered only eight of the 76 days of concreting operations.

Although the concrete in this project is not a main structural material, we were informed by a representative of the architect that portions of the concrete slabs in nine buildings were used for structural support purposes.

According to LHA records, the concrete in only one of these buildings was tested for compliance with contract strength requirements.

After we brought this matter to the attention of HUD's acting regional chief of construction, a series of Swiss hammer tests were made, under the supervision of the project architect, in all buildings in which tests of concrete cylinders had not been made. The architect subsequently advised the LHA's Executive Director that, based on the results of the Swiss hammer tests, it was his professional opinion that all concrete slabs either met or exceeded the required specified strength. According to the architect, the requirement for making concrete compressive-strength tests had been inadvertently overlooked on many days when concrete was poured at the project.

The contractual arrangements for paying for concrete compressive-strength tests varied among the projects included in our review. At some projects, the construction contract required the contractor to pay for the concrete tests, while at other projects the LHA entered into a contract with a commercial testing laboratory for the tests. Since for three projects where we found that insufficient tests had been made the contracts required the contractors to pay for the concrete tests, we expressed the opinion to HUD regional construction officials that the contractors should be required to reduce the contract costs in consideration of the required tests that were not made. HUD construction officials in Region II agreed with us and initiated action to obtain appropriate credits from the contractors for the required tests that were not made at two of the three projects. According to HUD's records, the HUD chief of construction in Region IV was advised by the architect for the other project that an appropriate credit would be obtained from the contractor when the construction work was completed.

In commenting on the results of our review, the Assistant Regional Administrator for Housing Assistance in Region II agreed that it was important for HUD construction representatives to review concrete-testing practices and to enforce compliance with contract-testing requirements at all projects under construction. His counterpart in



Region IV stated that the construction representatives in that region did not have sufficient time during their relatively short visits to construction projects to determine whether all tests required by the construction contracts were being made. We noted that each of HUD's construction representatives in Region IV had an average of 15 active projects to visit each month and that each of the construction representatives in Region II had an average of only nine active projects to visit each month.

Under its procedures, HUD's construction representatives are required during their visits to construction projects to examine contractors' payrolls and supporting documents, to determine the propriety of periodic payments to the contractors for in-place work, to review the enforcement of contract labor and nondiscrimination provisions, and to check administrative matters and paper work not related to the adequacy of inspections of construction materials and workmanship. From construction representatives' trip reports covering their visits to construction projects included in our review, it appeared to us that much of their time at project sites was spent in examining into matters of this nature.

A HUD Region II official informed us that construction representatives in that region generally spend 2 days at a construction project during each visit--1 day for physical observation and evaluation of the construction work and 1 day for checking paper work and other matters. He said that during each visit the HUD construction representative evaluates and reports on the adequacy and quality of the LHA inspection staff. An Assistant Regional Administrator in Region IV informed us that, in view of the heavy workload in that region, the construction representatives in many cases spend only a few hours at a construction project and cannot possibly perform all the duties required by HUD's instructions.

We believe that HUD's controls relating to construction of low-rent housing projects would be strengthened through a redirection of HUD's construction representatives' responsibilities to make more of their time available for evaluating the adequacy of LHA inspections of the quality of the construction materials and workmanship being furnished.

If HUD's construction representatives do not have sufficient time during their visits to construction projects to perform all the required duties, it is our opinion that they should concern themselves with those aspects of contract compliance that are the most important at the various phases of project construction and that unrelated paperwork responsibilities should be assumed by the LHA. Since concrete is one of the main structural materials for many construction projects and has important uses for structural support purposes at others, we believe that, during their visits to such projects, HUD construction representatives should determine whether all concrete tests are being made and whether the concrete meets contract specifications.

After we had discussed some of the matters noted early in our review with construction officials in HUD's Region II, a circular was issued instructing all construction representatives in that region to examine more closely into concrete inspection matters, such as those discussed in this report, during future visits to construction projects. If properly implemented, the circular should result in improved inspection practices in Region II.

Also, HUD central office officials informed us that HUD realized the need for reexamining the duties of the HUD construction representatives, and was in the process of making such a reexamination.

NEED FOR CONTRACTS TO SPECIFY MINIMUM  
TESTING FREQUENCIES FOR CONCRETE

We noted that contract specifications for three low-rent housing projects did not contain any specific provision regarding the frequency at which concrete compressive-strength tests should be made as a means of determining compliance with contract requirements regarding concrete. In the absence of specific testing provisions in the contracts, concrete compressive-strength tests were made for less than half the days on which concrete was poured at the projects, even though concrete of specified compressive strengths was required by the contracts.

We believe that, to provide assurance that concrete of the proper strength is used, concrete placements made in the construction of low-rent public housing projects should be tested in accordance with American Concrete Institute (ACI) Bulletin 318 which provides that, when strength is a basis for acceptance of concrete, not less than one test comprised of two specimens shall be made for each 150 cubic yards of structural concrete, but at least one such test shall be made for each day's concreting.

In discussing the results of our review at one of the projects with HUD regional construction officials, we expressed the belief that HUD, in approving the construction contract specifications for a low-rent housing project, should require LHAs to include a provision in construction contracts setting forth specific testing requirements for determining compliance with specifications regarding concrete. We expressed the belief also that HUD construction representatives should observe and evaluate the adequacy of concrete-testing practices employed by LHAs.

The LHA contracting officer subsequently informed us that, under advice of the project architect, the LHA would have compressive-strength tests made for concrete placements in the remaining structural areas of the project, in accordance with the testing requirements prescribed in the ACI Bulletin 318.

HUD regional construction officials contacted the responsible LHA regarding the absence of specific

concrete-testing requirements in the contracts of the other two projects and requested that the regional office be informed of any future action to be taken in this regard. The HUD regional acting chief of construction was subsequently advised by the LHA that a specific provision regarding concrete testing would be included in all future construction contracts.

### CHAPTER 3

#### PROPOSALS, AGENCY COMMENTS, AND

#### OUR EVALUATION AND RECOMMENDATIONS

##### PROPOSALS, AGENCY COMMENTS, AND OUR EVALUATION

We submitted a draft of this report to HUD for comment. We proposed that HUD's regional offices be required to make more effective use of their construction representatives during the representatives' periodic visits to low-rent housing construction projects, by requiring them to place greater emphasis on determining whether the on-site inspections provided by the LHAs are adequate to ensure compliance with contract specifications for the construction of the projects.

We proposed also that HUD's internal auditors schedule reviews of HUD regional office activities and controls relating to low-rent housing construction projects as an aid to management in protecting the Government's interests in such federally assisted housing projects.

In addition, we proposed that HUD's regional offices require LHAs to include a provision in construction contract specifications setting forth specific testing requirements for structural concrete to be used in housing project construction.

The Assistant Secretary for Renewal and Housing Assistance of HUD in a letter dated December 1, 1969 (see app. II), furnished us with HUD's comments on our draft report.

HUD stated that, although it was continually striving to obtain full compliance with contract requirements from all persons involved in the development and construction of low-rent public housing projects, it recognized that certain administrative failures had occurred on the part of architects, architect's inspectors, LHAs, and HUD construction representatives. HUD stated also that it had advised each regional office to be more alert to such inspection failures

and to give greater attention to enforcing contract requirements. HUD informed us that revised construction procedures to be issued shortly would impress upon the LHAs and their architects the importance of carrying out all of their responsibilities and of fully enforcing all contract obligations, including inspections, which HUD considers to be of primary importance.

HUD pointed out that paper-work functions performed by construction representatives--such as those connected with labor standards and equal employment opportunity, along with the need for general overview of how the LHA is enforcing its rights under the architect's contract and construction contracts--are of considerable program and statutory importance.

We recognize the importance of LHAs' enforcing their contractual rights in connection with the construction of housing projects. We noted, however, that visits by HUD construction representatives to project construction sites were relatively infrequent and of short duration and, as pointed out by a HUD official, the construction representatives might not have sufficient time to perform all the duties required by HUD's instructions. We believe that the technical knowledge and experience of HUD construction representatives could be utilized most advantageously in determining whether LHA inspections give adequate assurance that contractors are providing materials and workmanship in accordance with contract construction plans and specifications.

In our opinion, some of the paper-work functions that HUD construction representatives are required to perform at construction project sites are unrelated to whether the construction work and materials comply with contract requirements and could be performed by the LHAs instead of by HUD construction representatives. We believe that our position in this regard is consistent with a statement by HUD officials that an underlying assumption of a recent HUD study was that, if HUD's low-rent housing program production goals are to be met, HUD will have to assume certain risks, such as vesting greater responsibility in LHAs whenever the administrative cost to HUD of additional control seems to outweigh the potential danger of loss.

We therefore believe that HUD's revised inspection procedures should provide for greater emphasis on the critical area of evaluating and strengthening LHA on-site inspections of the construction of low-rent public housing projects, so as to better ensure that contractors are providing materials and workmanship of the quality specified and paid for and to help ensure the durability and economy of maintenance of the project buildings. Weaknesses in construction inspections and deviations from contract specifications could result in adverse effects which may not appear for many years after the construction of a project has been completed.

Regarding our proposal that HUD's internal auditors schedule reviews of activities covered in this report, HUD informed us that preliminary surveys of regional office activities, including those activities discussed in this report, were undertaken by the HUD Office of Audit at two HUD regions subsequent to completion of our field review. We were advised that, because of the limited findings disclosed by these two surveys, the Office of Audit did not consider this area of activity to be of sufficient priority to warrant a full operational audit in fiscal year 1970 but that the area would be given full consideration in planning program audits for fiscal year 1971.

In response to our proposal that HUD require LHAs to specify concrete-testing requirements in the construction contract specifications, HUD informed us that, although HUD guidelines on concrete specifications provide that American Concrete Institute standard specifications be used by LHAs in all phases of concrete work, including testing, LHA adherence to such guidelines is not mandatory and that the final determination as to the needs of specific testing requirements is made by the LHA architect after full evaluation of the particular condition. HUD also stated that the responsibility of its regional offices in this regard is that of offering advice and comments to LHAs concerning the preparation of pertinent documents.

Although we recognize that the LHAs and their architects have primary responsibility for establishing concrete-testing requirements, we believe that HUD should not

permit LHAs to deviate from the generally accepted standards for testing concrete unless such deviations can be fully justified.

#### RECOMMENDATIONS

We recommend to the Secretary of Housing and Urban Development that HUD's proposed revision to its construction procedures require that its regional offices make more effective use of their construction representatives during their periodic visits to low-rent housing construction projects by having them place greater emphasis on determining whether on-site inspections by the LHAs are adequate to ensure compliance with contract specifications for the construction of the projects. We recommend also that HUD's internal auditors schedule reviews of HUD regional offices' activities and controls relating to low-rent housing construction projects as an aid to management in protecting the Government's interests in such projects.

In addition, we recommend that, in the absence of specific contractual requirements for the testing of concrete, HUD's regional offices, as a minimum, require that LHAs adhere to the standards of concrete testing set forth in ACI Bulletin 318 and that they fully justify and obtain advance HUD approval for any deviations from these standards.



## CHAPTER 4

### SCOPE OF REVIEW

HUD statistical information showed that at September 30, 1967, about 26,500 low-rent public housing dwelling units were under construction in HUD Regions I, II, and IV. Our review covered 17 projects containing about 2,600 of the 26,500 dwelling units under construction and about 120 dwelling units that had been constructed prior to September 30, 1967. We reviewed applicable HUD and LHA policies, regulations, and practices relating to project development and examined construction contract documents, project development files, correspondence, test reports, and other related documents that were made available to us. We also held discussions with HUD and LHA officials and project architects.

Our work was performed at HUD headquarters in Washington, D.C.; at HUD's regional offices in Philadelphia (Region II) and Chicago (Region IV); at 11 LHAs under the administrative authority of the two regional offices; at one LHA under the administrative authority of Region I (New York); and at 17 project construction sites. We also visited several concrete-testing laboratories and discussed matters pertinent to our review with laboratory representatives.

**APPENDIXES**



## EXPLANATION OF CONCRETE AND CONCRETE TESTING

The explanatory data contained in the following paragraphs has been extracted from various engineering manuals and literature. This information is not intended to represent an all-inclusive summary of technology regarding concrete and concrete testing, but is presented to acquaint the reader with certain terminology used in this report.

Concrete is a mixture in which a paste of cement and water binds aggregates (inert materials such as sand and gravel, crushed stone, and blast-furnace slag) into a rock-like mass as the paste hardens through the chemical action of the cement and water. The quality of concrete largely depends on the proportion of the ingredients, especially the proportion of water to cement; the manner in which the concrete is handled and placed after it is mixed; and the thoroughness of the curing. Two of the principal requirements of hardened concrete are strength and durability-- strength to perform the functions of the structure and durability to resist exposure to the elements. The strength of the cement paste and, ultimately, the durability, strength, and other properties of the concrete depend on the amount of mixing water used.

The design of a concrete mix depends on the purpose for which the concrete is to be used and involves the determination of the most economical and practical combination of concrete ingredients that are workable in a plastic (fluid) state and that will develop the required qualities when hardened. To achieve economy, the design mix should minimize the amount of cement [required] without sacrificing the required concrete quality. The most direct method of determining optimum mix proportions is through the use of trial mixes, which may be relatively small batches of concrete made in the laboratory, job-size batches, or a combination of both.

Several tests are generally used to determine whether concrete complies with contract specification requirements. Certain tests are carried out while the concrete is in its fluid state while others are conducted on the hardened product. Some of the more frequently used tests in connection

with the construction of low-rent public housing projects are discussed below.

A slump test is generally made during the placing of concrete; it involves measuring the number of inches that a mass of concrete settles (slump) after the removal of a cone into which the fluid concrete has been poured. Changes in slump indicate changes in materials, mix proportions, or water content.

A compressive-strength test consists of the making of a set of concrete cylinders at the time the concrete is discharged at the project site. The cylinders are submitted to a commercial testing laboratory for curing, and certain cylinders are tested in compression at the end of 7 days. The remaining cylinders are tested in compression at the end of 28 days. The compressive-strength test measures the pressure in pounds per square inch that a cylinder of hardened concrete will withstand before it crumbles or breaks. The test is used as a means of determining whether the concrete from which the cylinder specimens were made meets the strength requirements of the contract specifications. Acceptability of concrete is based upon the compressive strength that results at the end of 28 days; however, the results of the tests at the end of 7 days generally are indicative of what the tests at the end of 28 days will show.

When tests of concrete cylinders fail to meet the strength requirements of the contract specifications, it is common practice to take test cores from the in-place concrete in the area where the strength of concrete is in question. The cores are soaked in water for several hours and tested in compression, in the same manner as cylinder specimens, to determine the strength of the in-place concrete.

The Swiss hammer test is a nondestructive method of measuring the surface hardness of in-place concrete based on the principle that the rebound of a steel hammer which has been struck against the concrete is proportional to the compressive strength of the concrete. In performing this test, a steel hammer within the testing device is cocked and then tripped automatically by pressing the instrument

against the concrete surface. The rebounding force of the hammer is registered on a scale in the testing device. The compressive strength of the in-place concrete can be determined from the relationship between the scale reading and a compressive-strength test chart.



DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT  
WASHINGTON, D. C. 20410

DEC 1 1969

OFFICE OF THE ASSISTANT SECRETARY  
FOR RENEWAL AND HOUSING ASSISTANCE

IN REPLY REFER TO:

Mr. Max Hirschhorn  
Associate Director  
Civil Division  
U. S. General Accounting Office  
Washington, D. C. 20548

Dear Mr. Hirschhorn:

The Secretary has asked me to respond to your letter of October 31, 1969, requesting the Department's views on your revised draft of a proposed report to the Congress entitled: "Review of Inspections of Concrete Used in the Construction of Low-Rent Public Housing Projects, Department of Housing and Urban Development."

The enclosed statement contains our comments on the material presented in the proposed report.

We appreciate the opportunity to review the proposed report before it is presented to the Congress.

Sincerely yours,

A handwritten signature in cursive script that reads "Lawrence M. Cox".

Lawrence M. Cox  
Assistant Secretary

Enclosure

Statement By The  
Department of Housing and Urban Development

GAO Draft Report to Congress  
"Review of Inspections of Concrete  
Used in the Construction of Low-Rent  
Public Housing Projects"

The report contains information that GAO personnel uncovered several instances of ineffective inspection in work involving concrete. The report also indicates that in most instances corrections have been made, or that the Regional Office promised corrective action.

In response to Mr. Hirschhorn's letter of November 19, 1968, in which was requested the Department's comments on a draft of a proposed report to the Congress entitled "Need to Strengthen Inspection Controls Over Construction of Low-Rent Public Housing Projects," we advised that we continually strive to obtain full compliance from everyone involved in the development and construction of low-income housing. We also stated that we nevertheless recognize that certain administrative failures have occurred. Subsequently, each Regional Office was advised to be more alert to such inspection failures and that greater attention be given to construction contract requirements.

During the fiscal years 1967 and 1968 the construction of approximately 750 low-rent housing projects was completed, and these projects containing approximately 80,000 units were made available for occupancy. We have not received any reports or information indicating a structural failure or any other adverse complaints regarding projects completed since the introduction of the construction representative method of project reviews in 1959. We have advised the Regional Offices concerning the functions of construction representatives which are designed to compliment and not replace or duplicate the services of the architect which are identical to those services relied upon by private industry.

It should be noted that many of the paper-work functions described by the GAO, such as those connected with labor standards and equal employment opportunity, along with the need for general overview of how the local authority is enforcing its rights under the architect's contract and construction contracts, are of considerable program and statutory importance. Because of the workload, the construction representative is no longer a construction inspector. He advises the local authority on procedures; reviews and makes recommendations concerning the organization of administrative supervisory and inspection forces; examines the records and physical progress for effectiveness in inspection and contract administration; and advises on changes and other construction matters. In revised construction procedures to be issued shortly we will impress upon the LHAs and their architects the importance of carrying out all of their responsibilities and fully enforcing all contract obligations including inspection which we agree are of primary importance.



Although HUD renders assistance to development of the project and confers with the local authority with respect to plans, specifications, documents, and other construction matters submitted to it, the responsibility for design and specifications, the observance of contract requirements and the enforcement of contractual obligations of contractors rests with the LHA and its architect. It must be borne in mind that LHA Commissioners are responsible public officials who take pride in the design and construction of their projects which are planned and constructed for a useful life of at least 40 years.

With regard to the recommendation concerning internal audits, the Office of Audit, by memorandum of March 14, 1969, scheduled preliminary surveys of Regional Office activities responsible for the general functions discussed in this report. The survey reports were issued in July 1969 (Region V) and August 1969 (Region I). On the basis of the limited findings in these two preliminary survey reports, the Office of Audit did not consider this area to be of sufficient priority for commencement of a full operational audit during Fiscal Year 1970. However, this area will be given full consideration during preparations of the Fiscal Year 1971 annual audit program.

With respect to the recommendation about contract specifications including specific testing requirements for structural concrete, HUD provides LHA architects with Bulletin No. LR-13, Guide Specifications. Although this Guide is not mandatory, its use is recommended because it reflects Housing Assistance Administration experience. Division 4 of this Guide furnishes information concerning the labor, materials, and related items necessary to complete the concrete work, and provides that the applicable parts of the American Concrete Institute Standard Specifications be utilized in all phases of concrete work including testing. Our Regional Offices offer advice and comments concerning the preparation of the documents but the final determination as to the need for specific testing requirements is made by the architect after full evaluation of the particular condition.

PRINCIPAL OFFICIALS OF THE  
DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT  
RESPONSIBLE FOR THE ADMINISTRATION OF ACTIVITIES  
DISCUSSED IN THIS REPORT

	<u>Tenure of office</u>	
	<u>From</u>	<u>To</u>
SECRETARY OF HOUSING AND URBAN DEVELOPMENT (formerly Administrator, Housing and Home Finance Agency):		
Robert C. Weaver	Feb. 1961	Dec. 1968
Robert C. Wood	Jan. 1969	Jan. 1969
George W. Romney	Jan. 1969	Present
ASSISTANT SECRETARY FOR RENEWAL AND HOUSING ASSISTANCE:		
Don Hummel	May 1966	Feb. 1969
Howard J. Wharton (acting)	Feb. 1969	Mar. 1969
Lawrence M. Cox	Mar. 1969	Present