Report to

ILLINOIS POWER COMPANY
Decatur, Illinois

MASONRY BLOCK WALL TESTS

by

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Submitted by

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INTRODUCTION

At the request of Illinois Power Company (IPC), concrete masonry block walls were subjected to flexural load tests to determine the modulus of rupture. Six nominally identical walls were constructed at the Construction Technology Laboratories (CTL) in accordance with applicable requirements of Clinton Project Specification No. K-2944 Form CPS-1-MW, Revision 10, January 8, 1982. This specification was provided by IPC. Materials and masons required for construction of walls were furnished by IPC. Test procedures conformed to ASTM Designation: E72-80, "Standard Methods of Conducting Strength Tests of Panels for Building Construction,"[1] and the Illinois Power Company Test Specification entitled, "Static Testing of Concrete Masonry Walls for Transverse Flexural Strength for Clinton Unit #1." Three walls were tested to determine the modulus of rupture. The remaining three walls served as reserve specimens.

This report describes wall construction, test procedures, and results obtained.

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TEST PROGRAM

The program included the tests of the following:

1. block walls to determine modulus of rupture
2. individual blocks for compressive strength of masonry
3. mortar cubes for mortar compressive strength

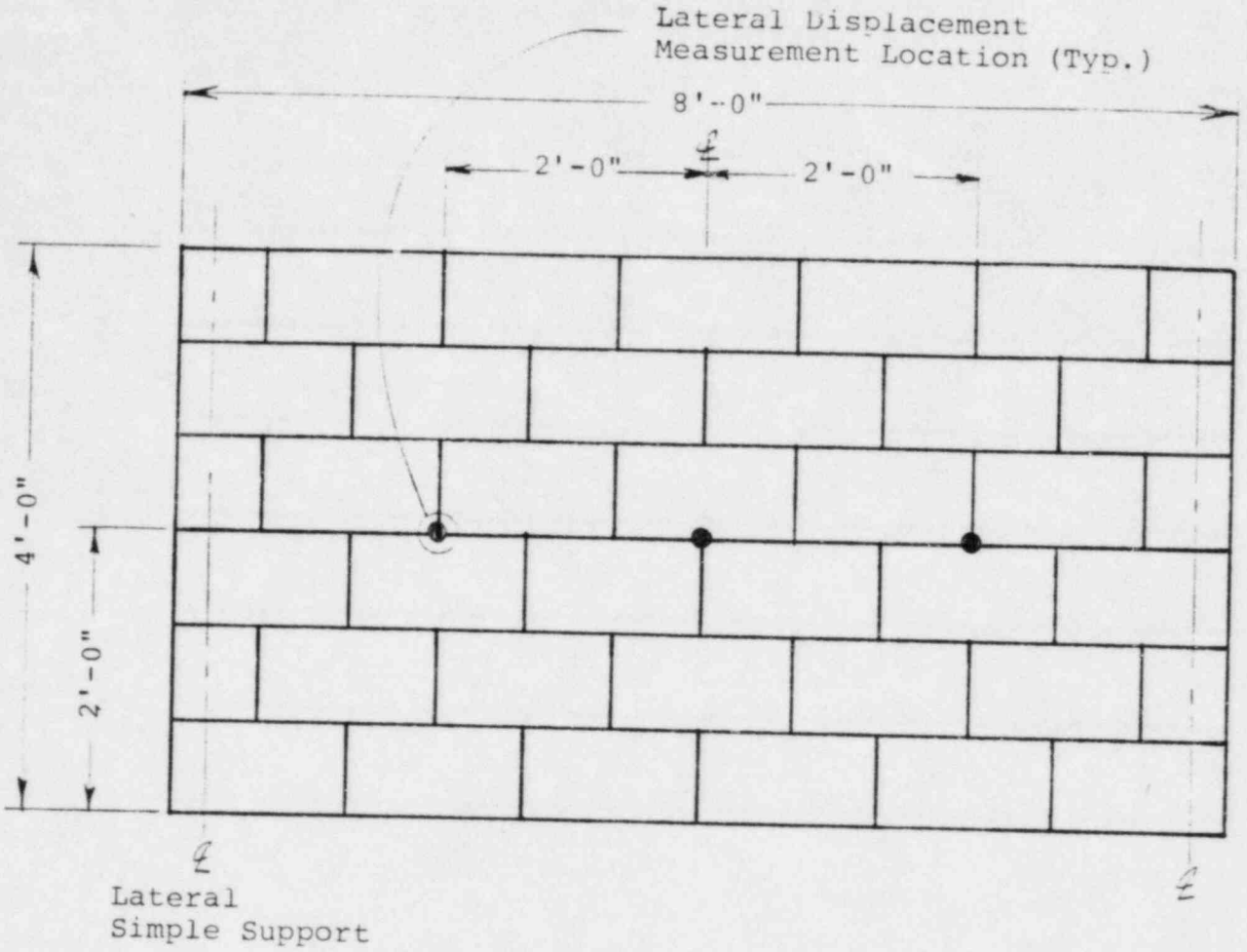
Wall Specimens

Details of a wall specimen are shown in Fig. 1. Test walls were 4-ft high and 8-ft long. They were constructed in running bond pattern using two-core hollow block units of 8x8x16-in. nominal size. Blocks were laid with 3/8-in. thick fully-bedded joints using Type M mortar proportioned in accordance with the requirements of ASTM Designation: C270-82, "Standard Specification for Mortar for Unit Masonry."[2] The bottom course of each test wall was laid on the laboratory concrete floor with a bond breaker. The bond breaker consisted of two nominal 4-mil thick polyethylene sheets under the mortar bed provided for the bottom masonry course.

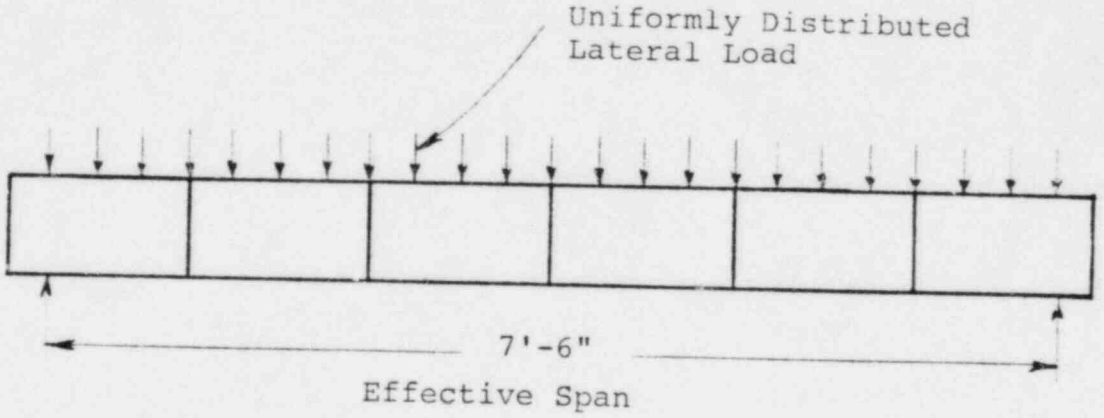
Truss type masonry joint reinforcement (3/16-in. dia.) furnished by IPC was placed in every second mortar bed joint resulting in a 16-in. vertical spacing. Test walls were cured in place for 28±3 days in a laboratory maintained at 70°±5°F and 60±10% relative humidity.

Masonry Units

The basic units used for constructing walls were two-core 8x8x16-in stretcher blocks, two-core 8x8x16-in. end blocks, and



(a) Elevation



(b) Plan

Fig. 1 Details of a Wall Specimen

single core 8x8x8-in. half blocks. Three each of stretcher and end blocks were used to determine compressive strength of masonry and physical properties of individual blocks. These blocks were selected at random as representative of the whole lot of units from which the test walls were constructed.

Mortar

Type M mortar was proportioned in accordance with the requirements of ASTM C270-82.[2] The quantities of Brixment Type M cement (blended cement) and masonry sand in the mix were respectively in the proportion of 1:3 by volume. Sufficient amount of water was added to the mix for required consistency. Six mortar cubes were prepared in accordance with ASTM Designation: C270-82.[2] Cube specimens were stored in a moist room maintained at 73.4° $\pm$ 3°F and not less than 95% relative humidity. Cube forming process is shown in Fig. 2.

Test Equipment

Wall specimens were tested in flexure under uniform lateral load applied with an inflated plastic bag. Effective horizontal span for a test wall, as shown in Fig. 1, was 7 ft 6 in. Each wall was supported laterally in a test frame at each end to provide the desirable effective span as shown in Fig. 3. Each of the two supports consisted of a steel roller with a stiff steel plate between it and the specimen. The other side of the wall was loaded uniformly with an inflated plastic bag placed between the test specimen and a firm back wall. Air pressure in the bag was monitored by an electronic pressure transducer accurate to within 1% of the actual reading over a range of 0-3 psig.

Fig. 2 Cube Forming Process

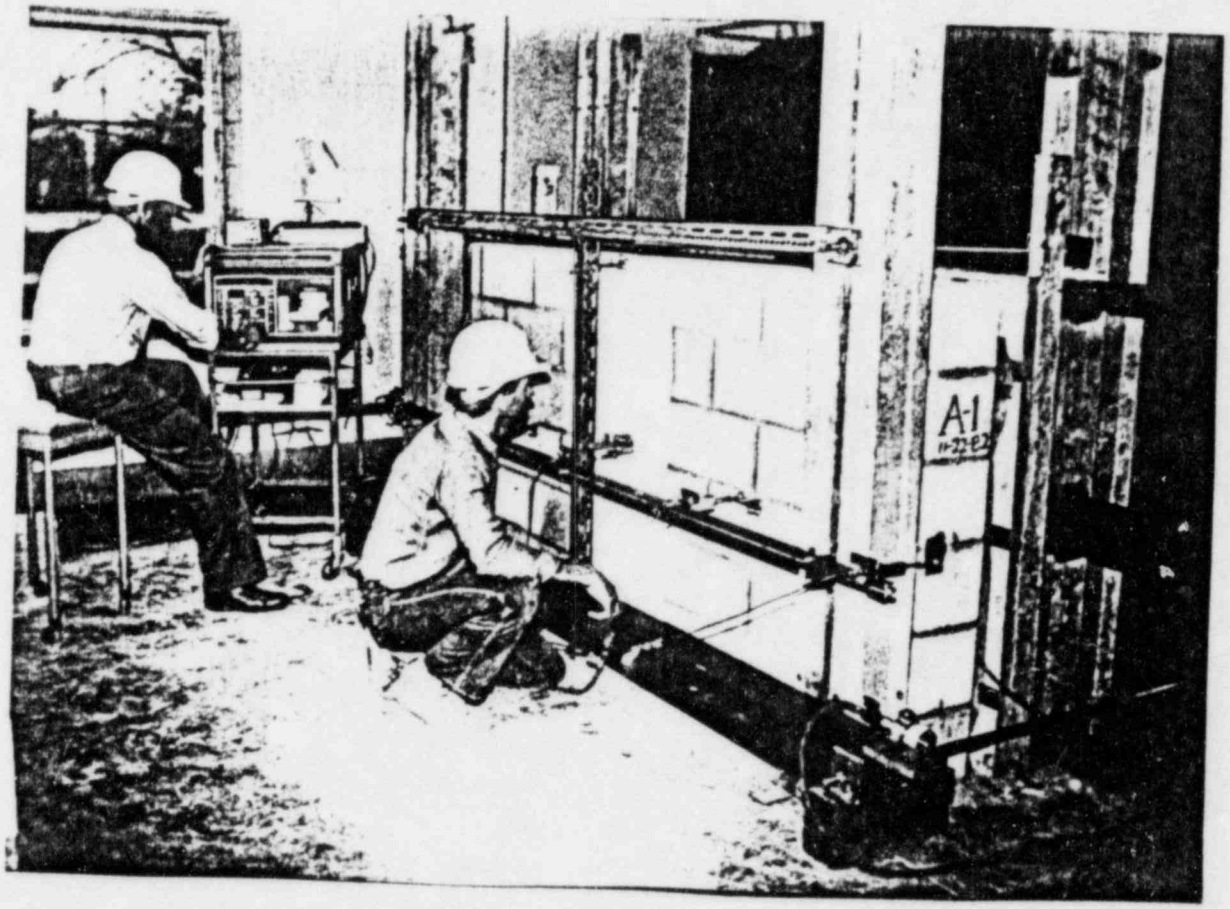


Fig. 3 Test Setup

Transverse deformations at three specified points at mid-height of the wall, as shown in Fig. 1, were measured by calibrated linear potentiometers with a maximum stroke of 2 in. Output of pressure transducer and potentiometers was read on a calibrated digital voltmeter.

Loading procedure

Specimens were cyclically loaded in increments of approximately 26 psf. Prior to recording deformation, an initial load of about 8 psf was applied for initial seating of loading hardware. This small load also permitted the inflated bag to maintain its desired loading position. The wall was then loaded in a cyclic manner as follows:

1. Increase load in air bag by about 26 psf
2. Read deflections to nearest 0.001 in
3. Hold load for 5 minutes
4. Read deflections
5. Release load and allow pressure to return to base load of 8 psf
6. Read deflections
7. Retain this load for 5 minutes
8. Read deflections
9. Increase pressure to about 26 psf greater than that at the previous load stage
10. Continue 5 minute cycles returning to base pressure after each increase in load

A load of 173 psf, estimated to be 75% of the expected ultimate load, was chosen as a termination point for cyclic loadings. Thereafter, the specimen was loaded continuously in about 8-psf increments until the flexural load capacity of the specimen was reached.

TEST RESULTS

Masonry Units

Dimensions and physical properties determined from average of measurements made on three stretcher and three end blocks are listed in Table 1.

At least three measurements were made on each unit for length, width, and height, and for minimum thickness of face-shell and web. Net area and compressive strength were determined in accordance with the requirements of ASTM Designation: C140-75, "Standard Methods of Sampling and Testing Concrete Masonry Units."[3] Compressive strength, block dimensions, and minimum thickness of face-shell and web conformed to the requirements of ASTM Designation: C90-75, "Standard Specification for Hollow Load-Bearing Concrete Masonry Units."[4]

Mortar

Compressive strength tests were performed on six mortar cubes prepared in accordance with ASTM Designation: C270-82.[2]

Average compressive strength of mortar cubes measured at 28 days was 2530 psi. Based on property specification requirements of ASTM Designation: C270-82, the mortar is classified as Type M.

TABLE 1 - DIMENSIONS AND PHYSICAL PROPERTIES OF MASONRY UNITS

Unit Type	Avg. Weight Lb	Avg. Density pcf	Dimensions* in.			Area $in.^2$		Min. Thickness* in.		Comp. Strength* psi	
			Length	Width	Height	Gross	Net**	Face-Shell	Web	Gross Area	Net Area
Stretcher Block	37.42	131.48	15.56	7.62	7.62	118.72	63.52	1.25	1.02	2265	4235
End Block	42.17	131.23	15.60	7.62	7.65	119.03	71.42	1.27	1.04	2400	4000

* Conforms to the requirements of ASTM Designation: C90-75.

**Calculated in accordance with ASTM Designation: C140-75.

Wall Flexural Strength

Wall dimensions, cross-sectional properties, ultimate loads, and moduli of rupture for three test specimens are listed in Table 2. Net cross-sectional area per ft of wall was proportioned from the properties of stretcher blocks determined in accordance with ASTM Designation: C140-75.[3] Net moment of inertia was based on the average of measurements on three stretcher blocks taken at the thinnest point of face-shells. Modulus of rupture was determined from the ultimate load using net moment of inertia for a simply supported wall subjected to uniform loading.

Maximum measured loads from the three tests ranged from 233 to 251 psf. Modulus of rupture calculated from the measured loads ranged from 243 to 261 psi. Maximum measured transverse deflections during cyclic loading ranged from 0.015 to 0.03 in.

The condition of each specimen after testing is shown in Figs. 4 through 6. As indicated by the cracking pattern of tested specimens, the cracks at ultimate loads extended through blocks and mortar joints. Thus, wall capacity was not controlled by the strength of mortar joints. Generally, loss of load occurred when flexural strength of the wall cross section was exceeded in the middle half of the wall span. Flexural cracking in the mid-span region was observed only during the last load increment.

TABLE 2 - FLEXURAL STRENGTH OF TEST WALLS

Wall Designation	Wall Dimensions in.			Cross-Sectional Properties Per ft of Wall*				Ultimate Load W_u psf	Modulus of Rupture*** F_r psi
				Area $in.^2$		Moment of Inertia $in.^4$			
	Length	Height	Thickness	Gross	Net	Gross	Net**		
A-1	96.07	48.15	7.62	91.50	48.95	443	309	238	248
A-2	96.07	48.18	7.62	91.50	48.95	443	309	233	24[illegible]
A-3	96.11	48.27	7.62	91.50	48.95	443	309	251	261

*Measurements made on stretcher blocks.

**Based on measurements of min. face-shell thickness.

***Modulus of rupture $F_r = \frac{12 W_u L^2}{8S}$

where:

W_u = Ultimate load, psf

L = Effective wall span center to center of supports, ft (7.5 ft in this case)

S = Section modulus based on net cross section (81 $in.^3$ in this case)

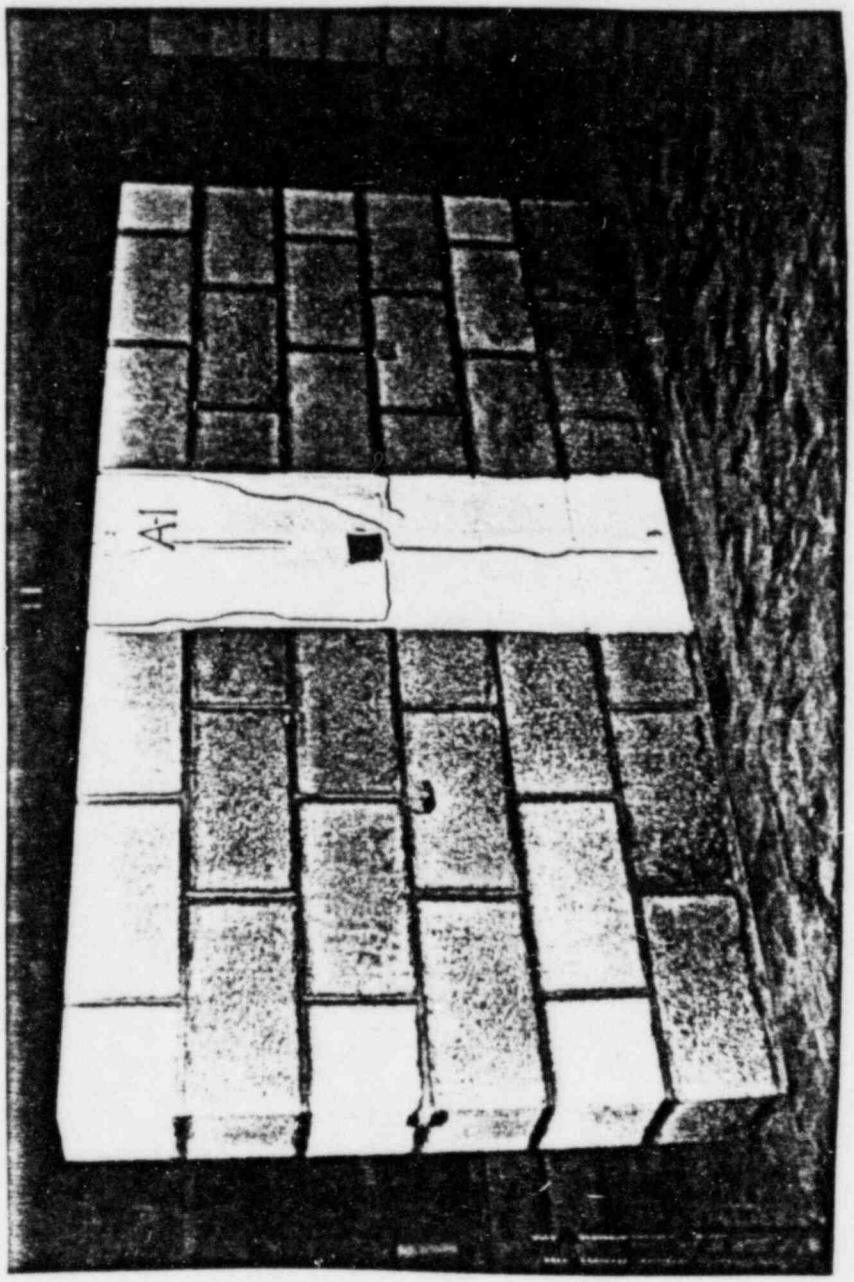


Fig. 4 Specimen A-1 After Test

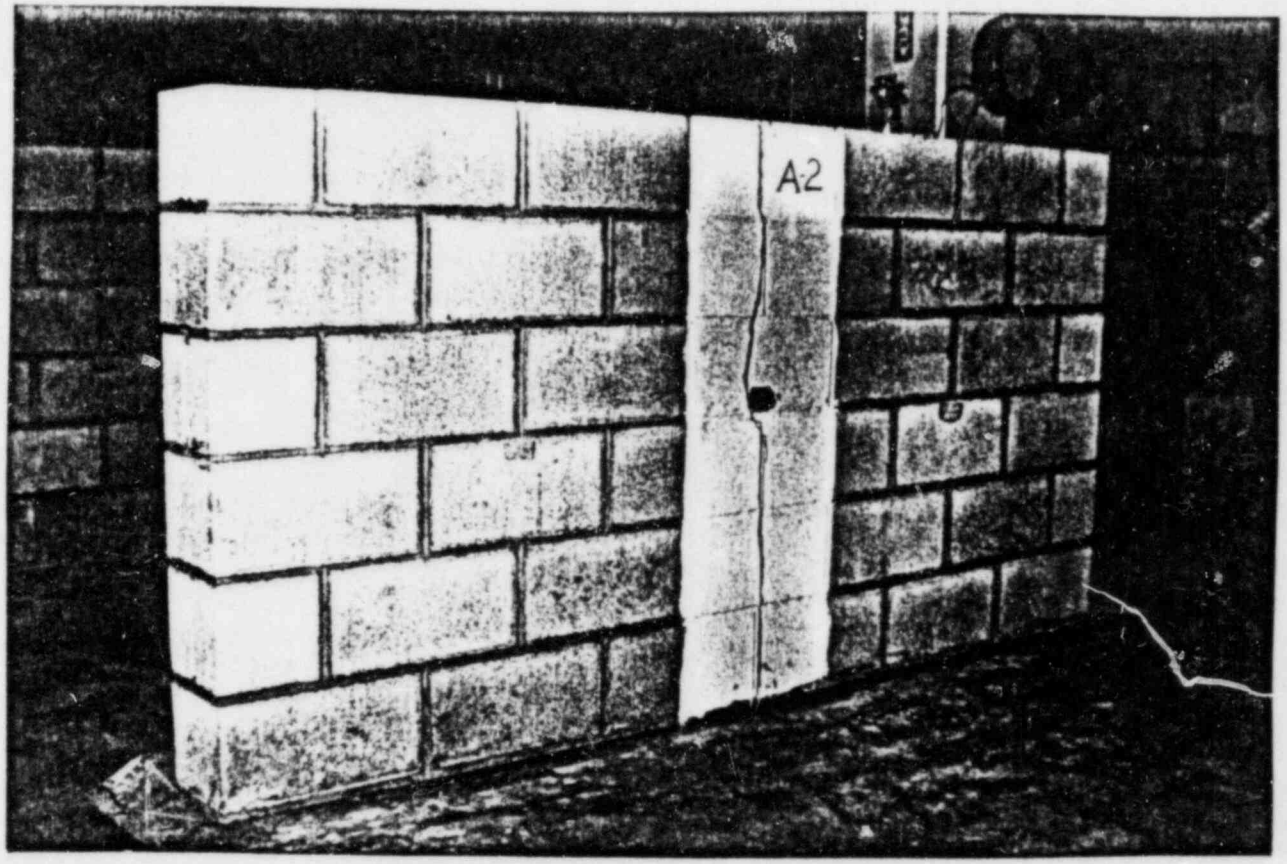


Fig. 5 Specimen A-2 After Test

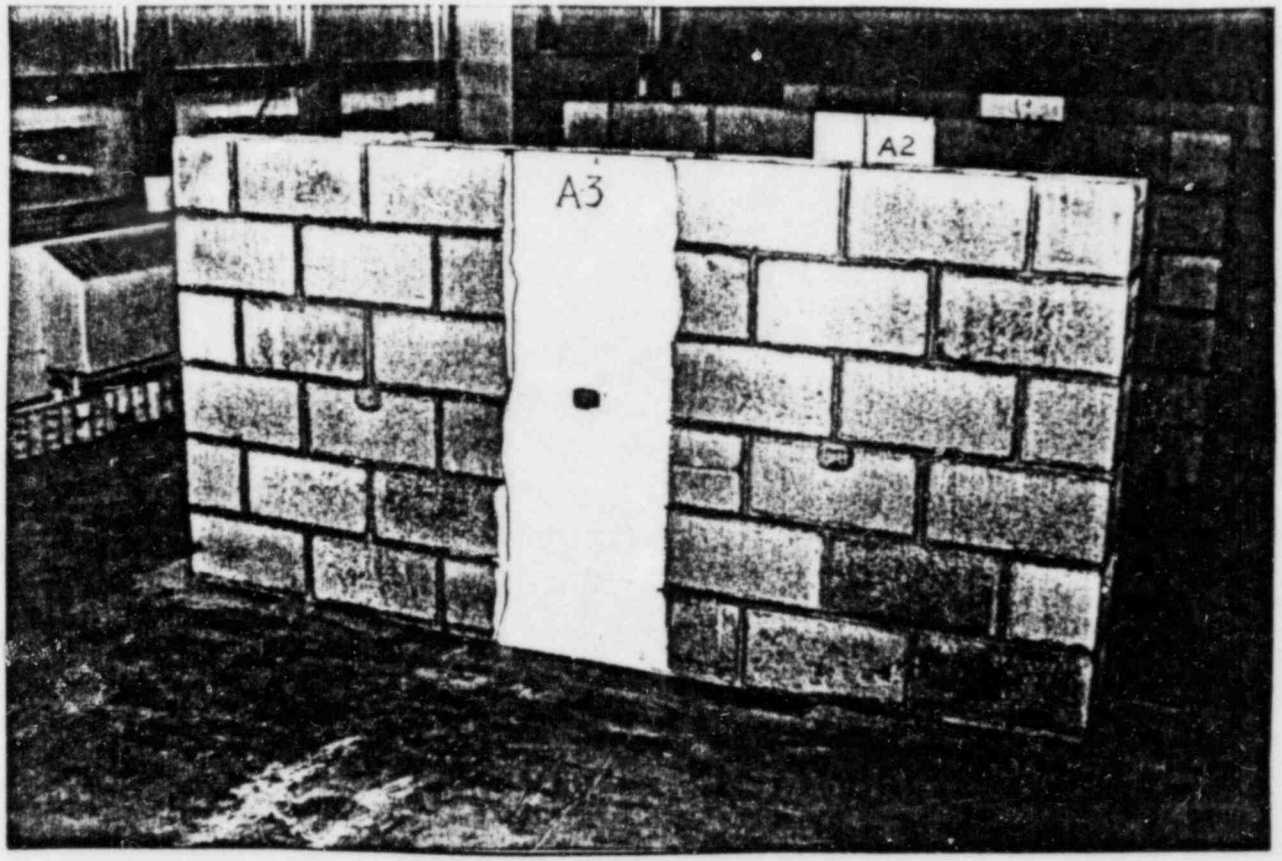


Fig. 6 Specimen A-3 After Test

SUMMARY AND CONCLUSIONS

Samples of 4x8-ft concrete masonry block walls were constructed and subjected to flexural load tests. The walls were constructed in running bond pattern, and tested in vertical position using an inflated plastic bag. Test procedures conformed to ASTM Designation: E72-80, "Standard Methods of Conducting Strength Tests of Panels for Building Construction,"[1] and the Illinois Power Company Test Specification entitled, "Static Testing of Concrete Masonry Walls for Transverse Flexural Strength for Clinton Unit #1."

Average of the maximum loads measured in three tests is 241 psf. This corresponds to a modulus of rupture of 251 psi. No significant cracking was observed prior to the final load stage.

Test results are summarized in Table 3.

TABLE 3 - SUMMARY OF TEST RESULTS

Wall Designation	Ultimate Load W_u psf	Modulus of Rupture F_r psi
A-1	238	248
A-2	233	243
A-3	251	261

REFERENCES

1. American Society for Testing and Materials, "Standard Methods of Conducting Strength Tests of Panels for Building Construction," ASTM Designation: E72-80.

2. American Society for Testing and Materials, "Standard Specification for Mortar for Unit Masonry," ASTM Designation: C270-82.

3. American Society for Testing and Materials, "Standard Methods of Sampling and Testing Concrete Masonry Units," ASTM Designation: C 140-75.

4. American Society for Testing and Materials, "Standard Specification for Hollow Load-Bearing Concrete Masonry Units," ASTM Designation: C90-75.