"Proposed Test of Oven Wall"

Report to Armstrong Cork Company

by

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II. General Outline

The purpose of this test would be to determine the resistance to uniform lateral loading of a typical masonry wall as used in the material processing ovens at the Armstrong Cork Company plant in Lancaster, Penna.

For convenience of testing and other practical reasons, the north wall of #51 oven would be used for the test. Three separate test sections would be isolated from the existing wall by the removal of a vertical strip of masonry at each side of the selected sections. Sufficient roof anchorage and the attachment of dead-weight to the header beam above each section would simulate the conditions imposed upon the wall of an internal oven during actual operation.

The recommended method of applying a load to the test sections would involve the use of balloon-filled loading chambers which would be erected in oven #51. Control of air pressure within the balloons would permit the incremental uniform lateral loading of the test section directly in front of each chamber.

Engineers of the Armstrong Cork Company are familiar with the structural requirements of the tests described in this proposal. The over-all plans have been discussed in several meetings with Lehigh University representatives, and a conference held at the Bureau of Standards on August 5, 1954 resulted in acceptance of the entire scheme, by all parties represented, as a valid method to determine the strength of a masonry wall.
Preparations of the test wall and construction of the loading chamber would be accomplished by the Armstrong Cork Company at a time most convenient to them. When this work is completed the testing operation would be completed by the Lehigh University group.

Instrument installations may be made by the engineers of Armstrong Cork Company in order to supplement that which is listed in this proposal. Additional deflection measurements at several different points on the wall may be desirable.

The first test should be made on the section near the west end of the oven. This section has a vertical chase throughout its height and may give some information as to the effects of sharp cross-sectional area reductions.

The testing would progress from west to east along the oven wall with approximately one day allowed between tests for the changing of loading and instrument equipment leads.

The Lehigh University group would submit a report covering the data collected during the tests.

II. Responsibilities of Armstrong Cork Co.

The Armstrong Cork Company would be responsible for the preparation of the test wall and the construction of the loading chamber and support structure.

They would furnish technical personnel to work with the Lehigh group during the test operation and provide operators for any additional instrumentation which they may desire to use.
They will supply all facilities listed under "Required Facilities", and also the materials listed as items A, B, C, D, H, I, J, K, L, M, U, and W from "List of Materials".

They would ship to Fritz Engineering Laboratory, Lehigh University, Bethlehem, Penna. one each of items A and B and 10 ft. each of items C, D, and U at least 30 days before the testing is to begin.

They would paint the outer surface of the test sections, install the transit deflection scales, attach the electrical deflection gage leads to the wall and place the balloon-protecting plastic sheets in the loading chamber as part of the wall preparation.

III. Responsibilities of Lehigh University Group

The Lehigh University group would be responsible for the testing operation, collection of data and a report of the results. They would supply consultant services as requested in the design and building of the support structures and actively participate in the installation of measurement and loading equipment.

During the testing operation, they would furnish the test director, load control operator, electrical deflection instrument operator and any other technical personnel requested by the Armstrong Cork Co. A minimum of four persons from Lehigh University would be required during the actual testing operation.
The following gages, instruments and materials would be supplied by the Fritz Engineering Laboratory at Lehigh University:

1. Items E, F, G, N, O, P, Q, R, S, T, and V from "List of Materials".
2. Equipment for installation, calibration and checking of electrical deflection and load measuring instruments.
3. Blank forms for data recordings.
4. Complete valve panel for the control of the compressed air volume in the loading chamber, (sketch sheet #2).
5. Any special fittings or materials which are not listed in "Responsibilities of Armstrong Cork Co."

IV. Personnel Requirements During Test

1. **Test director** - must be familiar with the entire test procedure. He would co-ordinate and control the testing operation and inform the loading control station each time a load increment is to be applied. Any change in the planned procedure would be cleared through him before it is put into operation.

2. **Load control operator** - must regulate the volume of air going into the loading chamber and maintain a constant pressure on the test wall during the intervals when static deflection measurements are taken.

3. **Deflection instrument operator** - to operate deflection measurement equipment. He should be familiar with the equipment and understand the electrical circuits in use.
4. **Two camera operators** - to operate motion picture cameras used to photograph collapse of wall.

5. **Transit instrument operator** - must observe deflections as indicated by scales attached to the surface of the outer wall.

6. **Wall observer** - must inspect outer wall surface for cracks or other damage during test. The white paint should simplify this job and a pair of binoculars would enable him to observe small crevices which may be the first indication of damage.

7. **Four data recorders** - to record data dictated by the equipment operators. Special data sheets would be prepared prior to the tests.

**V. Preparations for Test**

1. **Wall sections**
   
a. Three wall sections, 8 ft. wide, have been selected for testing. (Sketch sheet #4) These sections should be examined carefully to determine their general condition. Records should be made of cracks, curvature or lack of plumbness which may affect the strength of each section.

b. A 2 ft. wide strip of masonry must be removed from the remaining wall on each side of the test sections. The cut edges of the test sections must be smooth and their width must be 8 ft., plus or minus 1/2 in.

c. The outer side of each test section should be given a thick coating of white cement paint in order to provide contrast for photography and to enable observers to
locate cracks that may occur during the load application.

d. The loading chamber support structure should provide access for much of the work required on the wall sections, and the sequence of work performance should be planned to take full advantage of this condition.

2. Loading Chambers

a. The loading chambers and support frame should be constructed in accordance with, or similar to plans submitted and discussed at the August 5, 1954 meeting at the Bureau of Standards.

b. While the loading chambers are being constructed, it is important to provide attachments for wire deflection gages (sketch sheet #5), means for insertion of plastic sheet to protect balloons (sketch sheet #1) and access doors for the positioning of the balloons within the chamber (sketch sheet #1).

3. Load Control

a. The load control system should be assembled as shown, (sketch sheet #2) with the control valves and manometers located at the door of oven #51.

b. The balloons should be placed inside the chambers shortly before each test and after the air supply lines have been bled to eliminate any water caused by condensation.

4. Instrumentation

a. Scales for reading deflections on the outside of the oven wall (sketch sheet #3) should be attached while
the outside scaffolding is in place. The base line wire for use with the scales may be installed at any time prior to the test.

b. The wall attachment and lead wire for the electrical deflection gages (sketch sheet #5) must be installed as the loading chamber is erected. The resistance elements and electrical cables should be installed one day prior to the test.

c. All instrumentation and load control equipment should be installed and in operating condition at least six hours before testing is started.

d. Calibration of recording equipment, zero readings of transit measured deflections and positioning of cameras for photography will be accomplished in the six hours immediately proceeding each test.

VI. List of Materials

Loading System


B. Twelve (12) tube connectors, T shape, bore 5/16", for 1/2" tubing, catalog No. 82-210. Available from Burrell Corp., Fifth Avenue, Pittsburgh 19, Penna. at a cost of $.80 each.
C. 150 ft. of rubber tubing (pressure type) 1/2" bore, catalog No. 75-090. Available from Burrell Corporation at a cost of $0.30 per ft.

D. 200 ft. of rubber tubing (gum rubber) 1/2" bore, catalog No. 75-012. Available from Burrell Corporation at a cost of $0.35 per ft. (less 10% discount).

E. Eight (8) air-line adapters for filling balloons will be made to suit the balloon vents.

F. Two (2) 3/8" stop valves with adapter to fit the available compressed air supply line. (see sketch #2)

Measuring Equipment

G. Two (2) "U" tube water-air manometers with a measuring range of 30 in. Atmospheric differential type for use with water.

H. Electric clock with sweep second hand.

I. Robot camera for photographing periodic pressure-time readings.

Photography

J. Two (2) 16 mm motion picture cameras for photography of outer wall at 32 frames per second.

Deflection Measuring Equipment

K. Eighteen (18) flat scales 18 in. long with clearly marked 1/10 in. or 1/16 in. divisions. (1/10 in. preferred)

L. Eighteen (18) mounting brackets for attaching flat scales to brick wall.

M. Three hundred (300) feet of approximately #18 soft steel wire for use as base line for scale measurements.
N. One (1) transit instrument for observing deflection of test section in relation to the remaining wall.
O. Six (6) resistance type deflection gages with 18 in. of travel.
P. One (1) switch box, non-shorting rotary, 10 position, 4 pole.
Q. Two (2) strain indicators (Baldwin SR-4).
R. Two (2) Brush Recorders with amplifiers.
S. One (1) Oscilloscope (Dumont 304-A).
T. Thirty (30) ft. of 1/4" diameter aviation shock cord.
U. Eight hundred (800) ft. of 4 conductor electrical cable.
V. One or two pair of binoculars for use in observing cracks in surface of wall during tests.
W. Three hundred and fifty (350) ft. of thin plastic sheeting 10 ft. wide for use in loading chamber.

VII. Required Facilities

1. Constant supply of compressed air at door of #51 oven. A minimum pressure of 30 lbs. per sq. in. in a 1/4" I.D. line or 50 lbs. per sq. in. in a 1/8" I.D. line is required to provide sufficient volume. The air line should terminate with a flexible rubber hose ending with a 3/8" threaded male pipe fitting.

2. Reliable supply of 110 volt A.C. power fused for 20 to 30 Amps. This power would be used for instruments located near the door of #51 oven. At least six standard plug-in receptacles should be available.

3. Power for cameras used to photograph the outer wall should be provided if they are not the spring wound type.
4. Two or three sturdy desks or tables would be required to support the load control and instrumentation equipment located at the door to #51 oven.

5. Sufficient lighting for good visibility in the test control area. Also, any additional lighting required for use with the Robot camera in photographing the manometer readings.

6. An electric horn or bell mounted in a position to be audible to the personnel operating the transit instrument and outside cameras. This signal device would be operated by a push-button switch at the load control table.

VIII. Test Sequence

Before the test is started, the test director should check the readiness of all personnel involved in the operation. If everyone is ready, the order would be given to start the test.

1. Zero load —
   a. Take manometer readings (should be zero).
   b. Take scale deflection measurements.
   c. Take electrical deflection readings on SR-4 indicators.
   d. At this time a ten second run of movies should be made with each camera to show the normal condition of the wall.
   e. Check by test director to make sure all data has been taken.

2. First increment —
   a. Sound two blasts on horn to indicate start of loading.
   b. Switch electrical deflection gages from SR-4 indicators to chart recorders.
c. Increase pressure in loading chamber by 2.6 lbs. per sq. ft. which would be indicated by a differential of 1/2" on the manometer. Wait until pressure is stable.

d. Sound one blast on horn to indicate that deflection measurements may be taken.

e. Photograph manometer reading with Robot camera and record reading on data sheet.

f. Switch electrical deflection gages from chart recorder to SR-4 indicators and take readings.

g. Take scale deflection measurements.

h. Inspect wall for signs of cracks or other damage. Photograph any significant changes.

i. Test director checks for completion of data recordings.

3. Second increment——

a. Sound two blasts on horn.—

Repeat first increment procedure until wall is destroyed.

If, at any time, the electrical deflection recorder or the manometer indicates that the wall is starting to collapse, a series of short blasts on the horn will warn the photographers to start the cameras.
BALLOON ARRANGEMENT IN LOADING CHAMBER

Position of access doors in rear of loading chamber for insertion of balloons.

View of access hole from outside of loading chamber.

Canvas hinge

Cross-section of rear wall of loading chamber showing door on inside with canvas hinge at top.

Test section of wall

Plan view showing position of protective plastic sheet.

Balloon connection

Access door

3/4" plywood
AIR SUPPLY AND CONTROL SYSTEM

AIR LOADING SYSTEM
AND PRESSURE MEASURING
DEVICES

Bleeder Valve

Air Supply

Stop Valve

Manometers (30" range)

Timing Clock (for photography)

1/2" i.d. pressure tubing

1/4" i.d. gum rubber tubing

Plywood chamber wall
Bushings or pipe sleeve
Rubber bands

Washer
Nut
Air line

3/8" pipe nipple

Air line connection to balloons

3/8" control valves
And fittings

Wood base board
TRANSIT MEASURED DEFLECTIONS DETAILS

Sheet #3

BASE LINE WIRE

18" long scales facing base line wire

TEST SECTION

WIRE SUPPORT BRACKET

18" scale at 1/4, 1/2, and 3/4 points

TEST SECTION OF WALL

No. 18 wires

14"

TENSION SPRING

SCALE AND BASE WIRE ARRANGEMENT

BRACKET DETAIL

ATTACHMENT DETAIL

Note: Scales are to be attached to face of test wall approximately 6" from each edge. They should be located at the 1/4, 1/2, and 3/4 points on the vertical wall.
RESISTANCE DEFLECTION GAGES

VIEW LOOKING DOWN ON CHAMBER

ATTACH TO WALL

TENSION

ATTACH WIRE HERE

TEST SECTION OF BRICK WALL

PLASTIC SHEET

LOADING CHAMBER

1/2" HOLE THROUGH PLYWOOD

1/4" I.D. FLEXIBLE CONDUIT

NO. 18 STEEL WIRE

POSITION OF GAGE ATTACHMENT WIRES

NOTE: FOUR GAGES ARE TO BE INSTALLED, TWO ON EACH SIDE OF THE TEST SECTION AT THE 1/3 AND 2/3 POINTS.

BRIDGE TYPE WIRING CIRCUIT

STRAIN INDICATOR

SWITCH BOX

CHART RECORDER

AMPLIFIER
12" I BEAMS - 318 IB.

DEAD-WEIGHT TO SIMULATE LOADED OVEN SHOULD BE APPLIED AT THIS POINT - USING STEEL CABLE EXTENDING TO FLOOR.

HEADER BEAMS SHOULD BE FASTENED ACROSS TWO ADJOINING OVENS.

1/2" CLEARANCE TO SUPPORT ROOF SECTION WHEN WALL COLLAPSES.
Sheet # 7

DEAD-WEIGHT ARRANGEMENT

ATTACH HEADERS OVER TWO ADJOINING Ovens

PROVIDE BEARING PLATE AND ANCHORAGE FOR SUPPORT BEAM

DEAD-WEIGHT LOAD
Loading System

Sheet #8

Compressed Air

Stop Valve

Bleed-Off Valve

Oil Manometers

Meteorological Balloons

Cloth Compartment Separators

Total Compartment Volume = 11,000 cu. ft.