THYOFLEX AIR BARRIER SYSTEM FOR MASONRY WALLS

Prepared for:

Canada Mortgage and Housing Corporation
Project Implementation Division
682 Montreal Road
Ottawa, Ontario
K1A 0P7

Prepared by:

Morrison Hershfield Limited

FOR:

Mr. J.S. Poupore, B.Sc.
1406-111 Wurtemburg St.
Ottawa, Ontario K1N 8M1

October 30, 1990

This project was carried out with the assistance of a grant from Canada Mortgage and Housing Corporation under the terms of the Housing Technology Incentives Program (HTIP). The views expressed are those of the author and do not represent the official views of the Corporation.

Morrison Hershfield Limited
Consulting Engineers

REPORT

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Presented to:

Mr. J. S. Poupore, B.Sc.

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Ottawa, Ontario
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1980 Merivale Road, Nepean, Ontario, Canada K2G 1G4, Telephone (613) 727-9802, Fax (613) 727-8165

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1. INTRODUCTION

Rain penetration through walls, icicles on claddings, frozen pipes in soffits, cold rooms, low humidity in winter, condensation in wall and roof cavities, corrosion of cladding components are symptoms of exterior cladding and wall performance problems occurring more and more frequently on newer buildings. Many of these deficiencies have been traced through investigation and research to uncontrolled air leakage through the building envelope and specifically the absence or defective air barrier system.

For air to leak through a building envelope, it must be under air pressure difference. The air pressure difference across the building envelope can be induced by a phenomenon known as stack effect, by fan pressurization resulting from operation of ventilation equipment, and also from wind effect.

Wind effects are perhaps the most critical because of the large pressure differences that can occur from time to time. Wind tends to cause an increased pressure on the windward side and a reduced pressure on the leeward and other sides. Generally a flat roof will experience suction pressures as well. The magnitude of these pressures vary with wind speeds and gusting but the design wind load may be as high as 1 to 1.5 kPa pressure and with gusting 2.0 - 2.5 kPa in some parts of Canada.

To control unwanted air leakage, one has to either remove the difference in air pressure or air seal all openings in the building envelope. Thus, the general solution to controlling the air leakage phenomenon rests with the air sealing of the building envelope to contain the air within the building. In a building envelope, this means *a set of components linked together in a continuous fashion within the walls, windows and roof of the building envelope as well as the below grade construction to resist the passage of air and to transfer the air pressure loads to the primary structure of the building. The set of components intended to perform this task is called the air barrier system.*

Morrison Hershfield Ltd. was retained by Mr. John Poupore to conduct air leakage and structural loading tests on a masonry coating (and accessory products) for use in the construction of an air barrier system. The authorization to conduct these tests was provided by Mr. Poupore on July 12, 1990.

The testing was carried out on this system on October 15, 1990, at Morrison Hershfield's Built Environment Research and Development Laboratory in Ottawa, Ontario. The tests were conducted by Michael A. Scott, B.Sc., C.E.T., and Michael C. McKay. Air leakage tests were observed by Mr. Poupore.

2. OBJECTIVES

The objectives of this project was to determine if the Thyoflex system could provide the air barrier resistance recommended by IRC/NRC of 0.1 $l/s\text{-}m^2$ at service load of 75 Pa, and to determine if the system could withstand both positive and negative pressure loading of 1000 Pa for one hour, and 2500 Pa for 10 seconds.

3. TEST CHAMBER DESCRIPTION

The test chamber was constructed on September 4, 1990. The chamber was constructed of 200mm lightweight concrete block with overall dimensions shown in Figure 1. The 'L' shaped chamber consists of five outside corners, one inside corner, four 25mm wide gaps, (top to bottom), a roughed-in window frame (400mm by 600mm), a wall with brick ties protruding, and a wall with a 45mm OD PVC pipe projection (See Figure 1). The top and bottom of the chamber consisted of plywood covered with 24 gauge satin coat steel sheet. The top and bottom sheets were clamped to the chamber walls with threaded rod. (See Photos 1 and 2).

The total wall area was measured to be 6.78 m^2, not including the top and base of the chamber, which is considered impermeable.

4. THYOFLEX SYSTEM DESCRIPTION

The air barrier system as tested consists of Morton International's Thiokol MC 2027 Masonry Coating, in conjunction with Thiokol 2157 joint sealant. Thiokol MC 2027 is a single component water based polysulfide coating. Thiokol 2157 is a non-sag water dispersion elastomeric caulking. Caulking in the 25mm gaps was backed by doubled 1/2" closed cell backing rod. The caulking was applied to joints and gaps in the test chamber and allowed to form a skin, (approximately 30 min.), before application of the coating.

The caulking and base coat for this series of tests was applied by Paul H. Anderson, a chemist for Morton International's Specialty Chemicals Group, on October 2, 1990. A second coat was applied by Mr. Anderson the following day. (See Photos 3 and 4). Application was by brush and roller, applied to an average wet coat thickness of 30 mils. Some caulking that sagged in the 25mm gaps was touched up at this time as well, (see photo 5). The coating was allowed to dry for 12 days before testing.

5. INSTRUMENTATION

Air pressure was applied to the chamber interior volume through the PVC pipe by the use of an Airstream suction/blower pump. Air pressure was monitored by an Air Ltd. micromanometer, model MP6KD. Air flow was measured by a volumetric bubble meter with 0.5 litre graduations. The flow meter was set between the pump and the pressure chamber to measure incoming air at determined pressure levels. Timing of the soap film movement in the flowmeter was measured by two independent observers.

6. TEST PROCEDURES

Tests were conducted in general accordance with the methods outlined in ASTM E 283, "Standard Test Method for Rate of Air Leakage Through Exterior Windows, Curtain Walls and Doors", and ASTM E 330, "Standard Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Differences".

Before the application of the Thyoflex system, air flow measurements at 75 Pa were obtained on the masonry chamber, with joints and gaps taped with duct tape. The Thyoflex system was later applied and allowed to cure.

For the test of the air barrier system, an initial positive (exfiltration from chamber) air flow rate was established. A pressure of 1000 Pa was then applied for a one hour period, with a flow rate taken after a relaxation period. This procedure was then repeated for negative pressures.

For the structural loading tests, base level air flow measurements were taken between application of peak pressures of +/- 1500 Pa, +/- 2000 Pa, and +/- 2500 Pa.

7. TEST RESULTS

With duct tape applied to the joints and gaps of the chamber without the coating, a flow rate of 3.45 l/s at 75 Pa was determined. This converts to 0.55 $l/s\text{-}m^2$ for the masonry chamber without air barrier system applied.

Within days of the application of the second coat of the membrane, small tension cracks appeared in the coat on top of the caulking. (See Photo 6). These cracks initially lengthened upon application of air pressure, but did not appreciatively lengthen during or after the round of tests. No other anomalies in the coating or caulking appeared during the curing period.

Flow rates were very small at 75 Pa. The flow rate was well below the suggested limit of 0.1 $l/s\text{-}m^2$. Even at 800 Pa the flow rate through the system was only 0.02 $l/s\text{-}m^2$. No obvious leakage paths were found.

Flow rates measured at the beginning and the end of the hour long application of 1000 Pa were identical at approximately 0.021 $l/s\text{-}m^2$. No noticeable gain in air leakage rate was observed after the relaxation periods of 10 minutes each, both for the positive and negative pressures.

For the structural load tests, a reference level of +/- 400 Pa was used to review air leakage rates before and after the pressure loads were applied. This level was arbitrarily chosen because the air tightness of the chamber made air flow rates at lower pressures difficult to measure. No increase in leakage rates throughout these tests were observed.

8. DISCUSSION

To design an air barrier system for any building envelope, there are four principal requirements to consider: continuity and position in envelope, structural support and load transfer, properties of materials (air permeability) and the service environment or durability.

The air barrier system must be designed to support short duration high air pressure loads (hourly design wind loads) that may occur from wind and wind gust. An air barrier system must also be designed to resist and to transfer weak but sustained air pressures induced by stack effect or fan pressurization over periods of weeks and months without failing through creep and delamination. It must be designed to withstand these loads with minimal deflections so as not to displace other components, while at the same time be made durable especially if these sub-systems are deep within the construction of exterior wall or roof system.

The need to address the incorporation of air barrier design in Canadian buildings is mandated by the National Building Code of Canada (NBC). The first specific reference to air leakage control in new building design and construction was in the 1980 issue of the NBC. The 1980 and specifically the 1990 NBC now requires the industry *"...to provide an effective barrier to air exfiltration and infiltration..."*. The requirements are addressed in Section 5.3, subsection 5.3.1 "Air Barriers" of the NBC.

The NBC has been adopted by federal government agencies for applicability to their building projects. All of the Canadian provinces and the two territories have adopted this code for their jurisdictions, either in whole or in part. This code requires building designers and constructors to include certain requirements with respect to air and moisture movement through wall and roof building enclosure materials and assemblies.

The maximum permissible leakage through a conventional curtain wall has been set by the AAMA standards and is 0.3 $l/m^2 \cdot s$ at 75 Pa. While allowable leakage rates for air barrier systems is not specified by applicable building codes, a standard of 0.1 $l/s\text{-}m^2$ at 75 Pa is suggested in the 1986 Building Science Insight, of the National Research Council of Canada, 'An Air Barrier for the Building Envelope'.

Therefore, in the design of an air barrier system for any type of exterior wall, roof or window system, materials selected for the air leakage control function should exhibit a leakage rate that is less than 0.1 $l/m^2 \cdot s$.

To comply with the airtightness requirements of NBC 5.3.1, the following testing requirements should be considered.

Performance test results must be established for the air permeance and the structural capacity of the selected air barrier materials to restrict air leakage and to carry the specified pressure load. Where a design of any part of the air barrier system is deemed by the designer to be sufficiently unique that it will involve non-standard construction techniques, laboratory tests shall be conducted to establish the airtightness performance of this component of the building envelope system. These performance tests shall be conducted on full-scale specimens constructed in the laboratory using the materials and design specified in the contract documents. The test procedures shall conform with the requirements of ASTM Standards E283-84 and E330-84. All laboratory testing of components of the air barrier system shall be conducted prior to the commencement of construction of the envelope in the building. Components which do not meet the performance requirements for the air barrier system shall be redesigned and retested.

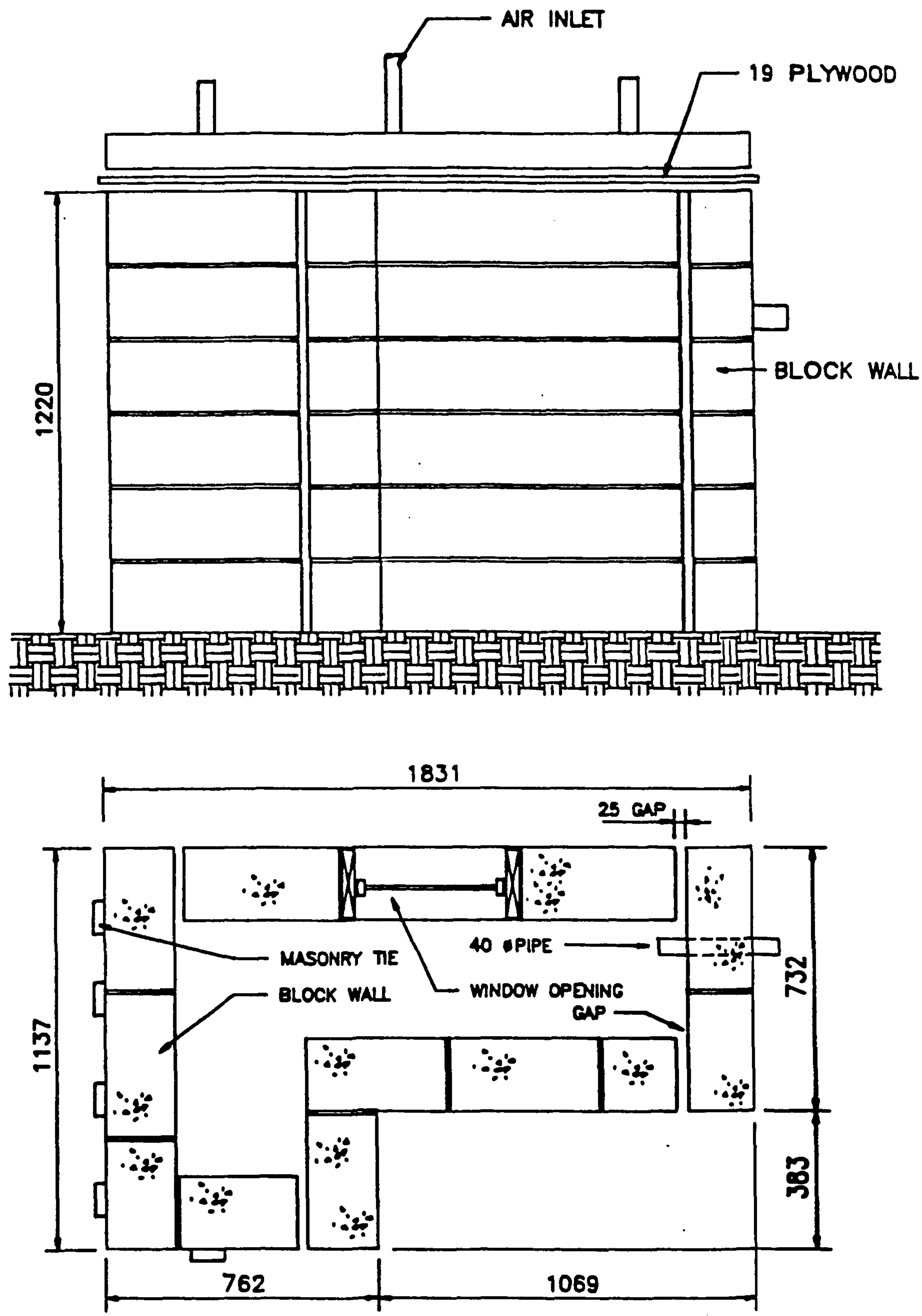
9. CONCLUSIONS

The air flow reading at 75 Pa obtained during tests of the Thyoflex system is well below the suggested Canadian standard for allowable leakage rate of 0.1 $l/s\text{-}m^2$. The Thyoflex system is therefore deemed suitable as an air barrier system provided it has the required durability and appropriate measures are taken to insure continuous application of the material.

MORRISON HERSHFIELD LIMITED

Michael A. Scott, B.Sc., C.E.T.
Technical Resources Manager

Richard L. Quirouette, B.Arch., OAA
Principal
Building Science Services



Morrison Hershfield Limited
Consulting Engineers

DESIGNED: R.L.Q.
DRAWN : W.R.S.
PROJ. ENG.:
APPROVED:

MASONRY TEST CHAMBER

DRAWING No.: 1

SCALE: N.T.S.
DATE: JUNE 1990

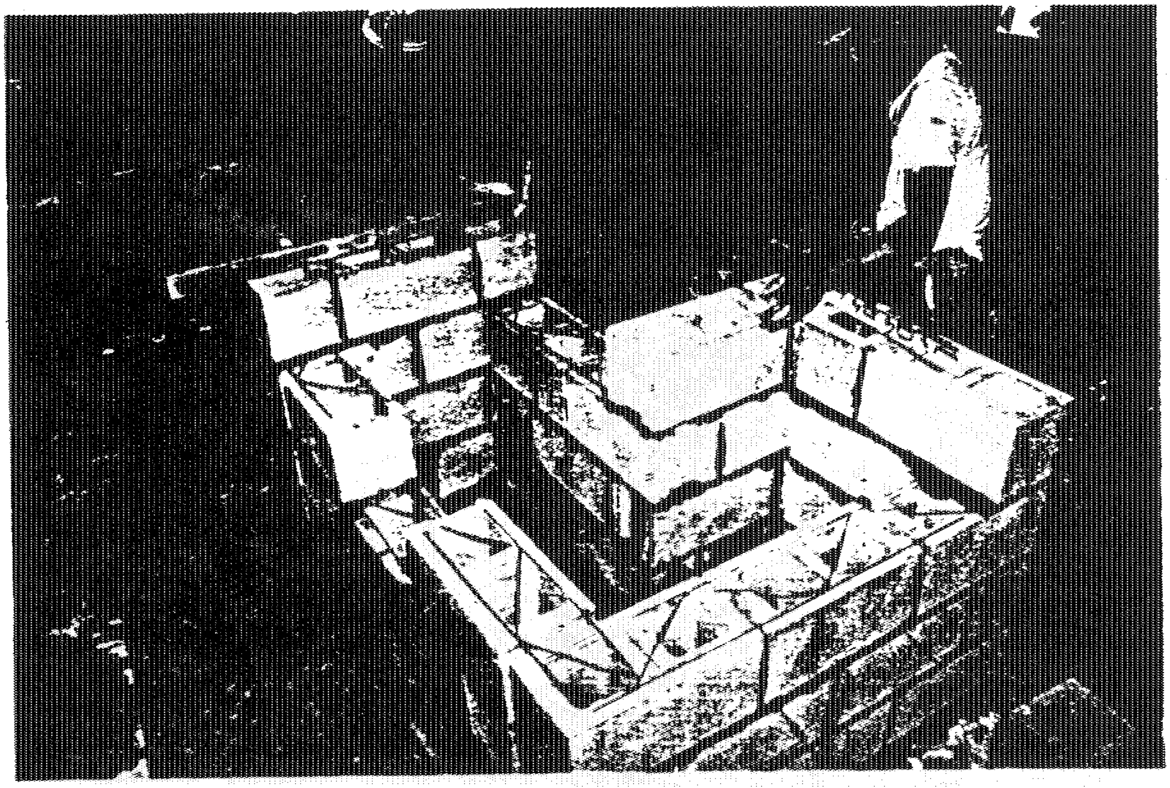


Photo 1
Construction of Test Chamber.

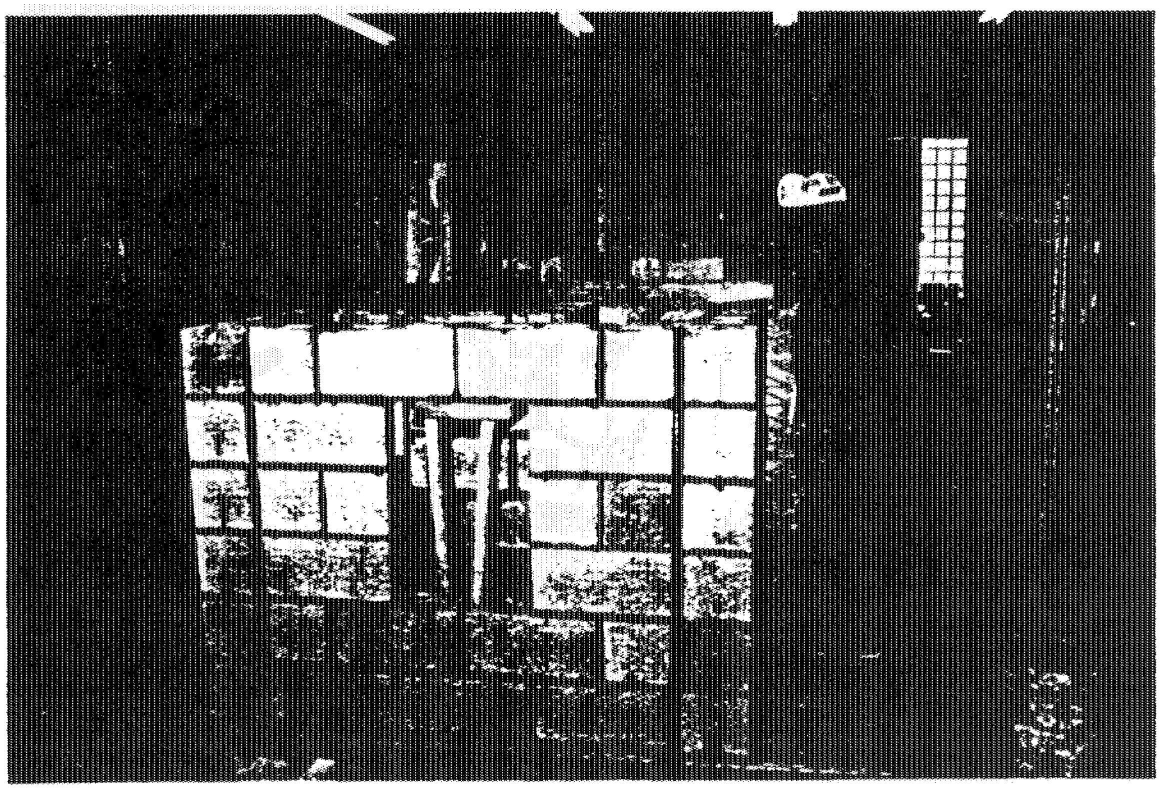


Photo 2
Construction of Test Chamber.

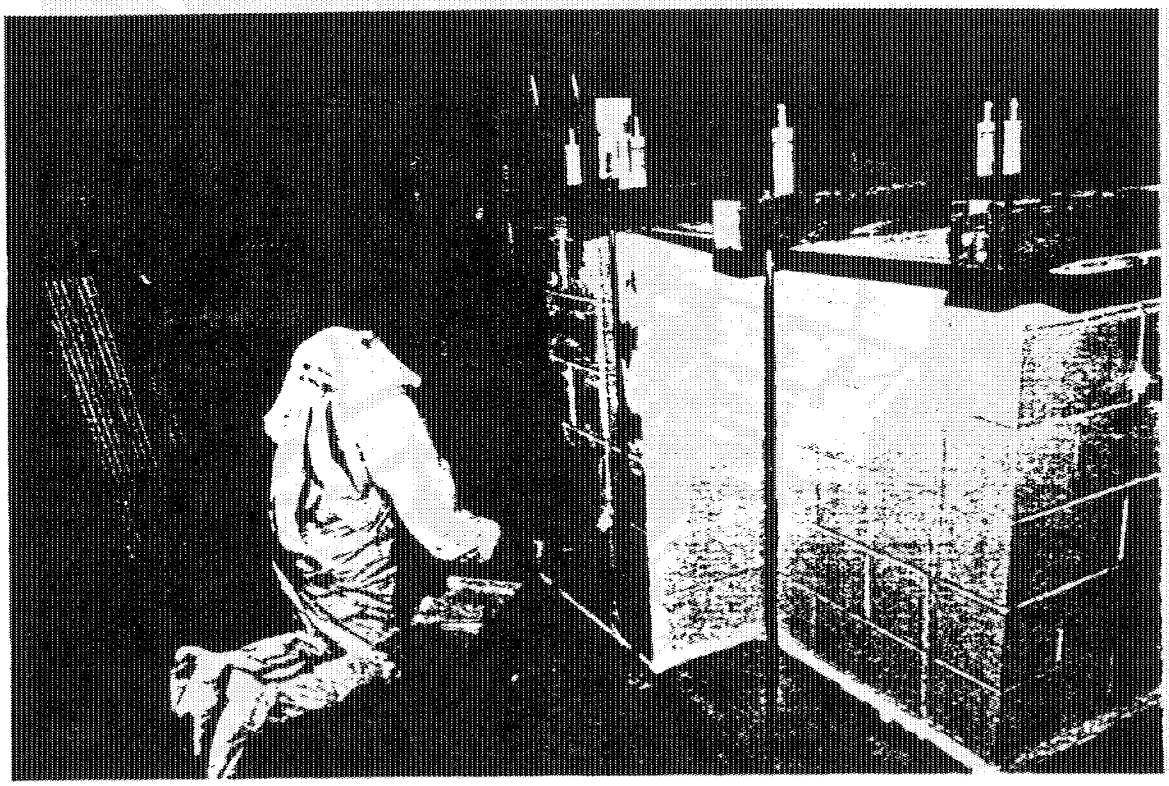


Photo 3
Application of Membrane over Caulking in Gap.

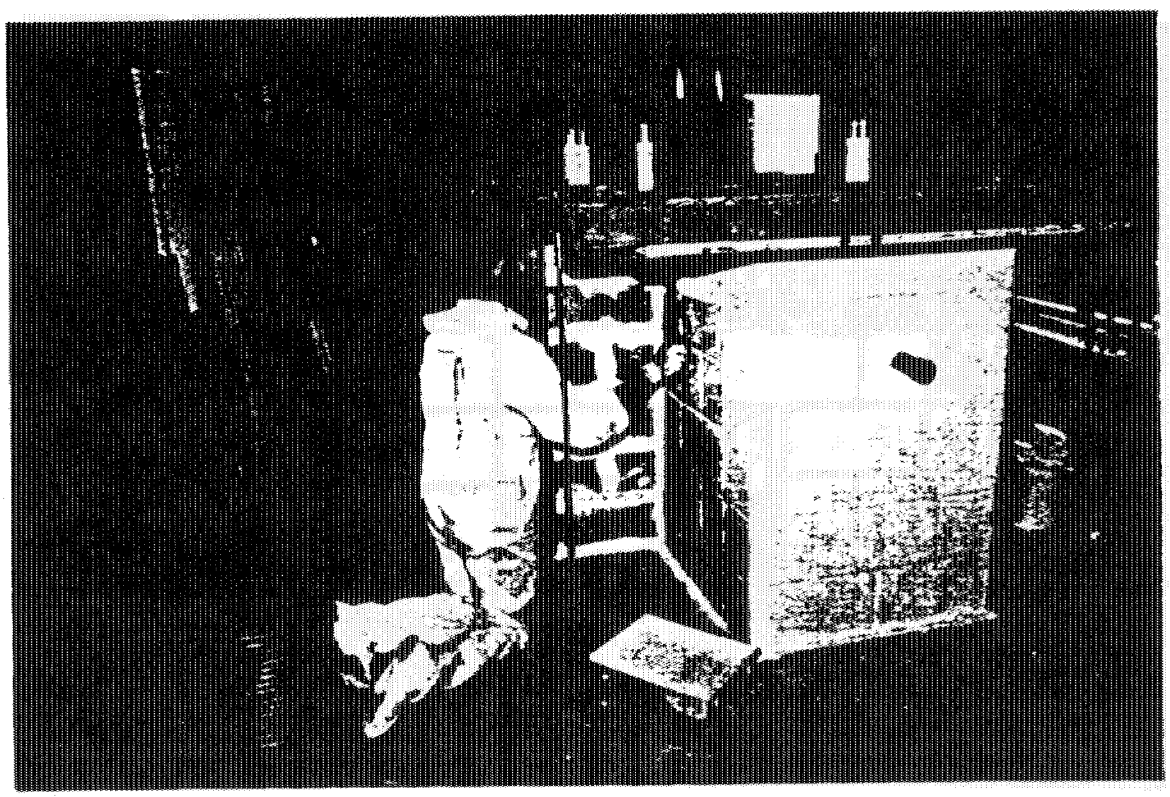


Photo 4
Application of Membrane by Roller.

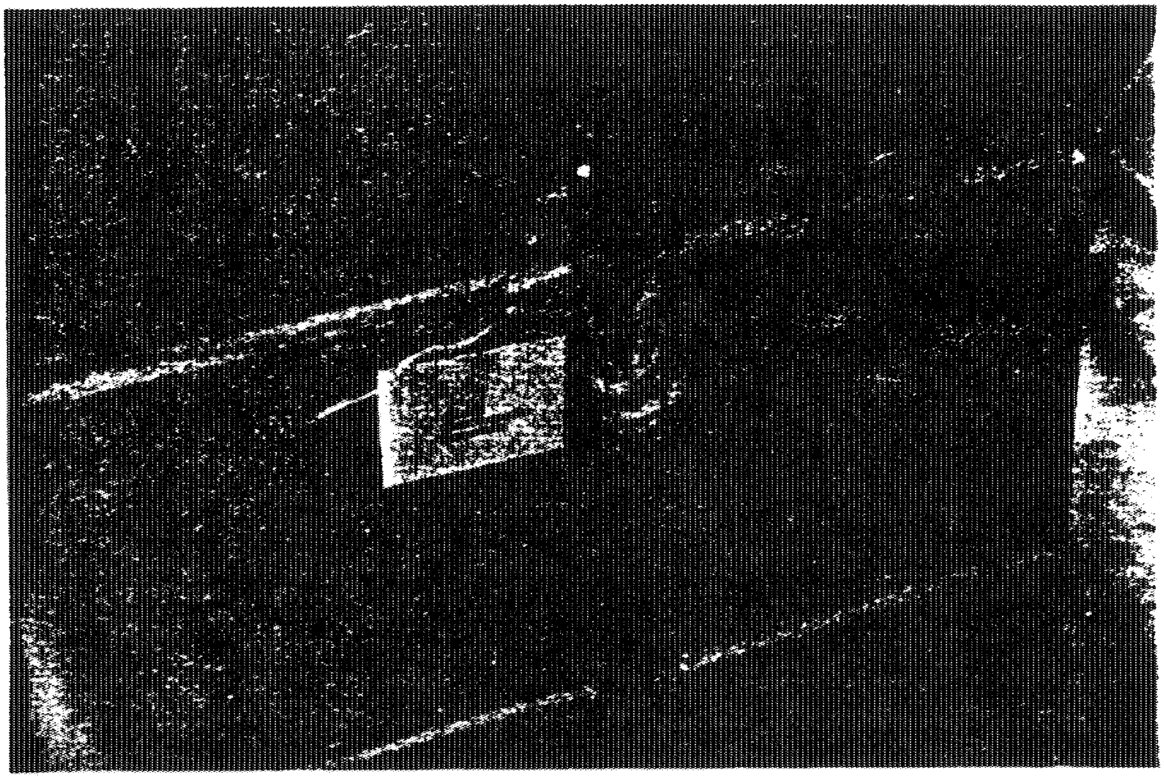


Photo 5
Sagging of Caulking in Gap.

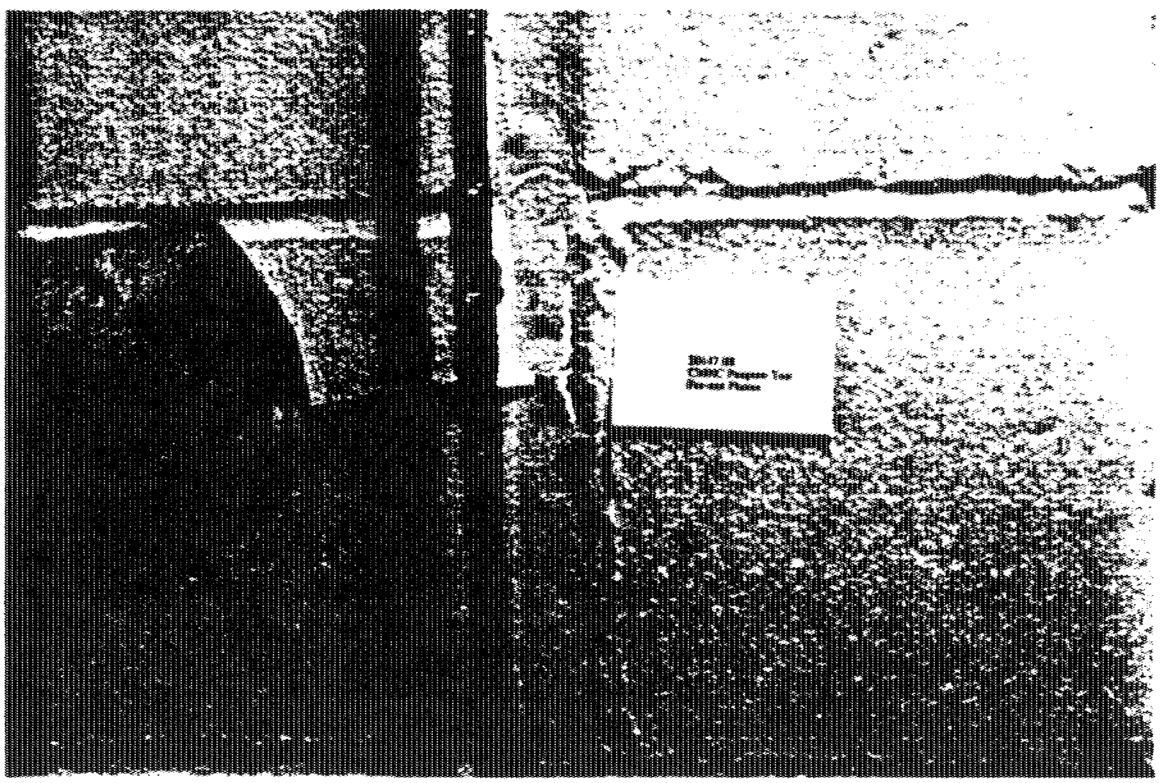


Photo 6
Crack in Caulking due to Curing.