Résumé of DBR Unit Masonry Studies (May 1957 - April 1958)

Gibbons, E. V.

Technical Note (National Research Council of Canada. Division of Building Research), 1958-06-01

Sent by RFL

NATIONAL RESEARCH COUNCIL OF CANADA

DIVISION OF BUILDING RESEARCH

No. 249

TECHNICAL NOTE

NOT FOR PUBLICATION — FOR INTERNAL USE

PREPARED BY E.V. Gibbons — CHECKED BY — APPROVED BY NBH

PREPARED FOR The members of the CIB Working Group on Rain Penetration. — DATE June 1958

SUBJECT Résumé of DBR Unit Masonry Studies (May 1957 - April 1958)

At the last meeting of the CIB (International Council for Building Research Studies and Documentation) Working Group on Rain Penetration held in Paris in May, 1957 commitments for further study were undertaken by a number of those present. Since then, inquiries have been received from different members of the Group concerning their particular study. This Note has been prepared for circulation to the members to report on work either completed or in progress by this Division since the distribution of DBR Internal Report No. 123, Studies by the Division of Building Research Related to Rain Penetration, at the last meeting.

Rain Penetration of Unit Masonry

The results of tests on the 27 large masonry panels constructed with different types of mortar and brick combinations were reported in DBR Internal Report No. 108, Preliminary Tests of the Rain Resistance of Brickwork Panels. Since completion of these tests the panels have been exposed to outdoor weathering for approximately 1½ years. Retesting of these panels is now in progress by means of the masonry panel leakage apparatus (DBR Internal Report No. 85, Design of a Masonry Leakage Test Apparatus). Completion of this work is anticipated within the next two months. The results obtained will be compiled into report form for comparison with results obtained initially when tested under identical conditions, 30 to 40 days after construction.

Since a number of these panels remain to be retested only a preliminary statement can be made at this time with regard to their leakage properties. In general, the clay brick panels have shown a small increase in resistance to leakage in most instances. Not much change was measured with the two concrete panels retested; one was slightly better and one slightly poorer.

The size of the panels for the tests just referred to is approximately $3\frac{1}{2}$ by $4\frac{1}{2}$ ft (1 by 1.5 metres). This size of panel presents a number of problems with regard handling, storage, laboratory time in testing a large number of individual bricks and cost of materials and fabrication. In addition such a large assembly is difficult to make for experimental purposes without variations over the panel which may affect leakage. Although more typical of actual masonry much work during the past year has been done in developing the use of small masonry panels.

The small panels measure 8 inches (20.3 cm) in width or one brick length and $11\frac{1}{2}$ inches (29.2 cm) high. Each consists of five bricks and four mortar joints in stack bond. To determine the resistance to leakage of panels constructed with different brick and mortar combinations, a small leakage testing apparatus is used. This is a scaled-down model of that used for the large panel and permits the tesing to be done under the same conditions of simulated wind-driven rain.

In fabrication of the small panels for test, special emphasis is placed in determining those physical properties of the brick and mortar, as well as those details of laying up the units, that will have a bearing on its resistance to leakage. Such properties as total absorption and rate of water absorption of the brick, workability and water retentivity of the mortar and time of placing the brick after laying the mortar bed are believed to be of particular importance. Care is also taken in tamping the top four bricks in place by control of the pressure exerted in each operation. The technique of preparing the panels has progressed to the stage where results are sufficiently reproducible to allow assessment of the particular factors under study. They are made in duplicate in a room conditioned at 73°F (22.8°C) and 50 per cent R.H. One panel is used for determining leakage resistance and its duplicate is used for measuring the strength of bond of the brick and mortar joint.

The bond strength is measured in tension. Apparatus has been designed, adaptable to a tensile testing machine, which holds the test panel in place and enables individual bond strength measurements to be made at each joint of the five-brick assembly. A limited number of tests have been made to date. The values of bond strength obtained are considerably lower than anticipated particularly with straight lime mortars, aged 30 days. The work has not progressed far enough to state what correlation, if any, may be expected between bond strength and leakage.

Cold Weather Masonry Studies

Building regulations in Canada in general require that "when the temperature of the surrounding atmosphere is 40°F (4.4°C) or lower, mortar and masonry materials shall be maintained

at a temperature of not less than 40°F (4.4°C) during laying and for at least 48 hours after laying". (National Building Code (1951), Section 4.4, p.11).

A very limited number of masonry failures have been brought to the attention of the Division of Building Research which could be attributed to inadequate protection during cold weather. In instances reported when failure had occurred data on the extremes of temperature were either meagre or lacking. There are, however, a number of buildings which were constructed during cold weather and for which no special protection was provided other than using heated materials during the laying operation. Visual examination of this masonry does not reveal any unusual weaknesses. Studies have therefore been undertaken to determine if existing regulations are too stringent and what precautions are sufficient for cold weather masonry construction.

No laboratory work on this study has as yet commenced. Facilities to enable work to be done has included the construction of a cold room, 8 by 11 by 9 feet (2.4 m. x 3.3 m. x 2.7 m.) inside dimensions. Refrigeration has been provided to maintain -10°F (-23.3°C) and with sufficient capacity for a rapid pull-down from above freezing to well below freezing conditions. Studies will be started in the near future to determine what degradation is caused with varying amounts of protection on different brick and mortar combinations.

Masonry Cement Standards

The use of masonry cements in Canada has increased considerably in recent years. Specifications covering both a high strength and a low strength type have been developed by the Canadian Standards Association with staff of the Division assisting on the Committee work. A specification has been published for the high-strength masonry cement which in most cases is an interground mixture of portland cement and limestone. Delay in having the low strength material specification made available has been due, in part, to lack of agreement within the committee on limits which should be set for the autoclave-expansion test. This type is usually a blend of a hydrated dolomitic lime and portland cement with a filler.

Mortars using each of these types are included in the masonry panel leakage program.

Waterproofers

Studies relating to the effectiveness of surface and integral waterproofers have of necessity been limited during the past year. Correspondingly studies of a fundamental nature on moisture migration have been curtailed due to lack of staff. Publications covering recent work and mentioned in DBR Report No. 123 are now available as reprints.

Participation by way of round robin tests in the work of Subcommittee V of ASTM Committee C-15 has continued. This preliminary series of tests was undertaken to determine the effectiveness of different types of silicone coatings in reducing the absorption of water by bricks with different absorption characteristics. Further work on the effect of silicones and other waterproofers applied to panels and tested under simulated wind-driven rain is under study. Eventually it is hoped that a method may be developed which will be applicable for testing leakage resistance of masonry panels when treated with different types of surface waterproofing.

Moisture Evaporation

A Technical Note No. 246, Evaporation Measurements in Canada, was prepared by D.W. Boyd on evaporation measurements presently being made in Canada and was reported to the last meeting. There have been no further developments on these activities. The Division has however recognized the importance of evaporation as a means by which heat may be lost from building surfaces and from the ground. A survey of rates of evaporation is presently being made to assist in assessing the magnitude of the effect of evaporation in heat losses from both buildings and from the ground. If these are found to be of considerable importance further work on evaporation in this connection may be undertaken.