DBR studies on unit masonry (May 1958 to July 1959)

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SUBJECT DBR STUDIES ON UNIT MASONRY - (May 1958 to July 1959)

The Division of Building Research has not always found it possible to send representatives to the meetings of the CIB Working Group on Rain Penetration on which it holds membership, but has attempted to report progress through Notes such as this to all meetings not attended. In May 1958, Technical Note No. 249 (1) was circulated to members of the Working Group. A short description was given of the work of the Division related to rain penetration since the Paris meeting in 1957. This present Note has been prepared to supplement the information given at that time and to inform the members of rain penetration studies carried on and other project work of special interest during the past year.

In the previous Note reference was made to DBR Internal Report No. 108 (2), which presented the initial results of rain penetration tests on 27 large masonry panels. These panels had been constructed with different types of brick and mortar combinations and tested when about six weeks old. The panels have now been retested after a minimum of 1 1/2 years of outdoor weathering. A report is being prepared in which a comparison is made of the information obtained at the two different times of test. The results indicate that those panels constructed with bricks of low initial rates of absorption (IRA, 3-9), and which showed little or no leakage initially, continued to have high resistance to leakage after two years of weathering. This was true of panels constructed with either a high proportion of cement or a high proportion of lime in the mortar mix. The test panels made with intermediate IRA bricks (15-19), and which showed some leakage initially, were found to have their resistance to leakage considerably improved after weathering. This too applied to panels made with either a high cement or high lime type of mortar.

A few panels which had been constructed with intermediate IRA bricks and a 1:2:9 mortar, and panels made with high IRA bricks with a high cement mortar, were subjected to five cycles

of wetting and drying after the weathering period. In each instance leakage was reduced to negligible quantities despite appreciable leakage when they were first tested.

Silicone was applied after the initial leakage tests to a concrete brick panel and to a pressed brick panel. The time for water to appear on the back side of the panel increased considerably in each instance over the time required for the panels when untreated. It was observed, however, that with a prolonged simulated wind-driven rain condition little improvement in the rate of leakage resulted.

The small panel leakage testing apparatus, described in DBR Internal Report No. 160 (3), has been used to study the influence of silicone pretreatment and wetting of bricks on moisture penetration of brick masonry. Many Canadian bricks are high in suction, and are therefore difficult to bond with mortar. Moisture can usually penetrate the brick-mortar interface readily. One of the three U.S.A. producers of silicones has promoted the treatment of bricks with water-soluble silicone (at the plant) in order to eliminate brickwork staining and efflorescence. Such a treatment reduces the brick suction and therefore was considered worth investigating as a means of improving bond between brick and mortar and so enhancing the resistance of the brickwork to moisture penetration. Soaking of bricks has long been recognized as being useful for improving bond, but in Canadian practice it is rarely done and may have some disadvantages.

Thirty-two small panels of the five-brick type used in previous studies were constructed of two types of bricks (both high suction) and two mortars (1:3 masonry cement: sand and 1:2:9 portland cement:lime:sand, relatively low and moderately high in water retentivity, respectively). Each brick was used in 4 conditions: (1) dry, (2) soaked 10 minutes, (3) treated with a relatively light application of water-soluble silicone, and (4) treated with a heavier application of silicone. After 14 days of curing, the panels were tested by water spray on the surface and an air pressure difference across the panel. Records were kept of the time for dampness to reach the back of the panel, the rate of leakage, and the total leakage in 24 hours of test.

The silicone pretreated bricks (condition 4, above) produced panels highly superior to the others in resistance to moisture penetration. Soaking the bricks improved the tightness of the panel also, compared with bricks used dry, but the improvement was much less than that obtained from the silicone pretreatment. The bricks with a light application of silicone (condition 3) produced panels which were generally inferior to

those of soaked bricks. It was concluded that water-soluble silicone pretreatment, which reduced brick suction to a low value, was very beneficial to the bonding of mortar to brick with regard to resistance to moisture penetration.

Several panels were exposed outdoors over one winter. It was observed that those in which silicone pretreated bricks had been used presented a much cleaner appearance, those of untreated bricks being stained by salts. None of the panels showed signs of damage from weathering.

Studies of the influence of soaking and silicone pretreatment of bricks on the strength of bond between brick and mortar have been started, but insufficient information has been obtained to draw conclusions.

Rain penetration studies at the Division's regional station at Halifax have constituted the major laboratory activity there during the past year. Extensive use has been made of the small panel leakage apparatus in investigating the performance of the local materials available in this maritime area. The results of a preliminary program involving some 25 small panels have been described in DBR Internal Report No. 161 (4). Since then further studies have been undertaken to determine the effect of such factors as (a) time interval between laying a mortar bed and placing the second brick in it, (b) the pressure applied to the brick after it has been placed, (c) flow properties of the mortar. This work will be reported in detail later, but in general it was observed that bond strength and resistance to leakage decreased when the time interval for (a) above was over 30 seconds. Increased pressure (heavy tap) gave better value for bond as did higher flow mortars. Some work is in progress to determine the effect of tooling the joints.

The effect of loss of moisture from mortars upon contact with bricks of various suctions has been given in DBR Internal Report No. 173 (5). This work was undertaken to investigate if the loss of moisture from the mortar bed to the lower brick would affect the ultimate bond of the top brick. From this study it was concluded that "A substantial reduction in the moisture content of a mortar takes place upon contact with bricks, and this reduction increases as the suction of the brick increases. Greatest moisture loss takes place during the initial stage of contact; and during this time, with bricks of high suction, moisture losses are sufficient to lower plasticity of the mortar to a point where it is not capable of good bonding with another brick."

COLD WEATHER MASONRY STUDIES

Reference was made in Technical Note No. 249 of the plans of the Division to study the effect of laying-up unit masonry in cold weather conditions. During the past year the construction of a cold room, designed for these purposes, was completed, and some laboratory work was undertaken. Preliminary studies were started to determine the cube crushing strength of frozen fresh mortar and the bond strength between bricks and frozen fresh mortars. The work has been extended to study the performance of various mortars with low IRA suction bricks. These studies were undertaken about seven months ago, and it is too soon as yet to show trends or draw tentative conclusions.

MASONRY CEMENT STANDARDS

Increased use of masonry cements continues in Canada. During the year committee work has been undertaken on the development of a standard for a high lime masonry cement. Field studies have been planned to observe the performance in buildings of this and other mortar materials over a period of years. Studies of the autoclave expansion test as applied to the high lime masonry cement have been started.

MOISTURE EVAPORATION

Studies were started to determine the heat transfer coefficients from an open water surface during the winter months. This work is being done by the Snow and Ice Section of the Division by means of a tank 9 feet in diameter and 1 foot in depth, exposed to the natural weather conditions. Observations to date indicate that a good correlation exists between the rate of heat loss from the water surface and the difference between the hourly mean scl air temperature and hourly mean surface water temperature.

MOISTURE MEASUREMENT

Methods for measuring the moisture content of soils in situ have been a continuing study of the Soil Mechanics Section of the Division. The proceedings of the Conference on Building Research 1953, contains a paper entitled "The Measurement of Moisture Content" (6). The paper outlines some of the problems in measuring moisture and describes a number of methods proposed.

More recently a neutron moisture meter has been constructed for measuring the moisture content of soil. As yet only limited use has been made of this instrument, but Technical Note No. 269 may be of interest since it assesses materials which might be used in the calibration of this type of meter.

Instrumentation has been developed which enables the length of time of wetness to be measured on an exposed metal surface. This work was undertaken as part of the studies of ASTM Committee B-3 on Corrosion of Non-Ferrous Metals. The sensitivity of the instrument permits traces of moisture as with a light dew or snow at low temperatures to be detected and be differentiated from moisture due to a heavy rain. A progress report in which the measuring device is described appears in ASTM Bulletin No. 228, February 1958 (7).

Two brick masonry test huts were constructed in 1954 by the Building Services Section. One of the huts was insulated, the other uninsulated. The temperatures through the bricks of the walls facing the four principal directions have been recorded continuously since the huts were put into operation. An analysis of these temperature cycles is now in progress and will provide information on freeze-thaw cycling in these walls. Rainfall measurements have been continued by means of NRC rain cups on each wall of the test huts as well as total rainfall by the directional rain gauge.

A start has been made on the development of a test method and design of equipment for the measurement of rain leakage and air infiltration of windows. This work is of special interest to ASTM Committee E-6 on Methods of Testing Building Constructions.

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