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NATIONAL RESEARCH COUNCIL OF CANADA

DIVISION OF BUILDING RESEARCH

No.

405

TECHNICAL NOTE

PREPARED BY T. Ritchie

CHECKED BY P. J. S.

APPROVED BY N. B. H.

DATE October 1963

PREPARED FOR Members of the Joint RILEM/CIB Commission on Mortar and Renderings

SUBJECT DBR Studies of Masonry Mortars

✓ PJS

The Division of Building Research of the National Research Council of Canada was appointed to membership in the Joint RILEM/CIB Commission on Mortar and Renderings in September 1962. This Note has been prepared for the meeting of the Commission to be held in Paris in October 1963, to inform members of the Commission of the interest of the Division of Building Research in certain problems of masonry mortars and to report the results of the Division's investigations. Copies of papers and reports dealing with these studies are submitted with this Note.

INFLUENCE OF MORTAR PROPERTIES ON RAIN PENETRATION AND BOND STRENGTH OF MASONRY

An important problem which sometimes arises with masonry buildings is rain penetration of the walls, and this problem has been under study in the Division for several years. Various factors which influence the resistance of masonry to rain penetration have been studied. It is well known from the extensive literature on the problem that mortar properties are important and the Division's studies have naturally included consideration of the influence of the composition and properties of mortars on the performance of masonry. In conjunction with laboratory studies of moisture penetration of masonry, studies of the strength of bond between bricks and mortar have also been made.

The interaction between brick and mortar when they are first assembled into masonry influences the nature of the bond which

develops between them and this ultimately governs the strength and "tightness" of brickwork. A study has been made of the changes which take place in freshly laid mortar because of the loss of water to the brick on which it is placed; this loss of moisture leads to a decrease in the ability of the mortar to establish a close bond with the brick laid in the mortar bed. This study has been described in a paper of the Division (1).

Properties of masonry mortars which are of particular interest in regard to the strength and "tightness" of brickwork are the water retention value, wetness (flow) when used, and the pore structure, especially that which results from air entrainment in the mortar. The importance of these factors has been confirmed by the results of laboratory tests made in the Division of Building Research. The results of some of these studies have been given in a recent paper (2) of the American Society for Testing and Materials. In this paper it is shown that the fluidity or wetness of mortar when used (as measured by the ASTM flow table) has an important influence on the properties of brickwork. As the flow of mortar is increased (over the range 100 to 140 per cent) the strength of bond increases and at the same time the resistance to moisture penetration also increases. The water retention value of mortar is also shown in the paper to have important effects on the properties of the masonry. Experiments were made on retempering of mortar after standing for various periods of time following mixing and these tests indicated that retempering of mortar has an influence on the "tightness" and strength of the masonry.

Experiments have been made on the effect on strength of bond by varying the air content of mortar. The results confirm the findings reported by other laboratories that in general increasing the air content of mortar results in decreased bond strength.

WORKING PROPERTIES OF MORTARS

The studies of workability of mortar which have been reported to the Commission by various European members have been examined with much interest in the Division of Building Research and some of the methods used by these laboratories have been applied. Investigations are being made of the relationships for various compositions of mortars between flow value, dropping ball penetration, density, etc.; water retention values as determined by the dropping ball method are being compared with water retention values obtained by the ASTM (flow table) method.

DIMENSIONAL CHANGES OF MORTARS

The influence of mortar on the dimensional changes of brick masonry is under study in the Division. Some of this work has been undertaken in connection with the use of magnesian limes in mortar and the question of the volume stability of such mortars. The results of early experiments on this subject have been published (3).

Further studies have been made on the effect of restraining forces on the amount of expansion of mortars (4). In this work mortars were used which expand a considerable amount when subjected to the autoclave test, which is a standard test method used in North America for assessing the soundness of certain mortar materials. Mortar bars of various materials have been prepared and have been autoclaved, some free to expand, others restrained during autoclaving by spring-applied forces. It has been found that relatively small restraining forces are capable of greatly reducing the amount of expansion of the mortars.

Volume changes of mortars during setting and in the first 24 hours after mixing are also being studied, using samples of mortar sealed in a rubber membrane then placed in a dilatometer. The pattern of behaviour of the mortars studied in this way is for slight expansion to take place in the first 15 to 45 minutes after the mortar has been mixed. This expansion is then followed by shrinkage, which continues for the 24 hours of test, but 20 per cent of the shrinkage takes place in the first 2 hours.

Many outdoor test samples of brickwork in the form of piers have been erected, and are being used for measurements of dimensional changes. Samples of the individual materials, bricks and bars of mortar, used in the piers, are also being measured for change of dimension, under various controlled conditions of exposure.

ASTM CO-OPERATIVE TEST WORK

The Division of Building Research is represented on the ASTM Committee on masonry mortars. This Committee currently is carrying out studies directed toward the development of tests of mortar for workability and for the production of efflorescence. The Division is assisting in this work and has taken part in several co-operative test programs of the ASTM Committee.

CONCLUSION

This Note has outlined the interest of the Division of Building Research in certain problems of masonry mortars. A brief description of some of the laboratory studies on mortar undertaken in the Division has been given. The work of the RILEM/CIB Commission is being followed with great interest, particularly since the Division is also participating in the work of the ASTM Committee on masonry mortar. The Division is therefore favoured by its liaison with these two important research groups. It is hoped that the Division may be able to make useful contributions to the studies of the RILEM/CIB Commission.

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