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DIVISION OF BUILDING RESEARCH

REPORT ON ROCKWOOD COURT APARTMENTS

SAINT JOHN, N. B.

by

D.C. Tibbetts

Atlantic Regional Station, Halifax

(Prepared for the Central Mortgage and Housing Corporation)

Report No. 97

of the

Division of Building Research

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PREFACE

The Division of Building Research is privileged to serve as the research wing on all technical housing problems to Central Mortgage and Housing Corporation. As a part of this service to the Corporation, field studies are carried out when necessary into building problems which evidence themselves in housing developments of the Corporation.

This report describes one such investigation carried out in Saint John, New Brunswick. As is always the case, these field studies yield much useful information and experience, quite apart from providing the Division with some opportunity of assisting the Corporation in their important work.

Attention may be drawn to the fact that this is the first report to be produced by a member of the D.B.R. staff in the new regional station of the Division at Halifax. This Atlantic Regional Station has been set up to serve the building industry in the four Atlantic provinces. The staff there are co-operating closely with the Halifax Regional Office of C.M.H.C. It is to be expected that this is but the first of a series of such reports of mutual interest to the Division and the Corporation.

Ottawa
September, 1956

R.F. Legget,
Director.

REPORT ON ROCKWOOD COURT APARTMENTS

SAINT JOHN, N. B.

by

D.C. Tibbetts

In July, 1955, the Division was requested by Central Mortgage and Housing Corporation to make an examination of damaged brickwork of the apartment buildings in the Rockwood Court Development in Saint John, N.B. Earlier in the summer a survey of the damage was made by an engineer of C.M.H.C., and it was decided by C.M.H.C. that some repairs would be necessary before winter.

Repairs had been made annually since the completion of the buildings in 1949 and, although failures had been recurring since that date, the cause of failure was not known. Before further repairs of a permanent nature were made, it was desirable that the cause of failure be established.

The Division was asked to assist in this aspect of the problem and to suggest what remedial measures should be taken. The author of this report visited the site on July 25th and 26th, 1955 and made a detailed examination of the exteriors of the buildings following preliminary discussions with officials of the C.M.H.C. Regional Office in Halifax, N.S.

Location

The apartments are located in the northeast section of the City. They are bounded on the southeast by the C.N.R. Saint John/Moncton main line and shunting yards, and on the north by Rockwood Park. The C.N.R. yards serve an industrial area immediately east of the project. There are thirty-two buildings in the development.

History

The following data regarding construction, maintenance and repairs were obtained from the Halifax office of C.M.H.C.:

(1) Contract for construction awarded March 15, 1948 to the Acme Construction Company of Saint John. The project was completed October 11, 1949;

(2) Contract for repointing awarded September 13, 1951 to Maritime Waterproofers Ltd., Saint John. Repointing work was completed July 31, 1952;

(3) Contract for reroofing awarded August 15, 1952 to the Annapolis Valley Construction Co., Truro, N.S. Reroofing was completed November 13, 1952;

(4) Numerous cracks were repaired and a bulge in Building No. 25 removed and repaired in the summer of 1953. This work was completed by Maritime Waterproofers Ltd. in October, 1953. The caulking compound used was Bulcatex;

(5) Repairs to the wood sills of all windows were made during the summer of 1954. Shrinkage and subsequent movement of the frames had caused the sills to tip inwards;

(6) Some additional caulking of cracks with Bulcatex was done in 1954.

Type of Construction

The buildings are three-storey wood frame with brick veneer. Because of the platform method of framing, there are 54 inches of end-grain wood in the height of the buildings making possible a total shrinkage at 5 per cent moisture content of 2¾ inches. The buildings originally had flat roofs. Chipman brick was used for the veneer on all buildings. The new roofs are sloped and are vented at the eave line. The spaces between joists above the third-storey ceiling are insulated.

Openings made in the walls (Fig. 1) indicate that the sheathing paper was properly applied and is in good condition. Masonry ties are at proper intervals and are free from corrosion. There is an excessive amount of mortar droppings between the veneer and sheathing at the corners. It is not known if this is general throughout the walls.

Windows are wood frame and have been caulked with a mastic-type compound.

Foundations are cast-in-place concrete throughout with stepped footings as required by topography. There is no flashing or weep holes at the top of the foundations.

Types and Locations of Cracks in Brickwork

The following summary has been compiled from Table I:

(1) Twenty-seven buildings have cracks at the reveals;

(2) Twenty-eight buildings have diagonal cracks either front or rear;

(3) Five buildings have diagonal cracks in front only;

(4) Fifteen buildings have diagonal cracks in rear only;

(5) Eight buildings have diagonal cracks both front and rear;

(6) Fourteen buildings have severe cracks in one form or another;

(7) Nine buildings have vertical cracks at reveals (Fig. 2) that extend from top of foundation walls to roofs. These are all rated severe because of their length as opposed to width of crack. The width of cracks vary from hairline to 1/16 inch;

(8) Almost without exception there are no cracks in the brickwork of end walls. There is an instance or two where diagonal cracks occur at corners but these are a continuation of larger diagonal cracks in side walls (Fig. 3). There are no openings or projections in these walls.

Buildings in Relatively Good Condition

The survey indicates that there are twelve buildings that could be more readily repaired than the remainder. The numbers of these buildings are as follows:

Buildings Nos. 6, 10, 11, 12, 14, 16, 19, 20, 23, 24, 25, and 28.

Foundation Walls

All foundation walls have cracks in one form or another. All end foundation walls have vertical cracks from brickwork to grade and probably to the footings. These cracks are the same width all the way down and appear to be due to concrete shrinkage rather than to structural movement. The end walls are approximately 26 feet long as compared to approximately 70 feet for the side walls.

Foundation cracks are common at the junction of buildings. These are particularly noticeable where there is a difference in elevation of two adjoining foundations and are usually accompanied by diagonal cracks in the supported brickwork (Figs. 4, 5 and 6).

The most general, and certainly the most peculiar type of cracking, occurs near the top of the foundation walls at end corners and at corners of reveals. These cracks are typical of those shown in Fig. 7, and appear to be caused by expansion of the supported masonry. There is no vertical movement of these corners and it is unlikely that cracking is due to the weight of the brickwork.

Buildings with Special Foundation Conditions

(1) Buildings Nos. 17 and 18 have severe diagonal cracks at the rear corners and have severe vertical cracks at reveals. These two buildings are separated only by a fire wall. The diagonal cracking is more severe in these two buildings than in others (Figs. 8 and 9).

Samples of bricks and mortar were taken from Building No. 17 for examination in the laboratory. Lot No. 1 was taken from the right rear corner (Fig. 1) and Lot No. 2 from R_1 R_2.

These buildings are founded on bed-rock at the centre and soil at either end. This condition is thought to contribute to the severity of the cracking due to consolidation of the base material at the ends with no movement at the centre.

(2) Buildings Nos. 29 and 30 are known to be founded on bed-rock throughout. It is interesting to note that diagonal cracking at the rear of these two buildings is of a minor nature. Vertical cracking at reveals, however, ranges from moderate to severe in keeping with this type of cracking throughout the project.

The Boiler House

This building shows little evidence of the cracking in the brickwork common to the apartment buildings. Cracks in some foundation corners do resemble those of the other buildings (Figs. 10 and 11). This is a one-storey building of concrete block faced with brick. There are several large vertical cracks on the interior surface of the blocks.

The boiler house has not been repointed and from its appearance it probably takes in considerable water from wind-driven rain. There would, however, be some outward movement of moisture due to the high temperatures maintained on the inside.

The foundation cracks would indicate expansion (Fig. 10); however, it is possible that there has not been enough drying-shrinkage to cause cracking of the brickwork.

The Heating Tunnels

Arrangement of the heating tunnels was noted as a means of determining whether or not a pattern of cracking could be attributed to their location. The tunnels, paralleling buildings, use the foundation walls as one wall of their enclosure. It was thought that the heat loss from these tunnels may have had some effect on soil shrinkage at the building footings.

The following data does not support this theory:

Number of Tunnels Paralleling Buildings		Location and Number of Diagonal Cracks	
Front	Rear	Front	Rear
13		7	8
	15	5	13

Some tunnels run to corners or ends of buildings.

Repairs

All buildings except the boiler house have been reroofed and repointed. Both repair jobs were necessary because of excessive leakage through roofs and walls. Leakage was extensive enough previous to repairs as to cause loss of revenue from rentals. This was particularly true of basement apartments. Each repair job was reportedly well done and particular reference is made here to the excellent appearance of the repointing work. If repointing had not been done the existing cracking would probably be more extensive than it is.

The possibility exists that since the repointing was done, less water is entering most of the wall area than before and the walls have dried out considerably. While this drying out may have contributed to the cracking due to drying-shrinkage, it is believed that benefits will result when future repairs are made as expansion will be reduced.

If repointing had not been done, the walls could not have dried out under Saint John climatic conditions and extensive annual repairs both inside and outside due to leakage would no doubt be necessary. Because of the "dishing" of the original roofs and the amount of leakage through them, the reroofing job was well advised. Wherever possible it is suggested that pitched or flat-pitched roofs with as much eave overhang as possible be provided in the Atlantic Provinces.

Data From Original Specifications

(1) Section 3-Concrete and Masonry:

(a) Cement. - All cement shall be best quality Canadian portland cement or high early strength portland cement.

(As it turned out some foreign cements had to be used because of the shortage of Canadian cements.)

(b) Sand. - All sand shall be clean, coarse and sharp, and free from dirt, dust, loam, vegetable or other foreign matter. Sand for exterior face brick and for pointing of face joints shall be clear, sharp grey sand. All aggregate shall be stored on site as to prevent admixture of foreign matter.

(c) Broken stone. - Broken stone shall be clean, crushed rock, durable and hard, free from loam, clay, dust or shale, and graded as to size for various parts of works as hereafter specified.

(d) Lime. - Lime shall be best quality, freshly burned and of approved brand, and shall be stored under cover. No air-slaked lime shall be used.

(h) Brick. - Brick, where called for, shall be new red stock brick, or wire cut, standard size, hard burned, sound and true for face brickwork.

(i) Gravel. - Gravel to be washed and to pass a $1\frac{1}{2}$-inch screen for plain concrete and $\frac{3}{4}$-inch screen for reinforced concrete.

(j) Lime Mortar. - Lime mortar shall be composed of one part lime, to three parts of clean, sharp sand.

(k) Cement Mortar. - Cement mortar shall be composed of one part portland cement, three parts of clean, sharp sand, mixed dry, wet to the proper consistency, and used immediately.

(l) Lime and Cement Mortar. - Lime and cement mortar shall be composed of one part lime, one part cement and six parts clean, sharp sand, the mixture to be used immediately.

Concrete. - Concrete shall be mixed in proportions to develop the following strength:

Plain concrete work for foundations, basements, floors, areaways, etc., to develop a strength of 2000 lb. in 28 days.

Weeping Tile. - Furnish and lay around the outside of all exterior foundation walls, completely encircling the buildings, a line of 3-inch tile weeping drains, properly graded and connected to sewers where shown. These tiles are to be laid not higher than the top of the footing.

Exterior Masonry Walls (Brick Veneer)

Exterior walls to be brick veneer and shall be constructed of 4-inch face brick on frame as provided in "Carpentry" specifications and drawings; all to be built up of respective dimensions, thickness and height as shown om drawings. Mortar for brickwork shall be lime and cement mortar (one part lime; one part cement; and six parts clean, sharp sand).

In warm weather all brick shall be well wetted before being built in the wall and during cold weather the water and sand for mortar shall be heated. Salamanders shall be maintained on the scaffolds to prevent mortar or freshly built walls from freezing.

Brick veneer shall be well secured to wood framing with rustproof metal ties; these are to be supplied and installed by masonry contractor, one to every fifth course of brick and each square foot of wall surface.

Probable Causes of Failure in Brickwork and Foundations

Diagonal Cracks

Most of the diagonal cracks are believed to be directly caused by building settlement on consolidation of the base material. These cracks may have been quite pronounced originally or the movement may only have caused hairline cracks or lines of weakness. It is possible that subsequent movement by expansion and contraction of the materials in the wall has aggravated the situation. These movements would be expected to follow existing cracks or lines of weakness.

No doubt most of the damage was effected by leakage through the walls and roofs. Water entering around the frames of openings would also contribute to the failures.

Minor diagonal cracks could be caused by movement of the materials. They could also be initiated by movement of the building frame on drying, particularly between and around openings, followed by movement in the masonry materials.

Where buildings are founded on bed-rock it is unlikely that cracking was due to foundation settlement; however, diagonal cracks of a minor nature do exist in walls of buildings known to be on bed-rock, e.g. Buildings Nos. 29 and 30.

Vertical Cracks

These cracks predominate at the corners of reveals and are straight-line through mortar and brick. They occur in most of the buildings and are just as extensive in buildings known to be founded on bed-rock. This type of cracking could be caused by expansion and contraction of the masonry materials on wetting and drying. In nearly all instances where such cracking exists, foundation cracks outlining large spalls at corners are in evidence.

In view of the reroofing and repointing work already done, less water will enter the walls and future expansion could be materially reduced. Most of the shrinkage should now have taken place because of the relatively dry summer this year (1956) and because the walls in general appear to be water resistant. While the repairs mentioned above have contributed to the drying out, and consequently the shrinkage, they were desirable in order for present repair work to be successful.

Foundation Cracks at Corners

These cracks (Fig. 7) are not believed to be due to loads from the brickwork. It is unlikely that the walls are carrying any load because the foundation corners are cracked from both sides; conversely, it would appear that the brickwork is, in some cases, holding the concrete spalls in their present position. There is no evidence of downward movement of these spalled sections.

There are a few instances where foundation cracks have occurred at corners and there is little or no cracking of the brickwork above. This would indicate expansion with no appreciable shrinkage taking place to date or else the cracks have occurred at weaker points in the wall. The boiler house (Fig. 10) shows cracking at foundation corners with no cracks in the brickwork at these points.

The concrete specified for foundations was relatively weak (2000 p.s.i.) while the bed mortar for the brickwork appears very dense and strong. In some instances mortar resembling that of the bed course was used to lay up the corners of the brick walls.

Some exterior concrete landings have corners cracked and spalled in shapes resembling those outlined by corner foundation cracks of buildings. Immediately behind the lines of cracking, steel pipe are embedded to serve as the endposts of railings. These pipes are rusted near the concrete surface. Some expansion due to rust action on the pipe could cause such cracking. In addition, freezing of water in these cracks would further serve to enlarge and weaken them.

Properties of the Masonry Materials

As mentioned earlier in this report samples of bricks and mortar were taken from two locations in the walls of Building No. 17 and sent to the laboratory of the Building Materials Section of the Division of Building Research for examination.

In addition, a bag of "snowflake" lime of the type used in the construction was shipped to Ottawa for test. Acme Construction maintain that most of the portland cement used on the project was of Canadian manufacture. The bricks used throughout the job were made by L.E. Shaw Co. Ltd. at their Chipman, N.B. plant.

The Brick

From the samples submitted, 2 slabs of mortar and 1 of brick were cut in size 6 inches long, 3 inches wide and 3/8-inch thick. These were dried and stored for three days at a constant temperature and humidity, after which the length was compared with a reference bar using a dial gauge reading to 0.0005 inch. The samples were then autoclaved in accordance with the procedure in ASTM C126-44T (for glazed masonry units) which involves raising the steam pressure to 150 p.s.i. in $\frac{3}{4}$ of an hour maintaining the pressure at 150 p.s.i. for 1 hour, and then releasing.

Following this, the samples were replaced in the constant temperature and humidity laboratory for four days and the length compared with the reference bar as before. The largest length change of any of the samples was less than .002 inch or 0.03 per cent of the length of the samples.

By comparison with the above results brick piers made using unsound mortar of the cement-lime type have been known to expand between 0.3 and 0.5 per cent depending on the mortar composition. Corresponding brickwork with sound mortar expanded 0.06 to 0.07 per cent after about 2 years exposure.

The tests made on the samples resulted in very little length change due to autoclaving compared with results of similar tests on unsound masonry conducted at the U.S. National Bureau of Standards. There is the possibility, however, that the mortar used in Rockwood Court was once unsound and has since become stabilized.

Previous laboratory studies on bricks indicate that the type of failure at Rockwood Court is not generally associated with the brick used in that project.

It was believed that little could be learned from laboratory examination of the "snowflake" lime. Results of earlier tests on limes were hard to interpret with regard to the suitability of a particular lime.

Suggested Corrective Measures

In order to expedite this report it is necessary to suggest certain corrective measures without benefit of an exact knowledge of the cause of failure.

All cracked mortar joints should be "raggled" out to a depth of at least $\frac{3}{4}$ inch, thoroughly cleaned, and packed with mortar. This should be followed by a repointing job to blend with the general appearance of previous repointing work. It is suggested that a 1:1:6 (cement:lime putty:sand) mix would be suitable assuming that replacement bricks are similar to the originals. It is obvious from examination that the surface of present joints are capped with a mixture (materials unknown) to a depth in from the surface of approximately 1/8 inch. This application seems to have been effective in sealing cracks between mortar and bricks and has a good appearance.

There will be a great deal of scaffolding and staging work involved whether the cracks are just patched up at this time or complete repairs are made. Because of this it may be well to replace all cracked brick instead of cutting back the cracks and sealing them with mortar.

Sections at the corners of foundations outlined by cracks should be removed and replaced with concrete. The face exposed when the cracked sections are removed should be cleaned, roughened, and washed with a cement and water grout to effect a good bond with the new concrete. It may be necessary in some instances to dowel the new sections to the corners. The corners will have to be formed to maintain the concrete until it sets. This will probably require a course or two of brick to be removed immediately above these corners.

Separations between window frames and masonry should be caulked with a good quality caulking compound. For a suitable type it may be well to obtain recommendations from a manufacturer listed by the Corporation in "Acceptable Building Materials Systems and Equipment". Cracks in the material previously used may have been caused by movement of the masonry and the wood frames or may be due to properties of the compound. Because of this it is impossible to say whether or not it would be suitable for future repairs.

For Future Observation

Once repairs are completed a few of the buildings should be selected for future study. If this is done, records should be kept as to the type of materials used in the repair work, dates, weather conditions while work is in process, and periodic checks made of these buildings for at least two years. This information would in invaluable should the type of cracking now in evidence recur in future years.

If buildings are selected for future study, the Division would appreciate knowing the buildings chosen by their numbers so that members of staff could examine them when in the Saint John area. From the damage survey it would appear that Buildings Nos. 1, 2, 29, and 30 would be suitable selections for future study. Any information as to the soil formation beneath Buildings Nos. 1 and 2 would be of value.

Acknowledgments

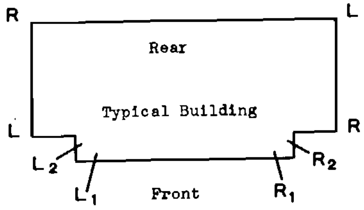
The author wishes to acknowledge with appreciation the co-operation and direct assistance in conducting the survey and providing data for this report of: Mr. A.J.E. Smith, Regional Supervisor C.M.H.C., Halifax (now Chief Construction Engineer C.M.H.C., Ottawa); Mr. P.A. Booth, Regional Compliance Inspector, C.M.H.C.; Mr. William Hazen, Manager, Saint John Housing Authority; Mr. William Grindlay, Building Superintendent, Rockwood Court Apartments.

The efforts of Mr. W.H. Ball and Mr. T. Ritchie in obtaining the laboratory data are also appreciated.

Survey of Brick Failures Rockwood Court Apartments, Saint John, N.B.

TABLE I

Legend



No.	Facing	Front	Degree	Rear	Degree
1	SE	Diag. left of L_1L_2	Moderate	Diag. between windows at two levels	Moderate
2	SE	R_1 brick to roof L_1 to 4 ft. up the wall Diag. at L to 1st window	Severe Minor Severe	Diag. at R to 1st window Diag. between window and door Diag. at junction 1 and 2	Severe Moderate Moderate
3	SE	L_1 to btm top floor window	Severe	Diag. up to 1st window from L	Moderate
4	SE	L_1L_2 cracks starting R_1 brick to 8 ft.	Minor Moderate	Diag. at three levels to R	Moderate
5	W	Diag. from 1st window to R	Moderate	Diag. from 1st corner to L	Moderate
6	W	O.K.		Diag. at junction 5 and 6 at three levels	Moderate
7	NW	L_1 to roof Diag. to right of entrance R_1 brick to 4 ft. Diag. from windows on 1st and 2nd level to R	Severe Moderate Minor Moderate	Diag. between window & door Diag. at junction of 7 & 8	Moderate Moderate
8	NW	Diag. to right of entrance R_1 to 8 ft. starting 2 ft. up from fdn R_2 for 18 in. starting 2 courses up	Moderate Moderate Moderate	Diag. between windows above entrance	Moderate
9	NW	L_2 starting	Minor	Diag. to btm window at L Diag. at top of door	Moderate Moderate
10	NW	O.K.		O.K.	
11	SE	Horiz. crack at L-10 courses up L_1L_2 R_1 started	Moderate Minor Minor	O.K.	
12	SE	R_1 for 4 ft.	Minor	Diag. at L to btm of window	Minor
13	SE	L_1 R_1 starting	Minor Minor	Diag. at L Diag. at R	Moderate Severe
14	SE	R_1 to 6 ft.	Minor	Horiz. between door and window	Moderate
15	E	R_1 to roof Diag. at R_1R_2	Severe Moderate	Diag. at L to bath window Diag. at junction 15 and 16	Moderate Minor
16	E	L_1L_2 inside corner Diag. from window to L_1L_2	Minor Moderate	O.K.	
17	E	R_1 to roof R_2 for 7 courses	Severe Minor	Diag. at R	Severe
18	E	L_1 to roof	Severe	Diag. at L and going around corner to end wall	Severe

TABLE I continued

Survey of Brick Failures Rockwood Court Apts., Saint John, N.B.

No.	Facing	Front	Degree	Rear	Degree
19	NE	O.K.		Vert. crack under window near L Diag. cracks near R	Moderate Moderate
20	NW	R_1 in brick	Minor	Diag. starting at 14th course and rising 6 courses to R	Moderate
21	NW	R_1 starts at 3rd course for 8 ft. R_2 crosses to R_1 at 3rd course L_1 to roof Inside corner L_1L_2	Minor Minor Severe Moderate	Diag. at top left corner of door Diag. up to rt from btm of 2nd storey window at left of door	Moderate Moderate
22	NW	R_1 to roof - also inside corner at R_1R_2 L_1 to 4 ft.	Severe Minor	Diag. from top of bath window down to R Diag. up to rt from door	Severe Moderate
23	NW	Diag. at R to window R_2 starts at 2nd course for 11 courses L_1 to 5 ft.	Minor Minor Minor	Diag. starting under window to rt of door	Minor
24	NW	R_1 to 15 ft. Diag. crack	Moderate Minor	L a few cracked brick	Minor
25	SE	Diag. at R on all levels L_1L_2 R_2 up 12 course crossing over to R_1 then up several feet Diag. junction 25 and 26	Moderate Minor Moderate Moderate	Vertical under window near R	Minor
26	SE	L_2 crossing over to L_1 at 10th course and then to roof R_1 to 4 ft. Diag. at R	Severe Minor Minor	O.K. but some efflorescence down 18 in. from eave line	
27	SE	R_1R_2 to roof L_1 to 8 ft. crossing over from L_2 at 8th course	Severe Moderate	Diag. at R Efflorescence as for No. 26	Moderate
28	SE	R_1 to 8 ft. Diag. to rt of entrance L_2 for 30 in.	Moderate Moderate Moderate	O.K.	
29	SE	L_1L_2 a few cracked brick R_1 to roof R_2 up 3 ft. and crosses over to main wall and up to btm of 3-storey window	Minor Severe Severe	Diag. at R	Minor
30	SE	L_1 to 18 ft. R_2 to 3 ft.	Moderate Minor	Diag. at R	Minor
31	SE	R_1 to roof R_2 for 3 courses crossing over to R_1	Severe Minor	A few cracked brick at L	Minor
32	SW	Diag. at R R_2 up to 3 ft. and crosses over to join diag. at R	Severe Moderate	Diag. at L	Moderate

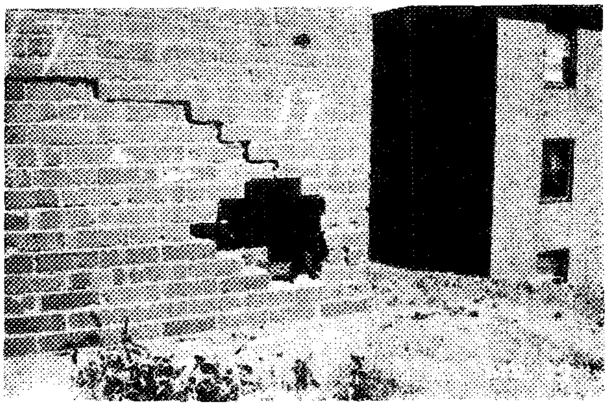
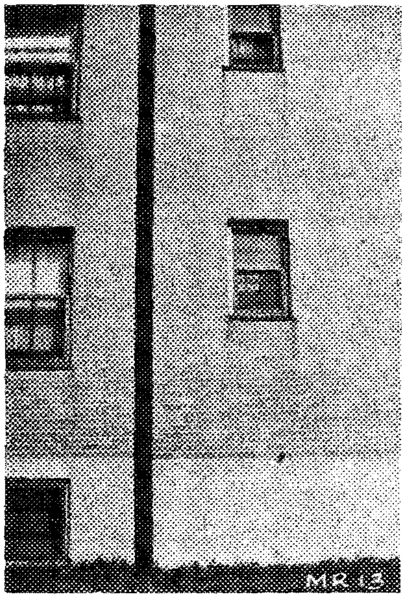


Fig. 1 Openings in walls showing sheathing paper in good condition.

Fig. 2 Vertical cracks at reveals extending from top of foundation wall to roof.



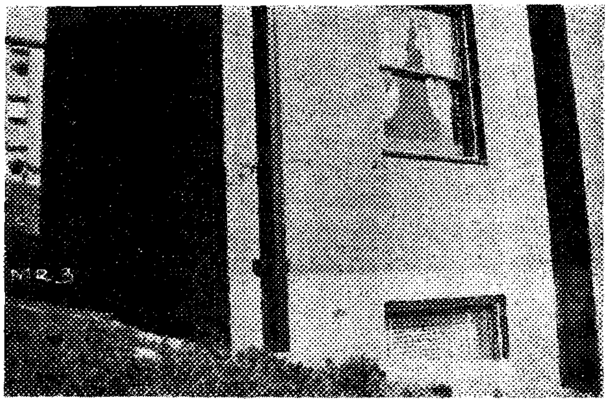


Fig. 3 Diagonal cracks at corners.

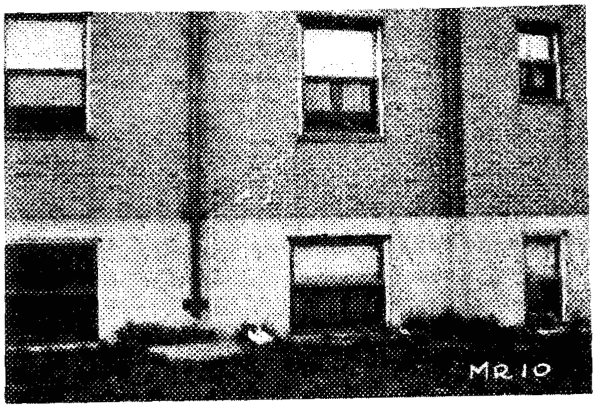


Fig. 4 Crack in foundation and diagonal crack in supported brickwork.

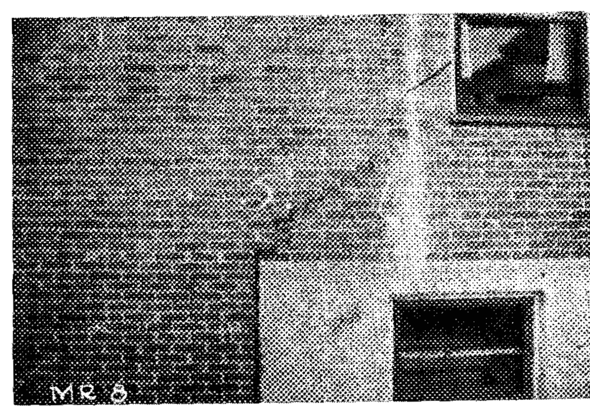


Fig. 5 Crack in foundation and diagonal crack in supported brickwork.

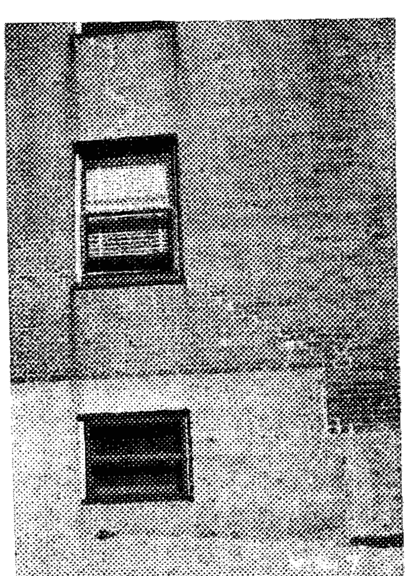


Fig. 6 Foundation and brickwork cracks at point where elevations of adjoining foundations are at different levels.

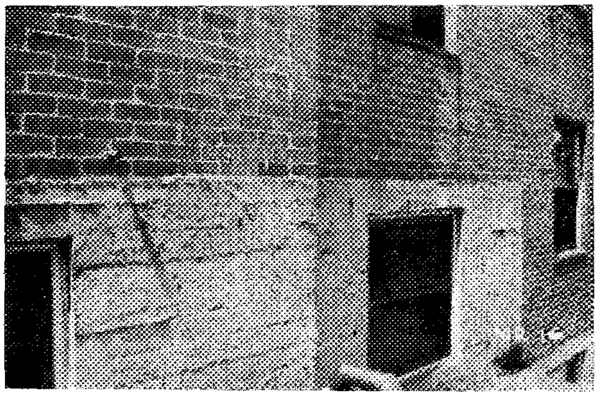


Fig. 7 Cracking near top of foundation wall at end corners and at corners of reveals.

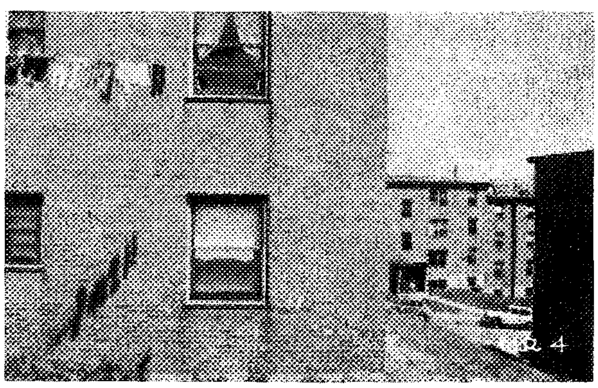


Fig. 8 Severe diagonal cracking.

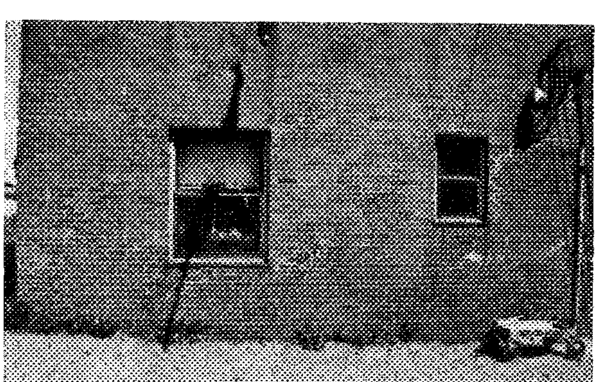


Fig. 9 Severe vertical cracks at reveals and diagonal cracks.

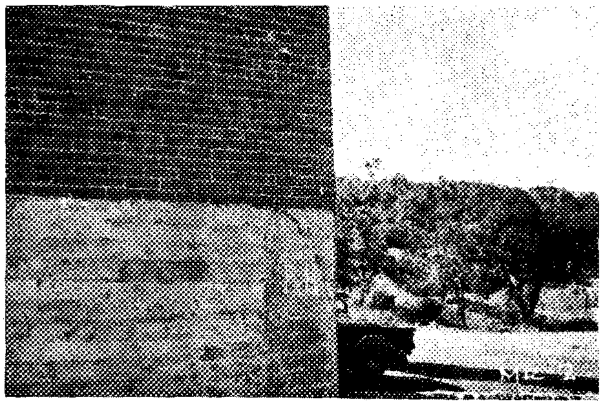


Fig. 10 Crack in foundation corner.

Fig. 11 Cracks in foundation but no cracks in brick-work.

Fig. 12

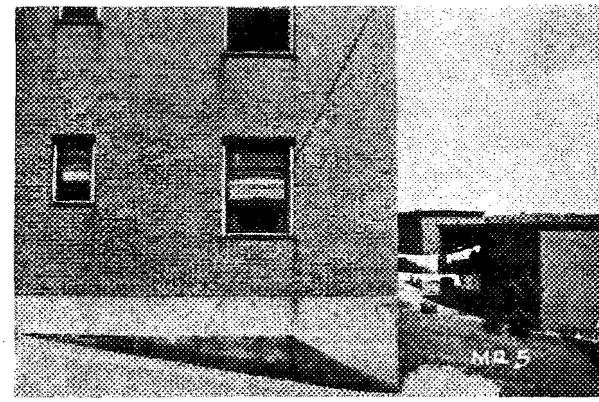


Fig. 13

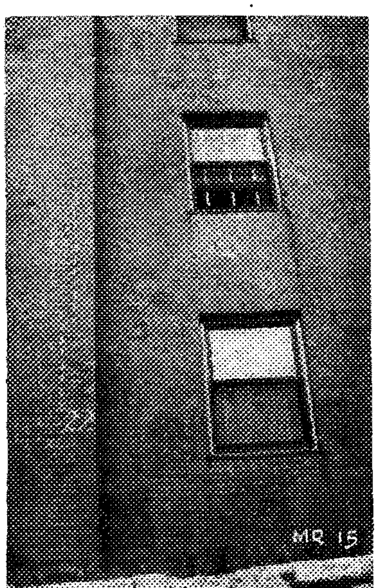


Fig. 14

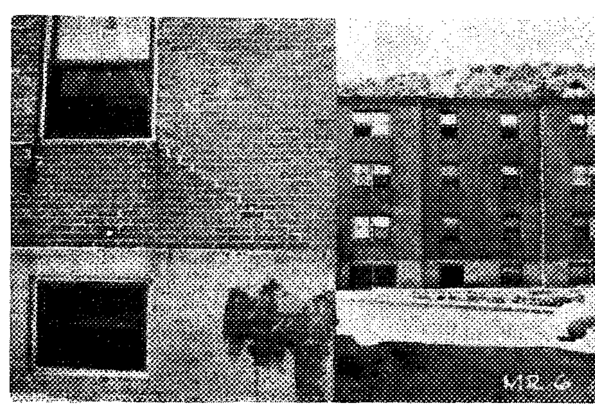


Fig. 15

Examples of cracking in foundation
and brickwork at Rockwood Court
Apartments, N.B.