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WALTER J. HICKEY ASSOCIATES
PROFESSIONAL ENGINEERS - CONSULTANTS

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INVESTIGATION

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of

COLLAPSE

at the

HOTEL VENDOME

prepared for

CITY OF BOSTON

Fire Department

REPORT

WALTER J. HICKEY ASSOCIATES, INC.
ENGINEERS AND PLANNERS

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VICE PRESIDENT
AUGUSTINE L. DELANEY, P.E.
ASSOCIATE

September 15, 1972

Mr. James H. Kelly, Commissioner
Fire Department
City of Boston
115 Southampton Street
Boston, Massachusetts

Dear Commissioner Kelly:

On June 21, 1972 we began a comprehensive investigation and study into the cause of the collapse at the southeast portion of the Hotel Vendome during a fire on June 17, 1972. This investigation and study has been completed and our report is transmitted herewith.

The investigation at the site was directed and performed by our Vice President, Roy O. Ventura, P.E. All additional work was conducted under the joint direction of Mr. Ventura and the writer.

The cooperation and assistance of all City officials, departments and personnel throughout the entire investigation were extremely valuable and are gratefully acknowledged.

Yours very truly,

WALTER J. HICKEY ASSOCIATES, INC.

Walter J. Hickey, P.E.
President

jr

encl: (6)

CONTENTS

PROLOGUE

In the late afternoon of Saturday, June 17, 1972, the Boston Fire Department suffered the worst disaster in its history when nine firefighters were carried to their deaths and several others were injured in the collapse of the southeast section of the old Hotel Vendome located at the corner of Commonwealth Avenue and Dartmouth Street, Boston. (See Photo A).

Shortly after 2:00 P.M., a fire was discovered in the upper stories of the old hotel which was in the process of being renovated into a combination luxury apartment and commercial building. Except for a cafe at the street level on the Commonwealth Avenue side, the hotel was not in use. About 100 persons were in the cafe at the time and they were evacuated when the fire was discovered. A few workmen were

also in the building at the time.

The box alarm was received by the Fire Department at 2:35 P.M. and the first piece of apparatus arrived at the scene at 2:37 P.M. Except for a few pockets of resistance, the fire was considered to be practically extinguished, when at about 5:20 P.M., without warning, the floors in the southeast section of the structure gave way, and the walls collapsed into a pile of rubble. It is estimated that approximately twenty firefighters were inside the easterly section of the building at the time. Nine of the men were crushed to death by the falling debris.

According to the survivors, there were no sounds of creaking of timbers or of crushing of masonry that experienced firefighters usually associate with an incipient failure. There were none of the usual signs or sounds that would warn or alert experienced firefighters of a major weakening or of an impending collapse, and which would have warranted an order to withdraw or abandon the area.

In view of these facts, it was felt that the cause of the collapse was something other than the fire itself, (since the fire in the collapsed area was confined to the top story); therefore, it was decided that an investigation should be made to determine the cause of the failure.

On June 19, 1972, the Fire Department of the City of Boston, acting through Fire Commissioner, James H. Kelly, engaged the services of Walter J. Hickey Associates, Inc. to investigate and report on the cause of the collapse.

HISTORICAL

The Hotel Vendome was constructed in two major sections. The first section was five stories and basement, and extended approximately 64 feet along Commonwealth Avenue and approximately 104 feet along Dartmouth Street. The available architectural drawings of this section have stamped dates of 1870 and 1871. It is estimated that construction began in late 1871 or early 1872 and completed in 1872. The second section consisting of six stories and basement, was an extension of the first section along Commonwealth Avenue. The available architectural drawings of this section have stamped dates of 1874 and 1875. The drawings indicate that this second section was more complex than the first section and might have been designed and/or constructed in two segments. Construction of this second section is thought to have been completed by 1880.

For the purposes of this report, attention is restricted more or less, to the first section mentioned above, and in particular to the collapsed southeast portion of that section.

The first section consisted of wood floors supported on masonry bearing walls. Details of the original construction at the southeast or collapsed portion were as follows:

FLOORS

The floors in general were of hardwood applied on a layer of tongue and groove sheathing on a mortar of gypsum fill over a tongue and groove wood sub-floor. The supporting joists were of wood and were parallel to Dartmouth Street. It is thought that the fill was for the reduction of sound transmission between floors. A portion of the first floor surface appeared to be of some material other than wood. (See Photo No. 1).

ROOF

The roof construction appeared to be of tar and gravel on wood sheathing with wood joists supported on masonry walls. (Subsequently, a leveling fill of concrete was placed over the existing roofing and a wearing surface of quarry tile was installed).

(See Photos No. 2, 3 and 4).

WALLS

Five brick masonry walls, Lines A, B, C, D and E were founded on wood piles. These walls were perpendicular to Dartmouth Street. Floors 1 and 2 were supported on all five walls. Floors 3, 4 and 5 and the roof were supported by three of the five walls; namely, Lines A, C and E.

The only records that were found in the files of the Building Department of the City of Boston originate in the year 1911. In that year, a sun parlor not within the collapsed portion was added to the roof of the first section.

The records called for the construction to be as follows:

> "It is proposed to build a sun parlor ... to be 28' wide, 36'6" long, and to go on the present low roof of the hotel on the corner of Dartmouth and Commonwealth Avenue; to be of steel frame covered with sheet copper, one end to be of present brick wall of higher part of building, three sides and roof to be of glass. Highest part of proposed structure 13'6" above present roof. Floor to be wood or aspetholith over incombustible floor supports ...."

Apparently, a sun deck over the other portion of the same roof was also a part of this project. (See Photos No. 2, 3 and 4).

Since that time, numerous other alterations have been made to the building. The information contained in these Building Department records is at best only sketchy. Although,

as it will be shown later in this report, an alteration of major importance was made in the collapsed portion prior to the year 1900. No reference relating to this alteration was found in these records.

(See Plates No. 1 and 2)

INVESTIGATION

Investigation began at the site on June 21, 1972. Large portions of the floors in the area between the A-Line and the C-Line were found stacked against the A-Line Wall. These portions were in an inclined position and were relatively undamaged. (See Photo Nos. 5, 6 and 6A). The portions of the floors between the C-Line and the E-Line were severely damaged. In general, the top surfaces of these floor sections were relatively undamaged with no evidence of sufficient debris to contribute to the collapse. Field measurements provided substantial verification of the original construction.

Several bricks at the broken end of the upper portion of the E-Line Wall above the third floor were tilted downward. (See Photo No. 7). While others at the broken end of the lower portion of the same wall were twisted outward. (See Photo No. 8). Large portions of the

collapsed wall originally near ground level were found relatively intact lying against Ladder Truck 15 which was positioned in the alley about three feet from the original wall. (See Photo Nos. 9 and 9A).

Most of the joist pockets along the A-Line Wall were found to be only slightly damaged.

Several metal beams were uncovered below the second story. (See Photos No. 10, 11, 12, 13 and 14). After the debris was carefully removed, a column (with an attached cap plate) and an isolated plate were found in the basement near the center of the area. (See Photos No. 15, 16 and 17). The column, though displaced, was intact, evidence that of itself it was not the cause of the failure. The isolated plate, later identified as being the base plate, was found alone on the basement floor. (See Plate No 3).

From the foregoing, it was evident that a major alteration other than recorded in official files had been

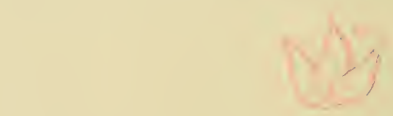
made in the area of the collapsed portion of the building. The extent of these alterations would be outlined after a review of the physical evidence.

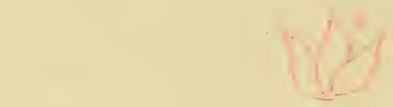
A section of sheet metal duct approximately 30 inches by 12 inches was found passing through the A-Line Wall near Line 2. Another flared portion of metal duct was found at a window opening in the E-Line Wall at ground level near Line 2.

(See Photos No. 18, 19, 19A and Plate No. 3).

Two pieces of granite measuring approximately 7 inches by 7 inches by 30 inches were also found in the basement.

The accumulation of water on the floors during the fire did not appear to be excessive at any time according to the men at the site. Estimates given by the firefighters of the depth of water varied from 1/2 inch to 6-inches. It would seem that openings made for renovations underway at the time together with those made by the men





fighting the fire would preclude any major accumulation of water.

Although small sections of the roof were lying on various areas of the fifth floor, the major portion of the roof was still intact prior to the failure according to the firefighters in the area.

Interviews with the surviving firefighters who "rode" the floors down were all essentially the same in describing the manner of collapse -- the floor on which they were standing (5th) dropped away like a descending elevator with no advance warning of sound, or of debris falling from above. The ceiling or roof above these men did not fall on them before the floor gave way. No firefighter in the collapsed area or in the immediate vicinity heard any sound that would normally warn him of an impending failure, such as the creaking or cracking of wood. There was no thumping or pancaking of floors on each other. There was only a sensation of falling.

This would indicate that the cause of the initial failure was from below.

Firefighters who were in the vicinity of the alley at Dartmouth Street were essentially in agreement in describing what occurred at the E-Line Wall. There was a loud cracking noise followed by a rumbling sound. The chimneys at the top of the wall fell outward landing on Ladder Truck 15, which was positioned in the alley adjacent to the E-Line Wall. Moments later, the wall bulged outward at about the third story and then collapsed. This was followed by the partial collapse of the Dartmouth Street Wall.

SOUTHEAST PORTION BEFORE FAILURE

Sometime around 1890 or before, alterations in the first story were made. The C-Line Wall and the partition on the D-Line were removed in this first story. Dual 15-inch wrought iron beams, together with a 7-inch diameter cast iron column at Line 2 were installed to carry the loads of the second floor and the floors above previously carried by the section of wall removed. The partition on the D-Line was replaced by 12-inch wrought beams suspended by a saddle on a 10-inch wrought iron beam spanning between the C-Line and the E-Line along Line 2. The 7-inch diameter column on Line 2 was based on a 12-inch by 12-inch by 2-inch plate directly over the lower portion of the wall at the C-Line.

(See Plate No. 4).

Other alterations outside the area were also made at this time, but are not considered pertinent to the matter

at hand. Sometime in the latter part of 1971, additional alterations to the wall on C-Line in the basement story were undertaken. These alterations consisted in part of an installation of a 30 inch by 12 inch sheet metal air intake duct.

(See Plate Nos. 3, 6 and 7).

In the first half of 1972, the B-Line Masonry Wall was also removed and shores placed.

(See Plate Nos. 3 and 7).

Floor framing on floors 3, 4 and 5 in the collapsed area were supported on a brick masonry wall along the C-Line. This wall of brick was in turn supported by dual 15-inch wrought iron beams at the second floor level. The interior ends of these 15-inch beams rested on a 7-inch diameter cast iron column on the wall at Line 2, while the outer ends were built into the existing masonry walls. In addition, one end of a beam along Line 2 was supported by the same cast iron column, while the far end framed into the wall along the E-Line at the alley. This member, a single

10-inch wrought iron beam, had two single 12-inch wrought iron beams suspended from it, all of which formed a part of the second floor framing system. Thus, the 7-inch cast iron column was the main support of the bearing wall above the second floor with the addition of at least half of the second floor load in the area. The base plate of this column was positioned on the wall along the C-Line approximately at the first floor level.

(See Photos No. 20, 21, 22, 23, 24, 25 and 25A).

The 30 inch by 12 inch metal duct passed through the C-Line Wall in the vicinity of an existing doorway. The top of this duct was approximately 17-inches below the underside of the column base plate. The side of this duct was within 5-inches of the centerline of this column.

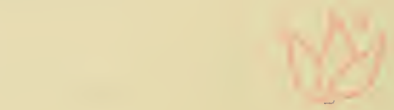
The opening required for this duct was therefore in a very critical location in relation to the bearing area of the column and base plate.

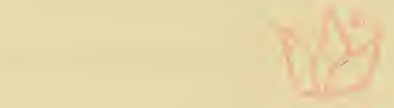
(See Plate No. 6, Detail "X").

CONCLUSIONS

When the computations were made, it was found that the load on the cast iron column from the dead LOAD alone, considering a small allowance for the corbelling action, was about 200,000 pounds. (A study indicated that the corbelling or arching effect of the C-Line Wall was only of minor significance). The bearing stress on the wall due to this load was about 7 to 8 times the allowable stress for a masonry wall of a good grade brick with a good lime cement mortar.

When the opening for the air intake duct was made through the wall, the bearing stress at the side of the opening, already too high, was greatly intensified and was approaching a critical stage. It should be emphasized that in computing these stresses no live load was considered.





With the addition of even a small live load or a slight moving load, it is probable that failure by crushing of the masonry in the area at the side of the opening could have been easily triggered, thus causing the tilting of the column base plate, the displacement of the column and the complete loss of support.

It is also conceivable that the same effect could be caused by the loss of support due to the weakening of the mortar upon being saturated with water. (This would apply only in the case of a lime or lime cement mortar and a saturated condition in the wall).

It is concluded that the collapse began when the 7-inch diameter column lost its support thus producing the failure of third, fourth and fifth story masonry walls along the C-Line. The floor sections losing support, dropped along the C Line and joists were pulled from the wall pockets along the A-Line and E-Line. The floors falling along the C-Line Wall exerted little, if any, thrust against

the E-Line Wall until they began to accumulate together with debris from the falling wall in a mass below the third story. At this point the exterior ends of the floor sections pushed out the lower portion of the E-Line Wall resulting in the vertical collapse of the upper portion of the same wall. The partial collapse of the Line 3 Wall at Dartmouth Street quickly followed the collapse of the E-Line Wall.

COMMONWEALTH AVENUE

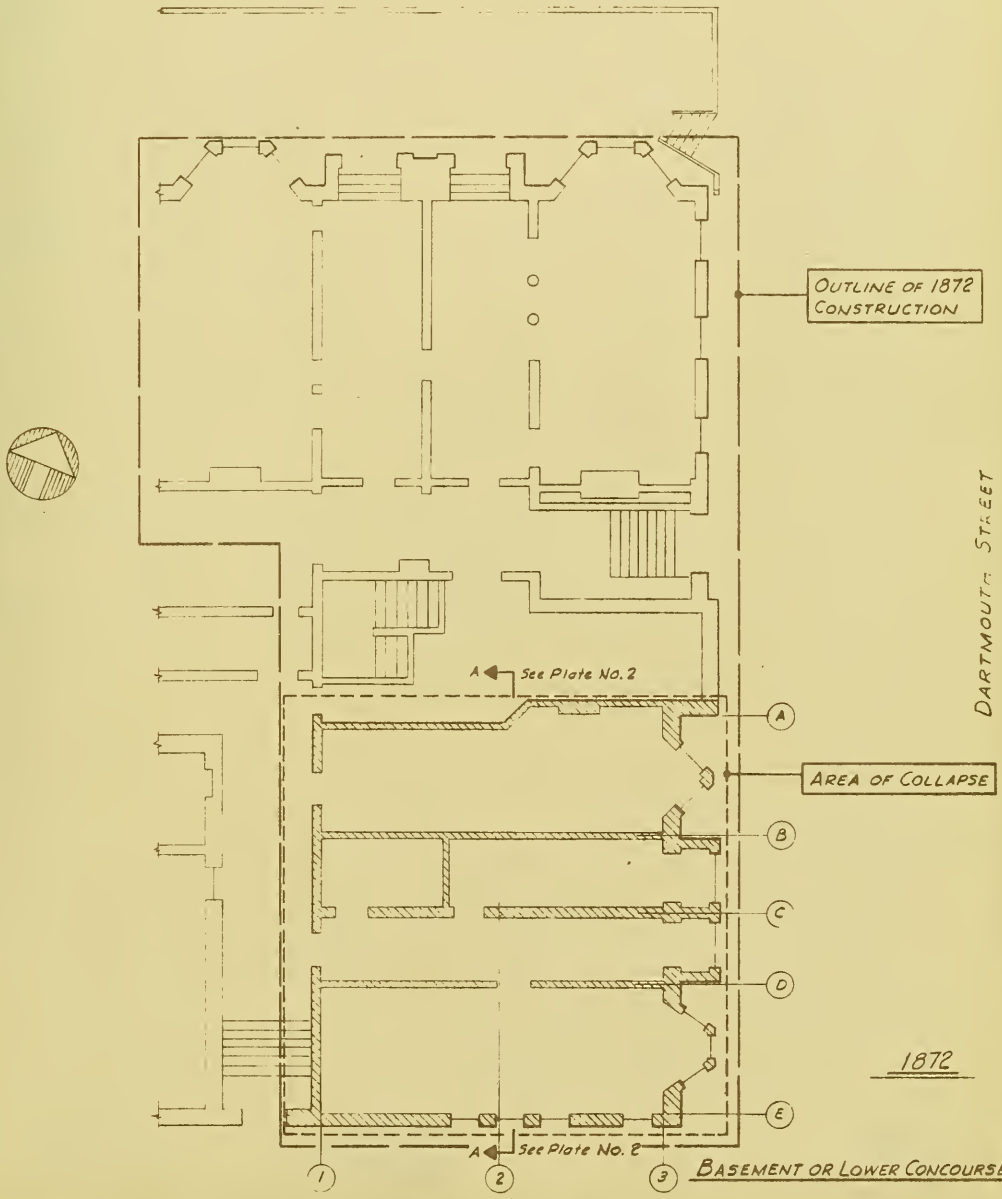
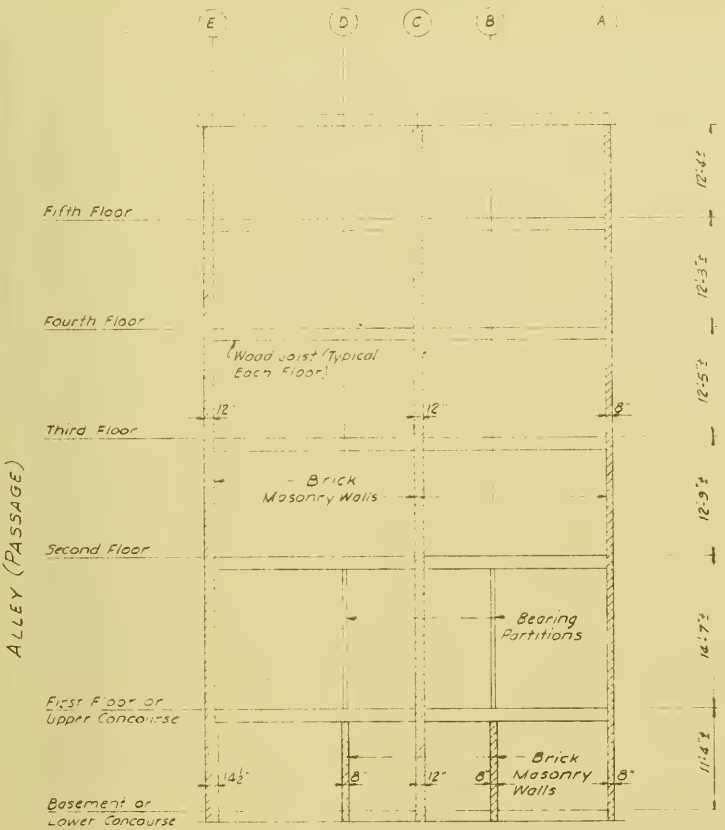


PLATE NO. 1

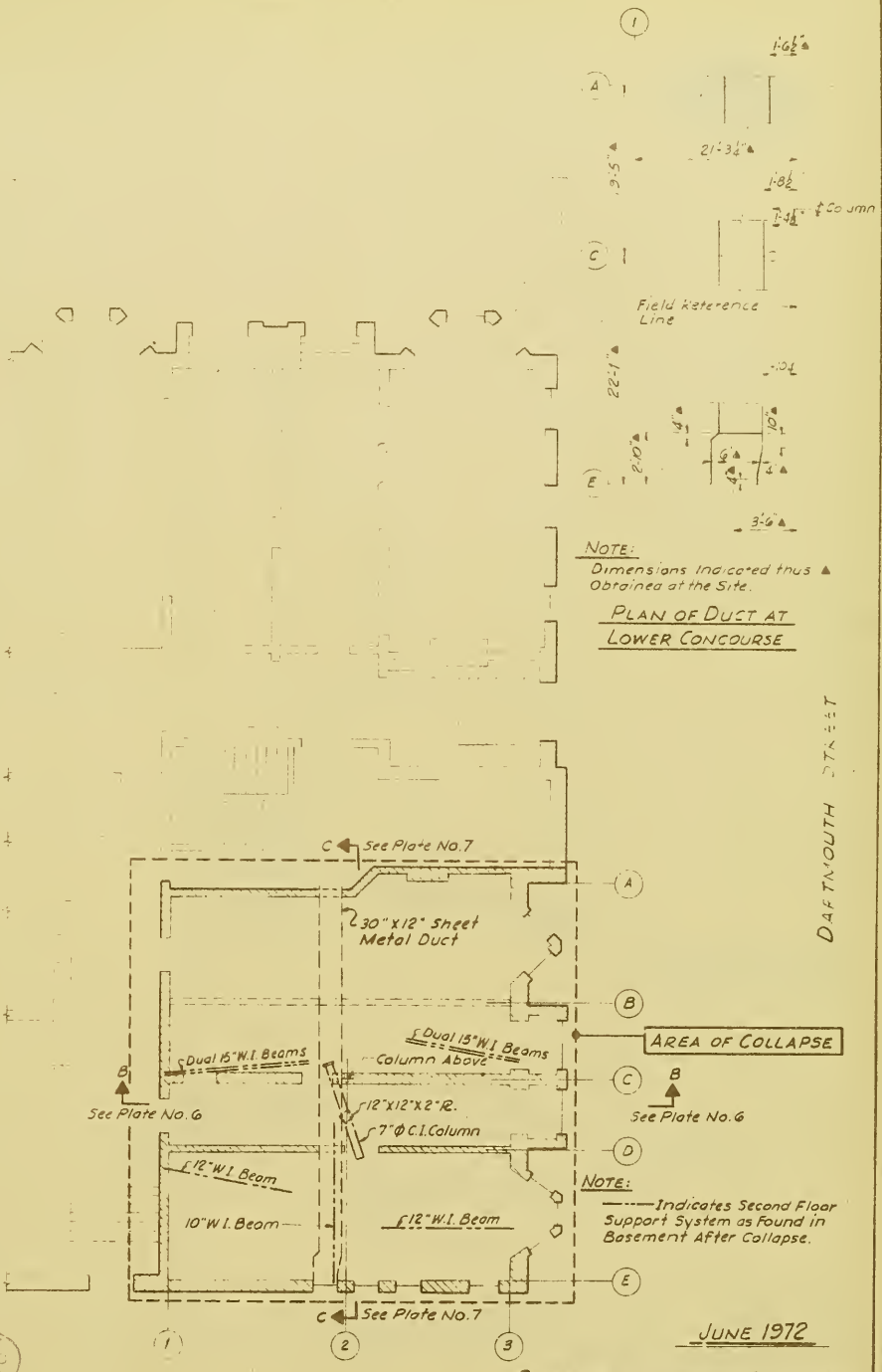


1872

SECTION A-A

PLATE NO. 2

COMMONWEALTH AVENUE



NOTE:
Dimensions indicated thus ▲ Obtained at the Site.

PLAN OF DUCT AT LOWER CONCOURSE

NOTE:
——Indicates Second Floor Support System as Found in Basement After Collapse.

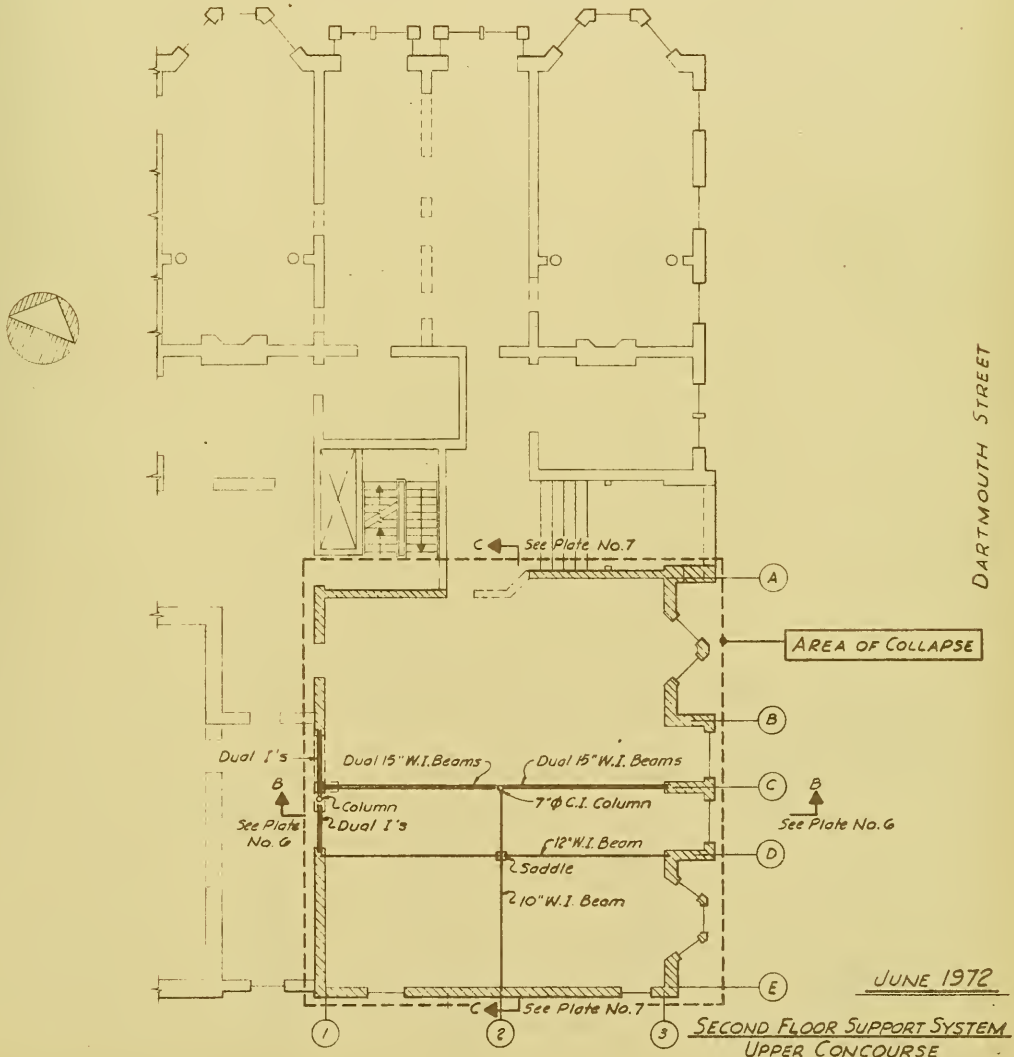
JUNE 1972

BASEMENT OR LOWER CONCOURSE

PLATE No. 3

ALLEY (PASSAGE)

COMMONWEALTH AVENUE

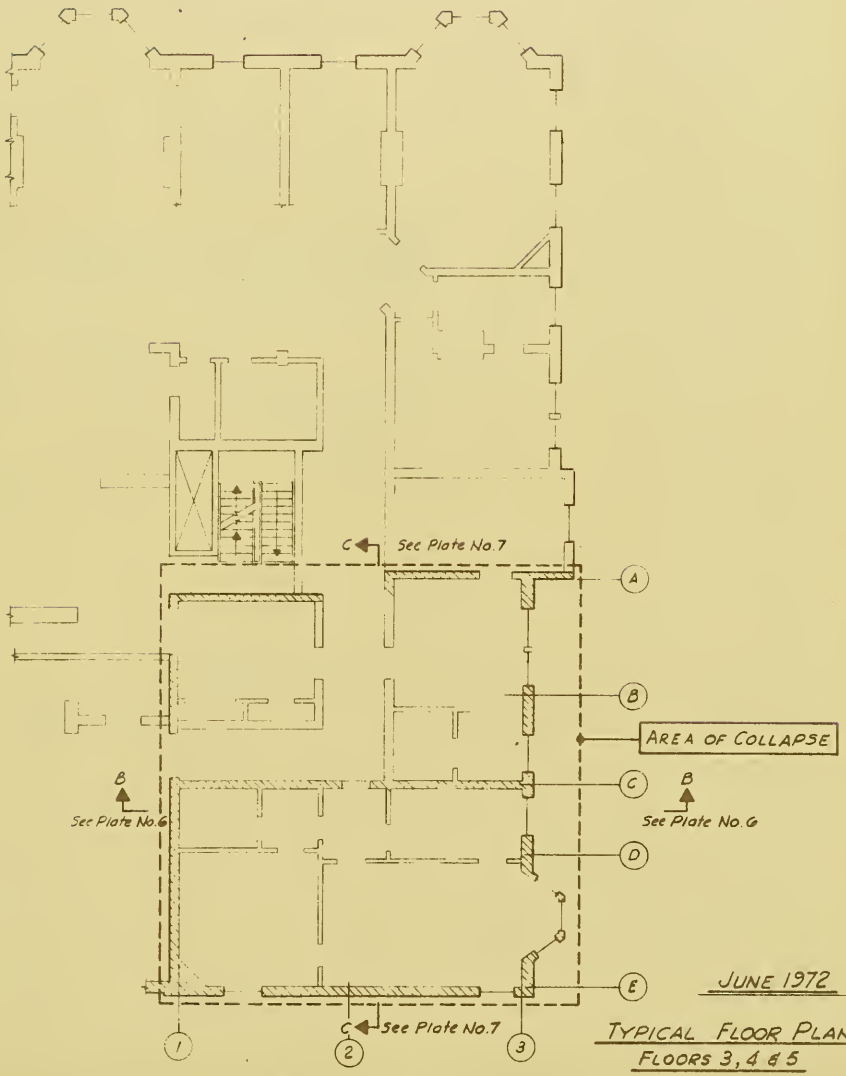


JUNE 1972

SECOND FLOOR SUPPORT SYSTEM
UPPER CONCOURSE

PLATE No. 4

COMMONWEALTH AVENUE



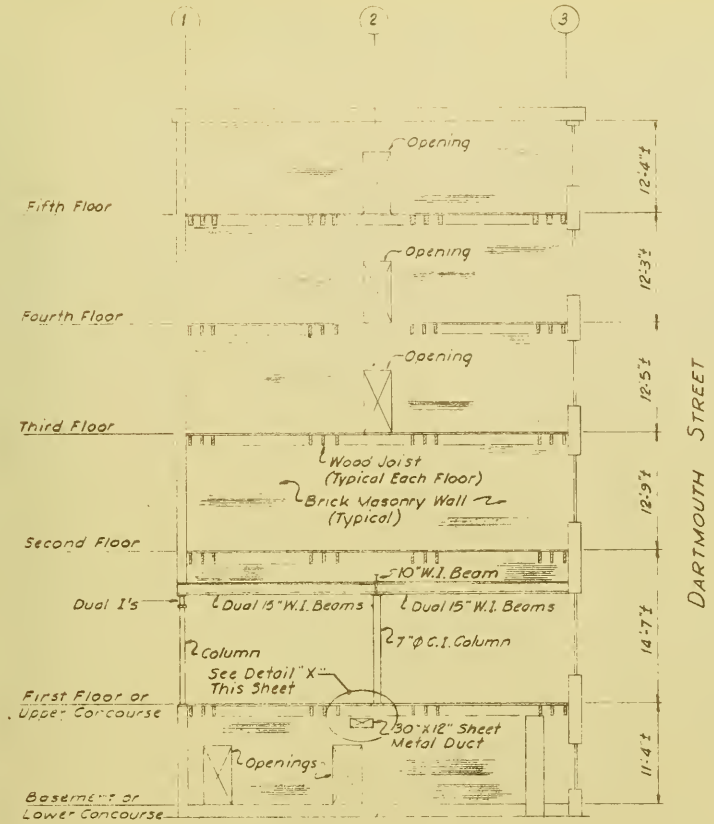
DARTMOUTH STREET

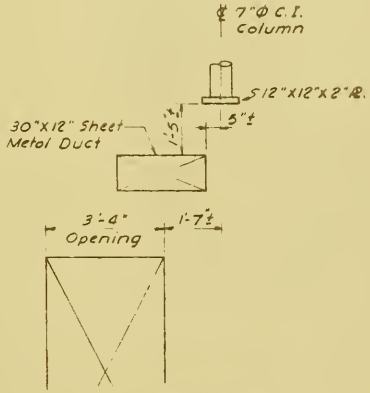
ALLEY (PASSAGE)

JUNE 1972

TYPICAL FLOOR PLAN
FLOORS 3, 4 & 5

PLATE NO. 5



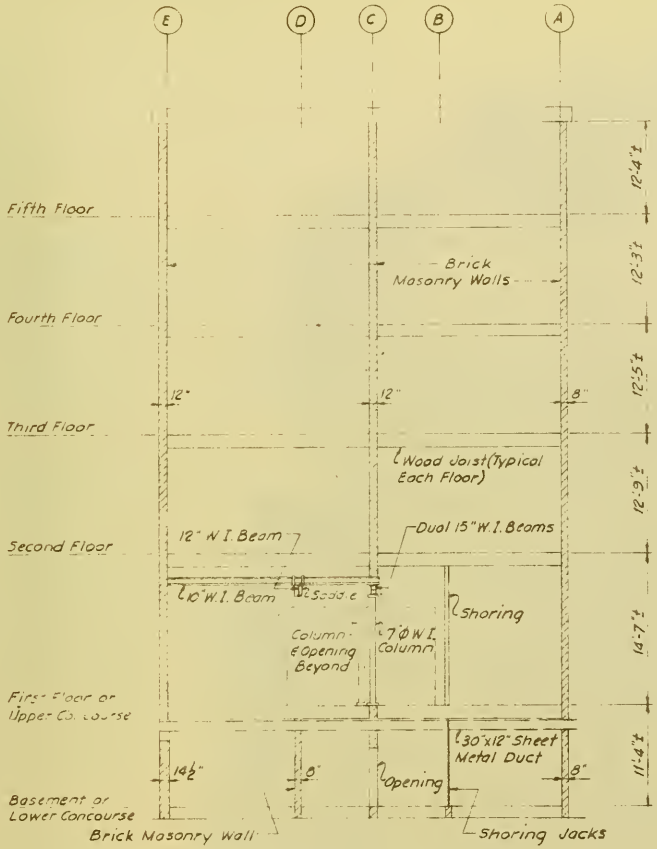


DETAIL "X"

JUNE 1972

ELEVATION B-B

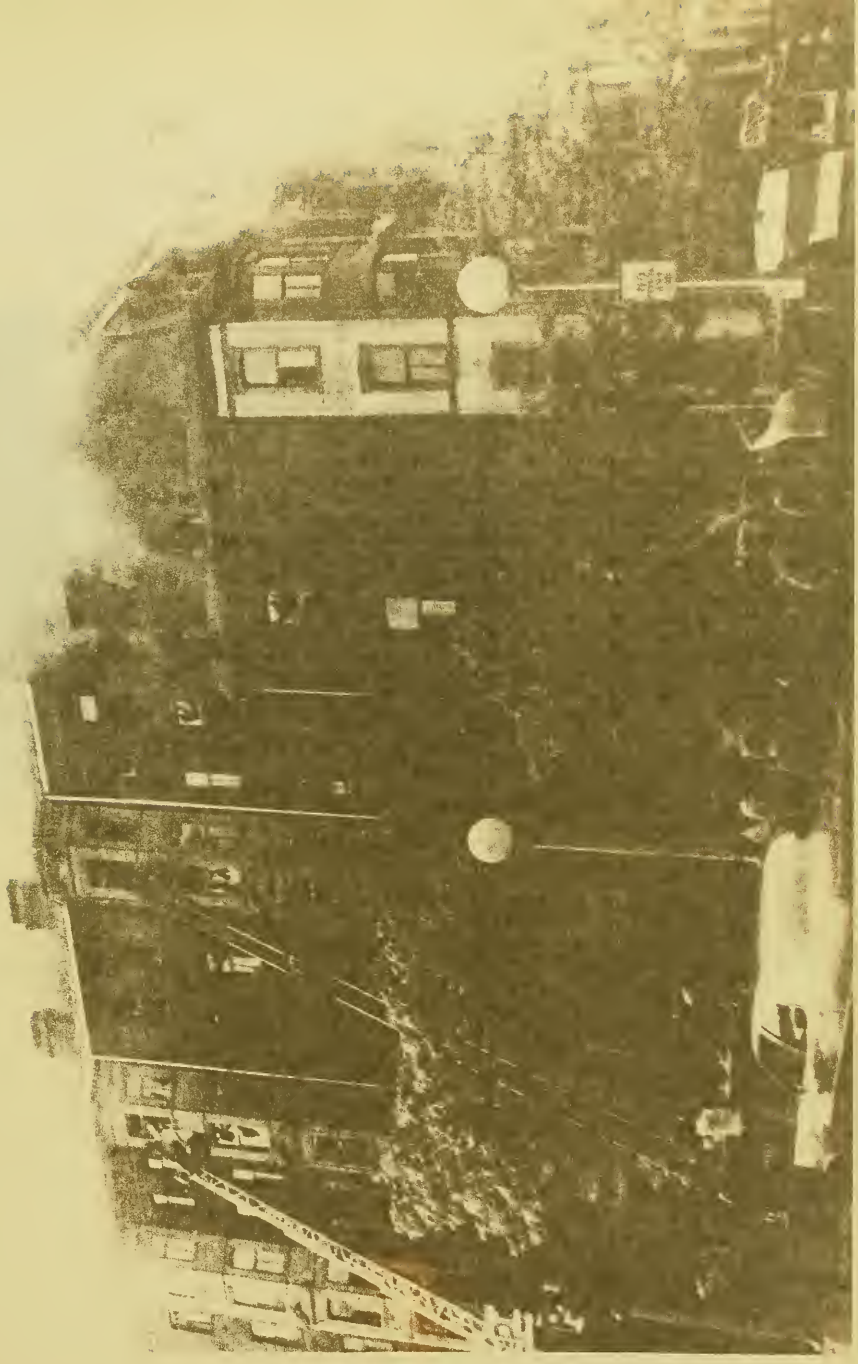
PLATE NO. 6



JUNE 1972

SECTION C-C

PLATE NO. 7



SOUTHEAST SECTION DURING FIRE Photo A

Photo No. 1

FLOOR, TYPICAL SECTION

Photo No. 2

ROOF, CONCRETE
FILL AND
SHEATHING

Photo No. 3

ROOF, CONCRETE FILL AND QUARRY TILE

Photo No. 4

ROOF, CONCRETE FILL AND QUARRY TILE

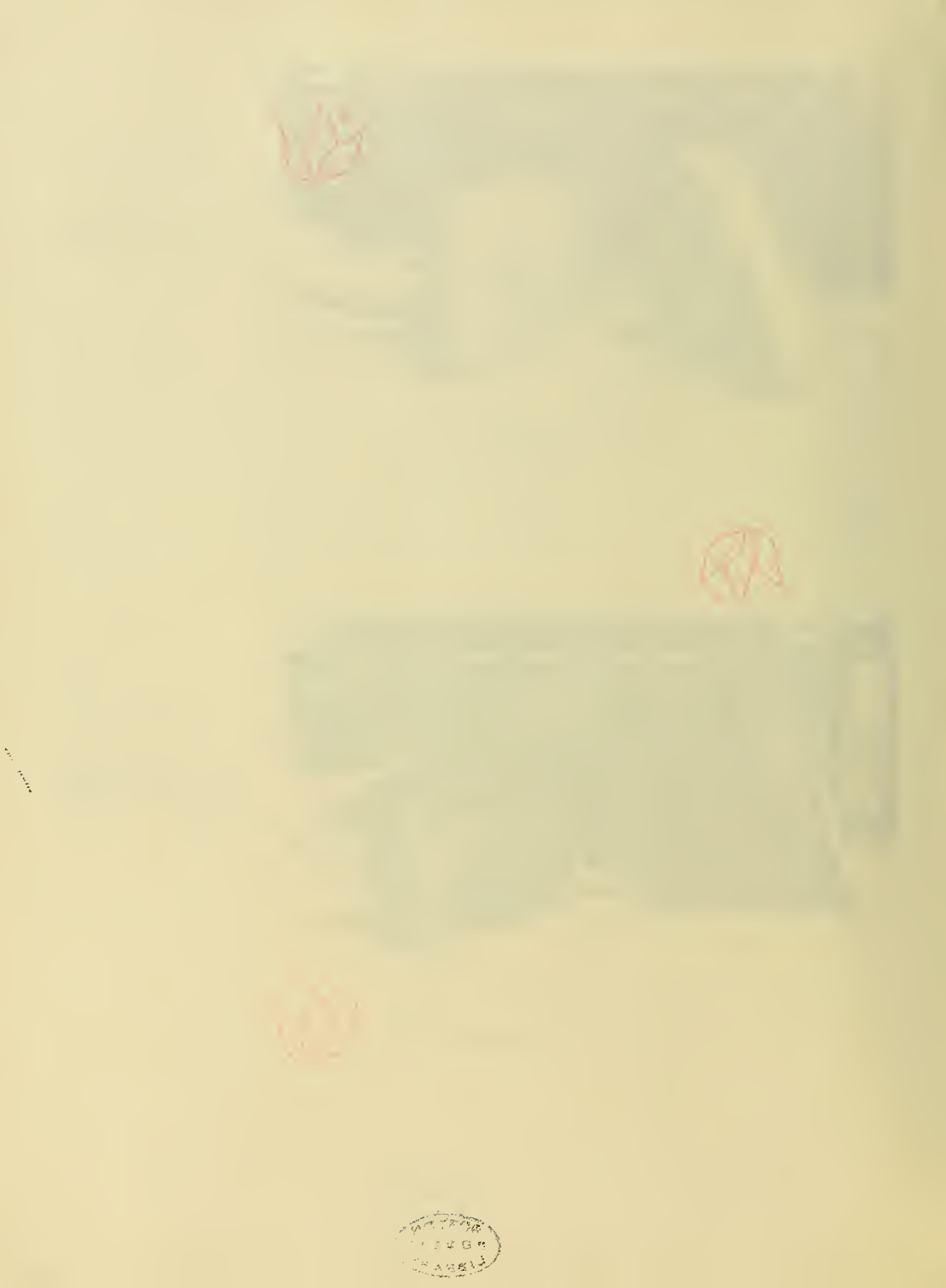


Photo No. 5

FLOOR PORTIONS AGAINST A-LINE, BETWEEN A-LINE AND C-LINE

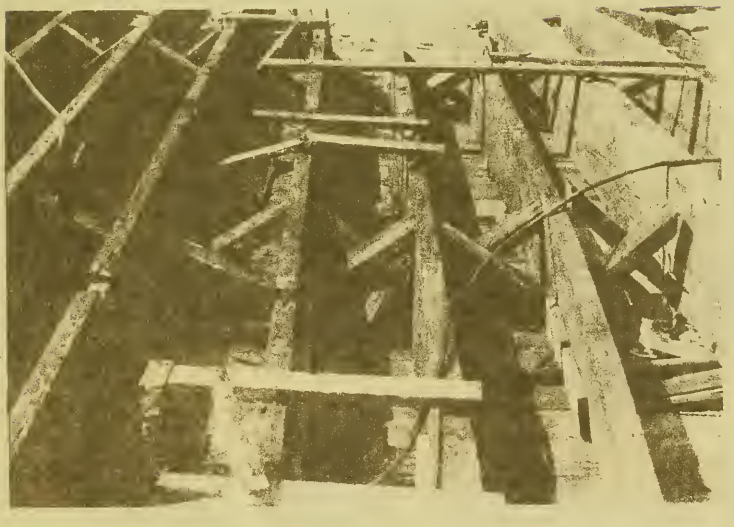
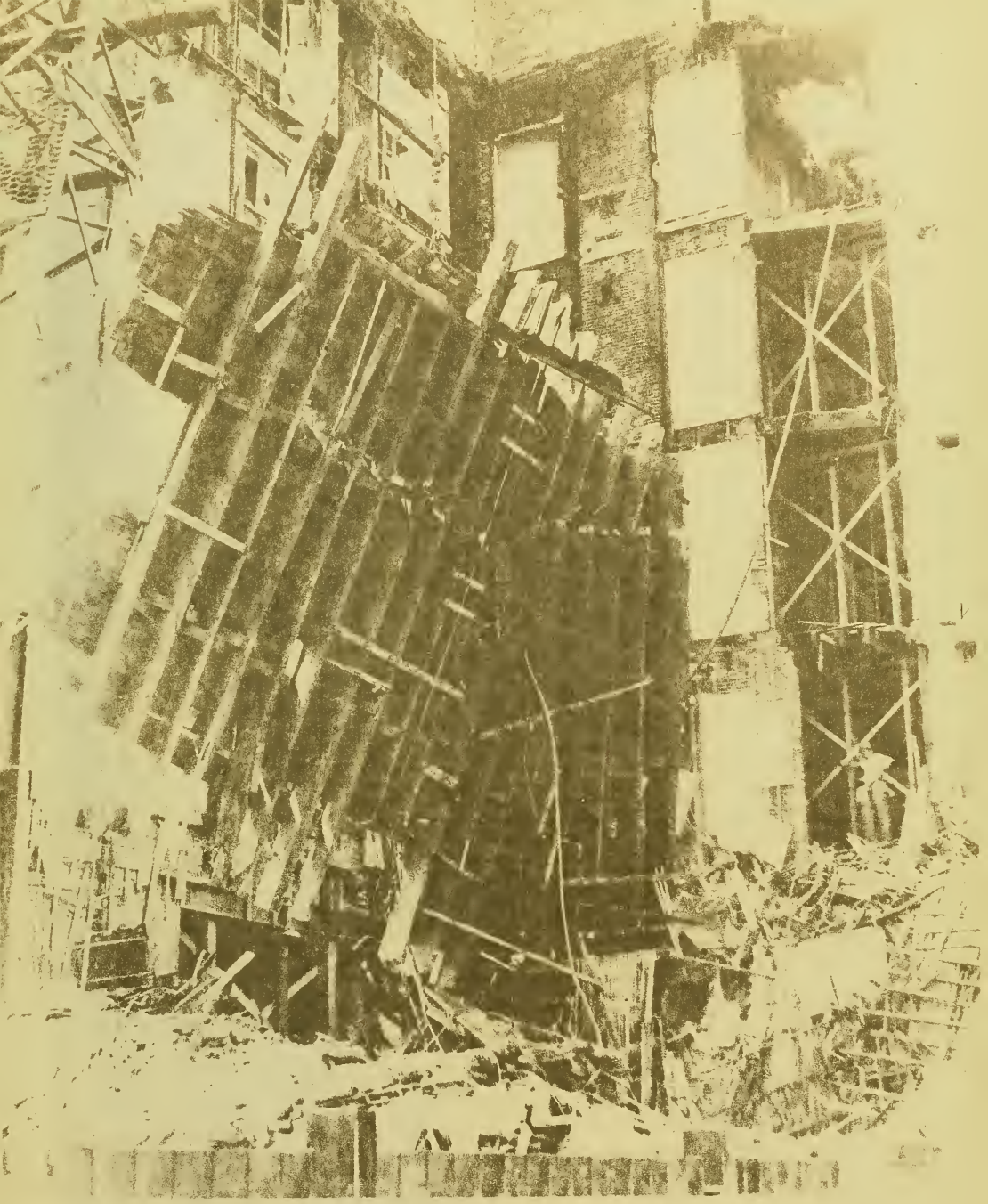


Photo No. 6

RELATIVELY UNDAMAGED FLOOR PORTIONS AFTER REMOVAL



FLOOR SECTIONS BEING REMOVED

Photo No. 6A

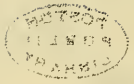


Photo No. 7

E-LINE WALL AT FOURTH STORY

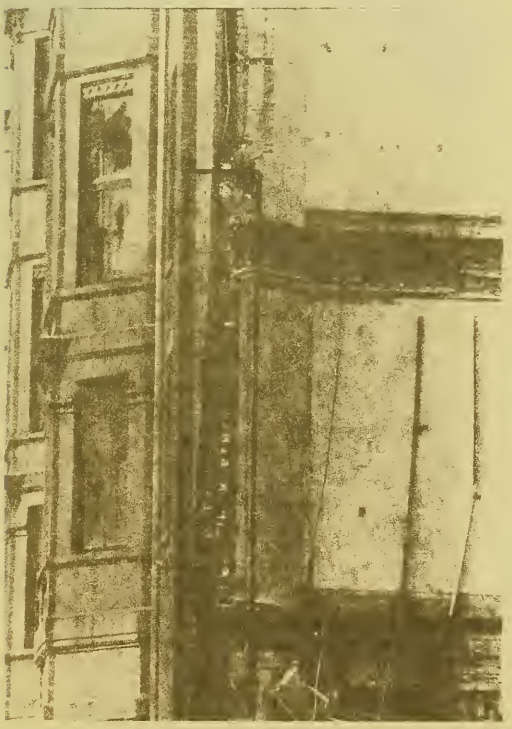


Photo No. 8

E-LINE WALL AT THIRD STORY

Photo No. 9

LOWER PORTIONS OF E-LINE WALL
LAYING AGAINST LADDER TRUCK 15

LOWER PORTIONS OF E-LINE WALL LYING AGAINST LADDER TRUCK 15

Photo No. 9A

Photo No. 10

DUAL BEAMS LAYING ADJACENT TO C-LINE WALL BETWEEN LINES 1 AND 2

Photo No. 11

DUAL BEAMS LAYING ADJACENT TO C-LINE WALL BETWEEN LINES 2 AND 3

Photo No. 12

SINGLE BEAM LAYING ADJACENT TO LINE 2 BETWEEN C-LINE AND E-LINE

Photo No. 13

SINGLE BEAM LAYING BETWEEN
LINES 1 and 2

Photo No. 14

SINGLE BEAM LAYING BETWEEN
LINES 2 AND 3

Photo No. 15

COLUMN LAYING NEAR LINE 2 BETWEEN C-LINE AND D-LINE. BOTTOM PORTION AT BASEMENT FLOOR

Photo No. 16

TOP PORTION OF COLUMN LAYING ACROSS C-LINE WALL

Photo No. 17

COLUMN BASE PLATE
LAYING ON
BASEMENT FLOOR

Photo No. 18

SHEET METAL DUCT AT A-LINE WALL

Photo No. 19

SHEET METAL DUCT AT E-LINE WALL

SHEET METAL DUCT PASSING THROUGH B-LINE WALL
(PHOTO TAKEN SOMETIME BEFORE COLLAPSE)

Photo No. 19A

SECOND FLOOR SUPPORT SYSTEM ASSEMBLED ON GROUND Photo No. 20

Photo No. 21

INTERIOR ENDS OF
REAL 15-INCH BEAMS
AT LINE 2 AND C-
LINE)

Photo No. 22

SADDLE USED TO SUPPORT 12-INCH
BEAMS FROM 10-INCH BEAM (AT
LINE 2 AND D-LINE)

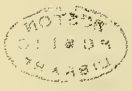


Photo No. 23

WALL POCKETS IN LINE 3 WALL FOR C-LINE AND D-LINE BEAMS

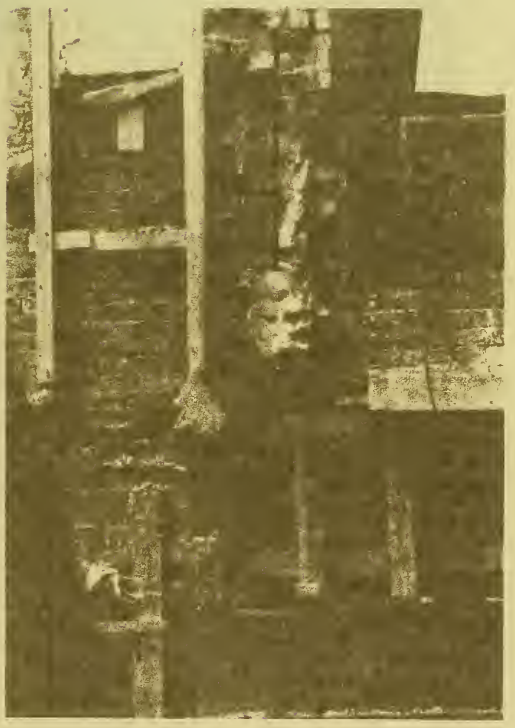


Photo No. 24

SUPPORT AT LINE 1 WALL FOR C-LINE BEAMS


PUBLIC
LIBRARY
BOSTON

Photo No. 25

SUPPORT AT LINE 1 WALL FOR
D-LINE BEAM

COLUMN AND PORTIONS OF C-LINE AND D-LINE BEAMS
(PHOTO TAKEN SOMETIME BEFORE COLLAPSE)

Photo No. 25A


BOSTON PUBLIC LIBRARY
THE TRVSTEES OF THE PVBLIC LIBRARY OF THE CITY OF BOSTON 1852 1878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