ADDRESS: 1416 DIAMOND ST
Proposal: Demolish front façade, the only remaining portion of the building
Review Requested: Final Approval
Owner: Temple University Commonwealth System of Higher Education
Applicant: John Higgins, Higgins Consulting Service
History: 1886, John M. Sharp, builder
Individual Designation: None
District Designation: Diamond Street Historic District, Contributing, 1/29/1986
Staff Contact: Megan Cross Schmitt, megan.schmitt@phila.gov, 215-686-7660

BACKGROUND:
The building at 1416 Diamond Street was originally one of five three-story houses with brownstone façades comprising a row. Currently, only the front façade of the building is standing. Everything behind the front façade has been demolished. The rear of the building was demolished with a permit in 1996. The original application for that permit requested permission to demolish the entire building. However, the Historical Commission only approved the demolition of the rear ell. The 1996 building permit indicated that the south wall would be rebuilt with cinder block and that no alterations would be made to the front façade. Aerial photographs show that the main block of the building was sealed until about 2010, when it appears that the rear wall and rear roof of the main block partially collapsed. Subsequently, the remainder of the building except the front façade was demolished. The Department of Licenses & Inspections declared the facade imminently dangerous on 30 August 2019. The applicant is now applying to demolish the front façade owing to its dangerous condition. The property owner is Temple University, which claims that, as a state entity, it is not subject to local building permit requirements.

SCOPE OF WORK
- Demolition of front masonry facade.

STANDARDS FOR REVIEW:

Section 14-1005(6)(d) of the historic preservation ordinance, the prohibition against demolition:
- *No building permit shall be issued for the demolition of a historic building, structure, site, or object, or of a building, structure, site, or object located within a historic district that contributes, in the Historical Commission's opinion, to the character of the district, unless the Historical Commission finds that issuance of the building permit is necessary in the public interest, or unless the Historical Commission finds that the building, structure, site, or object cannot be used for any purpose for which it is or may be reasonably adapted. In order to show that building, structure, site, or object cannot be used for any purpose for which it is or may be reasonably adapted, the owner must demonstrate that the sale of the property is impracticable, that commercial rental cannot provide a reasonable rate of return, and that other potential uses of the property are foreclosed.*
    - The application implies that the issuance of the building permit is necessary in the public interest to abate the imminently dangerous condition. However, the application does not address the feasibility of abating the dangerous condition by repair. Temple University has owned the property since 1970 and has, apparently, failed to maintain the building in good repair, as required by the preservation ordinance.

STAFF RECOMMENDATION: Denial, pursuant to Section 14-1005(6)(d).

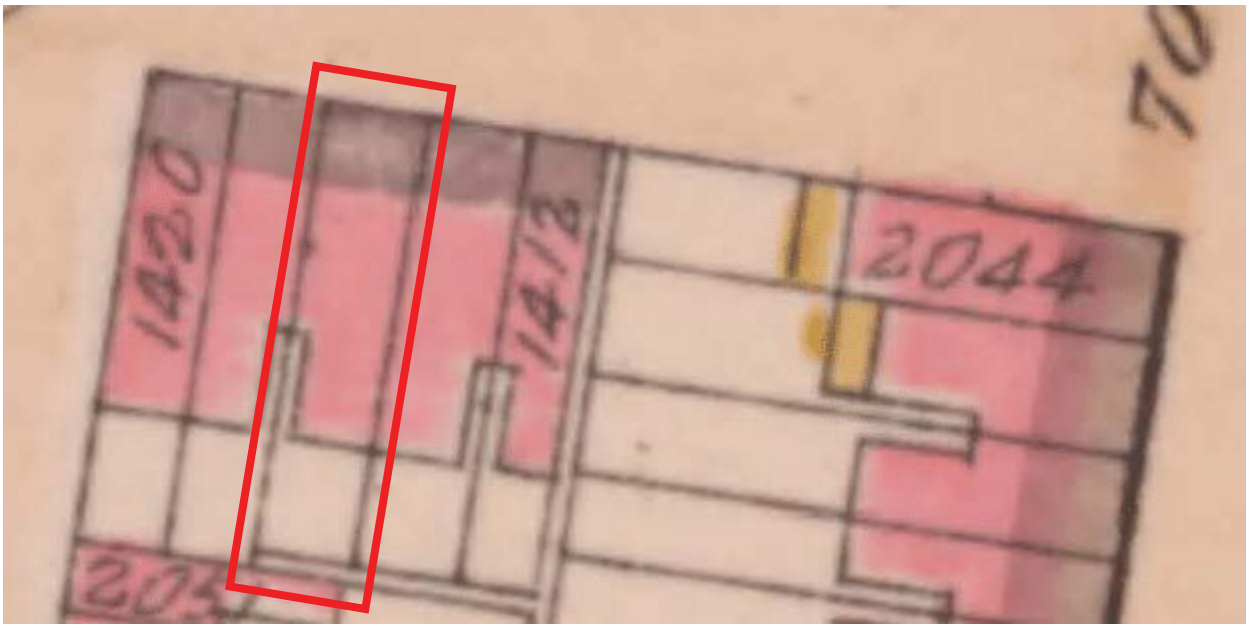


Figure 1. Historic Bromley Atlas, 1895

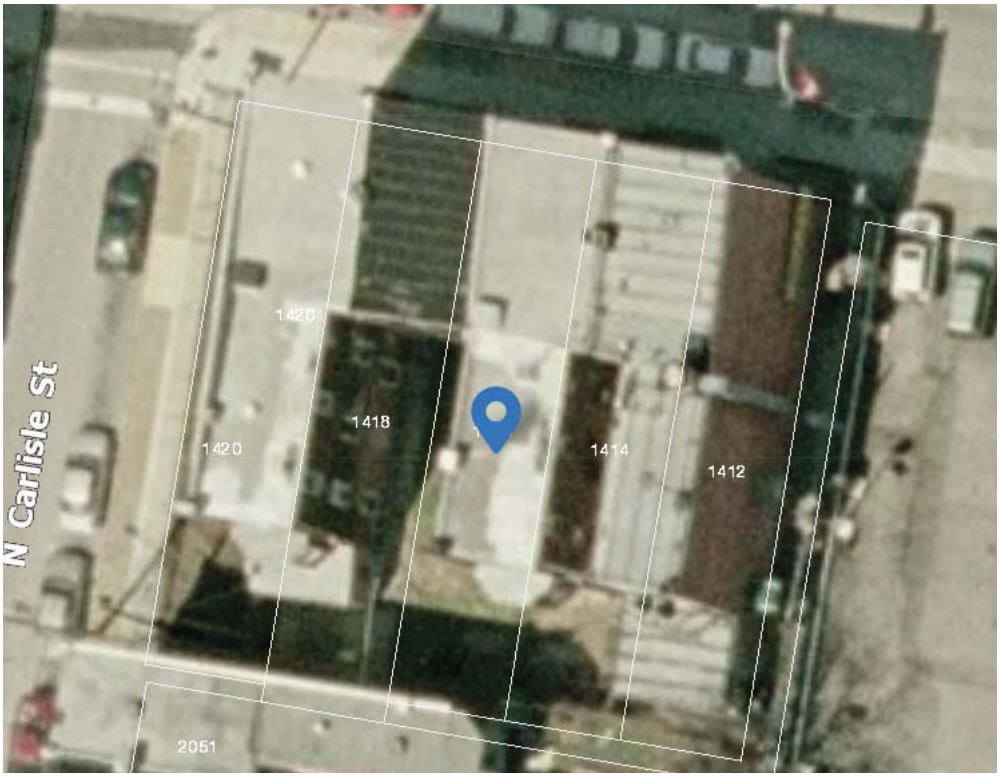


Figure 2. Aerial view of row, CityAtlas, 2004.

Figure 3. View of front facade, Department of Records, 2008.

Figure 4. Aerial view of row, CityAtlas, 2008.

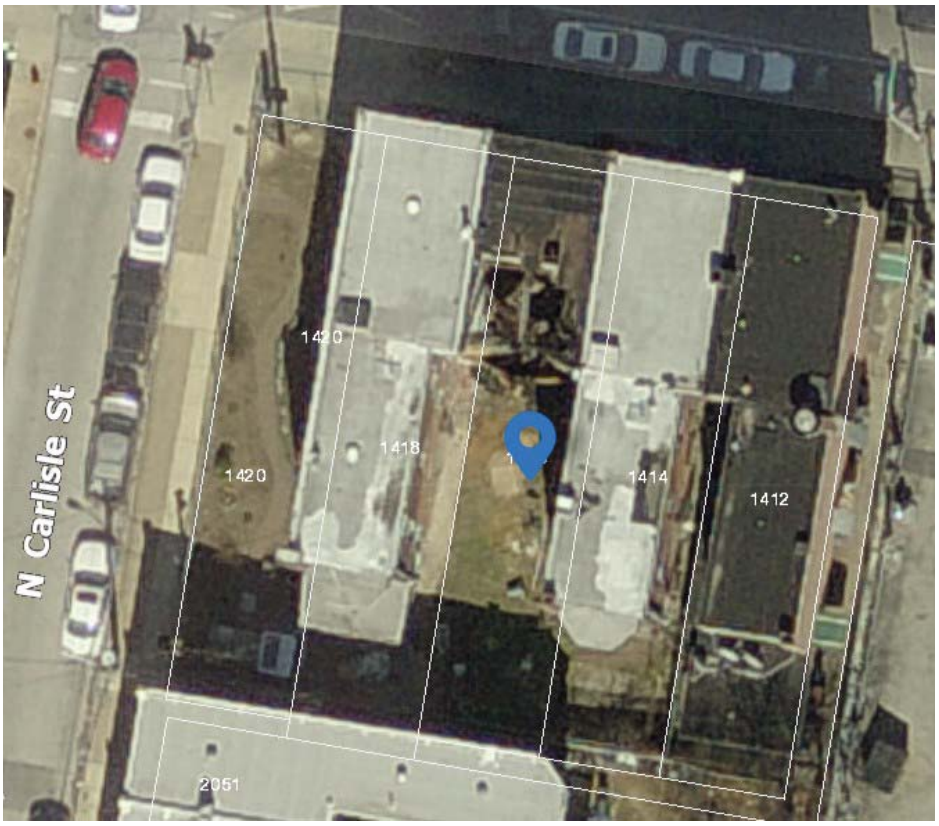


Figure 5. Aerial view of row, CityAtlas, 2010.

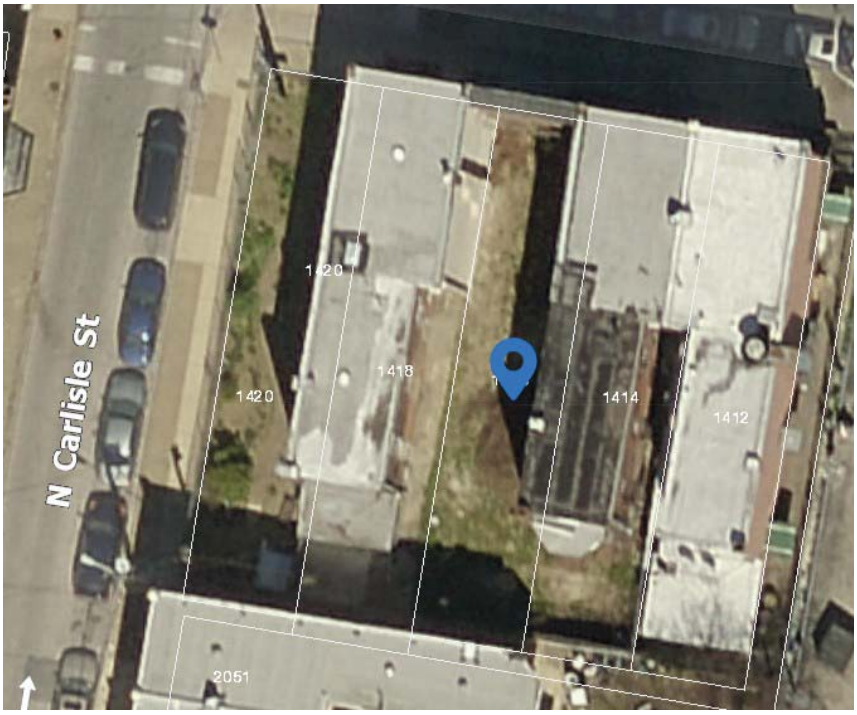


Figure 6. Aerial view of row, CityAtlas, 2012.

APPLICATION FOR BUILDING PERMIT

APPLICATION # _____

(Please complete all information below and print clearly)

CITY OF PHILADELPHIA
DEPARTMENT OF LICENSES AND INSPECTIONS
MUNICIPAL SERVICES BUILDING – CONCOURSE
1401 JOHN F. KENNEDY BOULEVARD
PHILADELPHIA, PA 19102
For more information visit us at **www.phila.gov/li**

ADDRESS OF PROPOSED CONSTRUCTION:
1416 Diamond St, Philadelphia, PA 19121, OPA# 321033900

APPLICANT:
John Higgins (ID 214306)

COMPANY NAME:
Higgins Consulting Service

PHONE # (215) 778-2171 **FAX #**

APPLICANT'S ADDRESS:
1122 Wakeling St
Philadelphia, PA 19124-2510

LICENSE # 39783 **E-MAIL:** higginsjj9@verizon.net

PROPERTY OWNER'S NAME:
Temple University Commonwealth System of Higher Education

PHONE # **FAX #**

PROPERTY OWNER'S ADDRESS:
1009 W Montgomery Ave, Philadelphia, PA 19122

ARCHITECT/ENGINEER IN RESPONSIBLE CHARGE:
N/A

ARCHITECT/ENGINEERING FIRM:

PHONE # **FAX #**

ARCHITECT/ENGINEERING FIRM ADDRESS:

LICENSE # **E-MAIL:**

CONTRACTOR:
TBD

CONTRACTING COMPANY:

PHONE # **FAX #**

CONTRACTING COMPANY ADDRESS:

LICENSE # **E-MAIL:**

USE OF BUILDING/SPACE
Vacant Structure

ESTIMATED COST OF WORK
$ 5,000.00

BRIEF DESCRIPTION OF WORK:
Demolition of front masonry facade to comply ID Case 704424

TOTAL AREA UNDERGOING CONSTRUCTION: 540.00 **square feet**

COMPLETE THESE ITEMS IF APPLICABLE TO THIS APPLICATION:

 # OF NEW SPRINKLER HEADS (suppression system permits only): _____ **LOCATION OF SPRINKLERS:** _____

 # OF NEW REGISTERS/DIFFUSERS (hvac/ductwork permits only): _____ **LOCATION OF STANDPIPES:** _____

IS THIS APPLICATION IN RESPONSE TO A VIOLATION? ☐ NO ☑ YES **VIOLATION #:** 704424

All provisions of the building code and other City ordinances will be complied with, whether specified herein or not. Plans approved by the Department form a part of this application. I hereby certify that the statements contained herein are true and correct to the best of my knowledge and belief. I further certify that I am authorized by the owner to make the foregoing application, and that, before I accept my permit for which this application is made, the owner shall be made aware of all conditions of the permit. I understand that if I knowingly make any false statement herein I am subject to such penalties as may be prescribed by law or ordinance.

APPLICANT'S SIGNATURE: _____ **DATE:** 10 / 24 / 19

(81-3 Rev 5/04)

CITY OF PHILADELPHIA
DEPARTMENT OF LICENSES AND
INSPECTIONS

Municipal Services Building
1401 JFK Blvd., 11th Floor
Philadelphia, PA 19102
215-686-2480
CSU@phila.gov

FINAL NOTICE OF VIOLATION AND ORDER
IMMINENTLY DANGEROUS BUILDING

TEMPLE UNIVERSITY COMMONWEALTH SYSTEM
1101 MONTGOMERY AVE SUITE 311
PHILADELPHIA PA 19122

Case Number:704424

PROPERTY IN VIOLATION: 1416 DIAMOND ST

Date of Notice:08/30/19

Dear Sir/Madam,

This is to inform you that the Department of Licenses and Inspections inspected the subject premises on **08/29/19** and has declared it **IMMINENTLY DANGEROUS**, in whole or in part, pursuant to Section PM15-110.1 of the Philadelphia Property Maintenance Code. The results are included in the violation section below.

You are directed to obtain all necessary permits as required by the City and to make repairs or demolish the structure to remove the imminently dangerous condition. Failure to comply with this order forthwith shall result in the City taking action to demolish the structure and stucco remaining party walls exposed by the demolition as per Department policy. You, the owner, will be billed for all costs incurred by the City, including administrative fees.

This is your final notice, if you have any questions regarding this matter please contact: **INSPECTOR MODRES** at **JOHN.MODRES@phila.gov** or the district office noted above.

VIOLATIONS:

The subject premises is located within a historic district. Neglect of the premises is causing deterioration, decay, and/or damage.
The owner of any such structure is required to keep in good repair the exterior of that historic structure and those interior portions of the structure, neglect of which may cause or tend to cause the exterior to deteriorate, decay, and become damaged or otherwise fall into a state of disrepair.
You must restore those elements that have been allowed to deteriorate and to make those repairs necessary to prevent further deterioration. Restoration must be in accordance with Philadelphia Code of Ordinances requirements for structures located within a historic district. (See 14-2007(8)(c))
LOCATION: Entire
Free standing wall,brown stone de-laminating

THE DEPARTMENT INSPECTED THE SUBJECT STRUCTURE AND DETERMINED IT IS IN IMMINENT DANGER OF COLLAPSE YOU MUST REPAIR OR DEMOLISH SAID STRUCTURE IMMEDIATELY. WHEN THERE IS IMMINENT DANGER OF FAILURE OR COLLAPSE OF A STRUCTURE OR ANY PART THEREOF WHICH ENDANGERS LIFE, OR WHEN ANY STRUCTURE OR PART OF A STRUCTURE HAS FALLEN AND LIFE IS ENDANGERED BY THE OCCUPATION OF THE STRUCTURE, THE CODE OFFICIAL IS AUTHORIZED AND EMPOWERED TO ORDER AND REQUIRE THE OCCUPANTS

TO VACATE THE SAME FORTHWITH IN ACCORDANCE WITH THE CEASE OPERATIONS PROVISIONS SET FORTH IN THE ADMINISTRATIVE CODE. IT SHALL BE UNLAWFUL FOR ANY PERSON TO ENTER SUCH STRUCTURE EXCEPT FOR THE PURPOSE OF MAKING THE REQUIRED REPAIRS OR DEMOLISHING THE STRUCTURE PM-110
LOCATION: Entire
Free standing wall,brown stone de-laminating

You are hereby ordered to obtain the services of a Pennsylvania Licensed Professional Engineer to serve as the design professional in responsible charge pursuant to Administrative Code Section A-304, and maintain, at a minimum, the following responsibilities:
1) Immediately assess the structure to determine the extent of the structural defects and submit those findings along with a timeline of corrective actions to the Department.
2) Design and observe the immediate installation of temporary protections of the public way and adjacent properties.
3) Develop a remediation plan, detailing the extent of the required removal and replacement of structural components and temporary shoring required for the remediation. The remediation plan must contain adequate construction details to confirm code compliance as well as provide the responsible contractor with necessary direction in approaching and completing the necessary repairs.
4) Submit such remediation plan with details to the Department along with an application for a building permit.
5) Provide periodic structural observations of the remediation work throughout the repair process.
6) Inform the Department if a condition arises which poses an immediate threat to public safety.
7) Upon completion of the repairs, submit a sealed statement to the Department that the structure has been made safe.
8) Inform the Department if oversight responsibilities are terminated by the owner.

LOCATION: Entire
Free standing wall,brown stone de-laminating

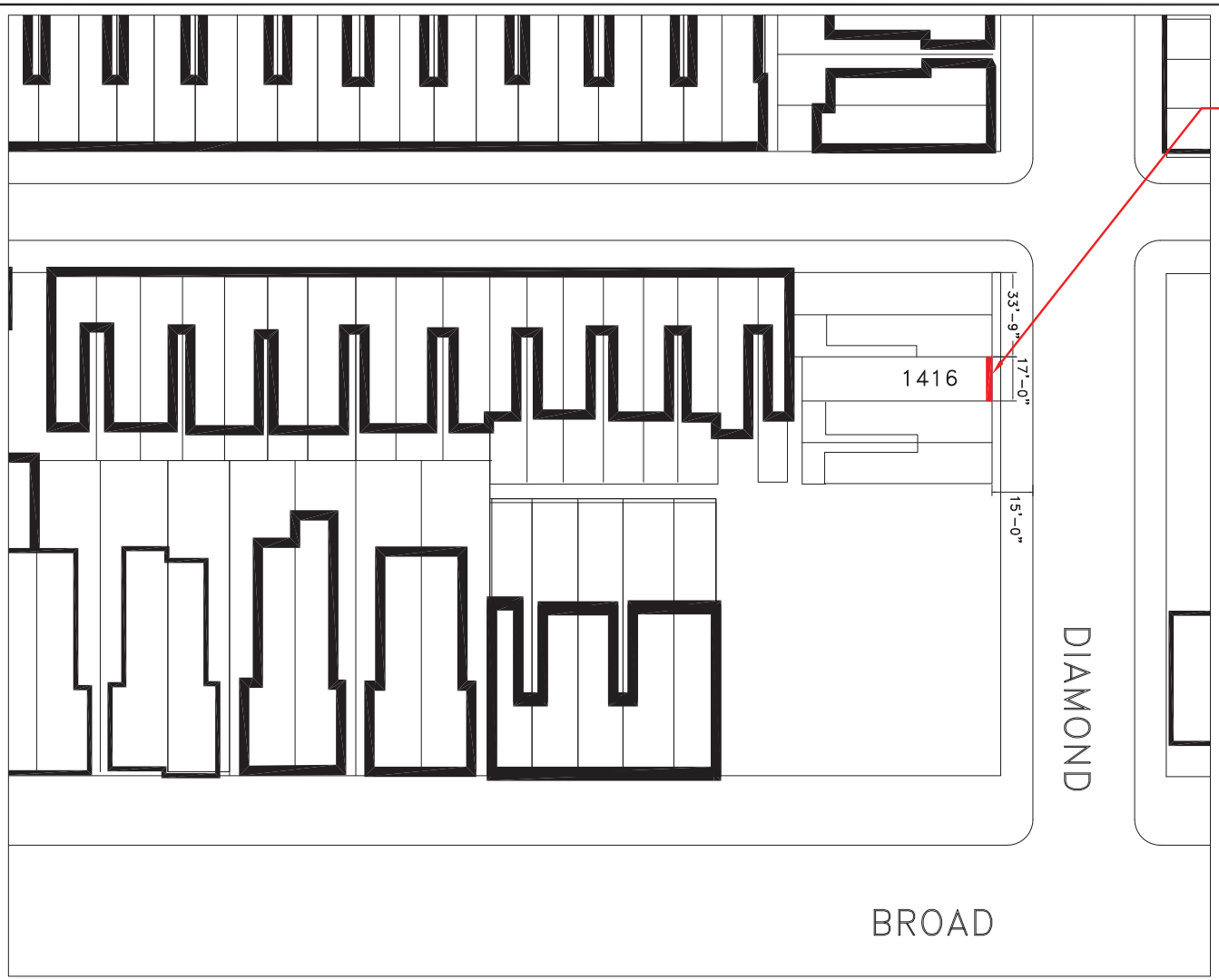
EXTERIOR WALLS ARE NOT ANCHORED TO SUPPORTING AND/OR SUPPORTED ELEMENTS OR ARE NOT PLUMB AND FREE OF HOLES, CRACKS OR BREAKS AND LOOSE OR ROTTING MATERIALS, ARE NOT PROPERLY ANCHORED OR ARE NOT CAPABLE OF SUPPORTING ALL NOMINAL LOADS AND RESISTING ALL LOAD EFFECTS PM-304.1(7)
LOCATION: Entire
Free standing wall,brown stone de-laminating

RIGHT TO APPEAL
You have the right to appeal these violations within five (5) days for Unsafe or Imminently Dangerous violations. Appeals must be submitted in writing on approved forms to the Boards Administration Unit 11th floor Municipal Services Building 1401 John F Kennedy Blvd Philadelphia PA 19102.The appeal form can be downloaded from the L&I website at www.phila.gov/li. If you have any questions call (215) 686-2427.

PENALTIES AND FEES
Fines shall be imposed from 08/30/19 and shall be assessed in the amount of $150 to $2000 per violation each and every day the violation remains uncorrected.

Your failure to correct the violations may result in the revocation or suspension of certain licenses and permits.

Your failure to correct the violations may also result in the City filing a legal action against you to obtain compliance, an injunction, and the imposition of fees and fines.



1416 DIAMOND STREET – EXISTING FACADE FRONT AND VACANT LOT BEHIND.

FACADE TO BE DEMOLISHED.

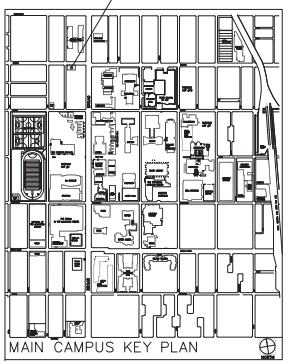
PARGE EXPOSED WALLS OF ADJACENT PROPERTY AFTER DEMO.

LOT TO BE GRADED LEVEL AND STABILIZED USING PERMEABLE MEMBRANE AND STONE OR SEED.

INSTALL 6' CYCLONE FENCE WITH GATE ALONG DIAMOND STREET FRONTAGE AND REPAIR / REPLACE REAR FENCING AS NEEDED.

PHOTO A – FRONT VIEW

PHOTO B – BIRDS EYE VIEW



NO.	REVISION	DATE

HVAC SIGN-OFF DATE
ELECTRICAL SIGN-OFF DATE
PLUMBING SIGN-OFF DATE

DIRECTOR SIGN-OFF DATE

CLIENT SIGN-OFF DATE

The client agrees that any changes following sign-off will result in additional design and/or construction costs which will be charged to the User Department.

TEMPLE UNIVERSITY
Facilities Management
Campus Planning and Design
1009 W. Montgomery Ave
Philadelphia, PA 19122
Tel (215) 204-1400 Fax (215) 204-1700

PROJECT NO: XXXXXXXXXX XXXXX
DATE: XX/XX/XX
SCALE: X=X-X
DRAWN BY: XX
CHECKED BY: XX

1416 DIAMOND STREET
FACADE DEMOLITION

FACADE DEMOLITION

DRAWING NO.

D-1

1 OF 1

ASCENT

30 S. 15th Street, Suite 800
Philadelphia, PA 19102
215-701-3860
info@AscentResto.com

October 22, 2019

Mr. Peter J. McColgan
Temple University, Office of Facilities Management
1009 West Montgomery Avenue
Philadelphia, PA 19122
E: peter.mccolgan@temple.edu

SUBJECT: Exploratory Removal and Laboratory Brick Analysis Report
1416 W. Diamond Street
Philadelphia, PA 19122
ARC No. 066-032-RC

At your request, Ascent Restoration Consultants (Ascent) visited the above-referenced site on October 1, 2019 to visually review exploratory openings and collect brick samples for laboratory analysis at locations identified on the attached exploratory removal scope. The purpose of our review was to determine the specific composition and condition of concealed elements referenced in our façade report dated September 13, 2019.

We selected three (3) exploratory locations for removal of existing brownstone veneer and back-up brick masonry for review and laboratory analysis. The exploratory opening and brick sample removals were completed by Palmer Masonry Restoration. Palmer was unable to complete the requested core sample removal as the existing masonry elements were too soft and deteriorated to anchor the core drill machine. Information needed from the proposed core sample location was gathered from the window infill removal location as well as the laboratory brick analysis.

DESCRIPTION OF BUILDING

The subject property consists of a row home style masonry façade approximately 3-levels above grade and +/- 40'-0" in height. The rowhome structure behind the masonry façade was removed circa 2010 and the masonry façade remains unsupported and exposed at the street and interior sides. The masonry façade elements consist of a brownstone façade at the street side over exposed brick masonry back-up at the interior. The brick masonry back-up appears to consist of three wythes of common brick with a 2" thick applied brownstone veneer. Existing window

openings have been infilled with CMU, covered over with plywood at the exterior and painted to match the brownstone veneer.

According to historic atlases the building was constructed in the late-19th century. This property was listed on the Philadelphia Register of Historic Places on January 29, 1986 within the Diamond Street Historic District.

EXPLORATORY OBSERVATIONS

We observed the following conditions at the identified exploratory openings:

- We confirmed that the existing brick back-up wall is composed of three wythes of common brick. We observed indications of brick failure at exposed brick elements including section loss, erosion, cracks, and spalls. (Photos 1 – 3).
- Existing brownstone veneer is approximately 2" thick. The veneer panels showed evidence of previous repairs with a cementitious material applied to the exterior surface and coated with an unknown material (Photos 4 – 7).
- Parging and coating of existing brownstone may be contributing to the advanced deterioration of existing masonry material. Brownstone is a soft and porous sedimentary rock composed of feldspar, quartz, mica, and iron oxides. Weathering or erosion of brownstone surface are caused by several factors including water infiltration, residual moisture, acidic rain water, snow, temperature fluctuations (freeze/thaw cycles), wind exposure, and atmospheric pollutants. These factors may also contribute to small cracks or fissures in the stone allowing for water infiltration, promoting salt migration and corrosion of supporting elements. Brownstone was commonly installed with the bedding planes of the stone laid vertically, parallel to the façade, to ensure the color and texture was uniform. However, this installation method contributes to the higher frequency of deterioration in brownstone facades. As bedding planes begin to delaminate, the face-bedded brownstone flakes off in sheets leaving an uneven surface and section-loss in the façade (See Photos 6 and 7). Improper patching, parging, and coating of brownstone may create a vapor barrier; trapping residual moisture within the face of the stone and contributing to the deterioration of adjacent brick and brownstone.

LABORATORY BRICK ANALYSIS

We identified locations for brick removal and submitted 11 undamaged brick units for laboratory analysis. Brick samples were sent to Construction Materials Consultants, Inc. located in

Greensburg, Pennsylvania. The full report was completed on October 15, 2019 and is enclosed for your review and reference. The laboratory conducted a comprehensive series of tests for the following:

a) Initial rate of absorption
b) 24-hour cold water absorption
c) 5-hour boiling-water absorption
d) Compressive strength

Brick Absorption

- The analysis found that the "absorption and saturation coefficient values of bricks were above the common ASTM C 216 recommended respective maximum values for facing brick... [and] determined to have poor freeze-thaw durability."
- The ASTM C 216 recommends an average limit value of .78 for saturation; the tested brick was well above .80.
- The absorption tests revealed a very high initial absorption rate.
- The average cold-water absorption value of tested brick was 19.15%, which is significantly higher than the ASTM C 216-recommended maximum 8%.
- The 5-hour boiling absorption values showed similar values as the cold-water absorption, with an average value of 19.51%, which is higher than the ASTM C 216-recommended maximum value of 17%. This indicates not only highly porous nature of the bricks but also high permeability.

Compressive Strength

The analysis found that the average compressive strength results of five bricks were noticeably lower than the ASTM C 216-recommnded minimum values. Four of the five bricks tested gave less than 2000 psi with an average strength of only 1770 psi. The recommended values are between 2500 and 3000 psi. Low strength values are consistent with high water-absorption rate of bricks.

RECOMMENDATIONS

Based on the visual and tactile observations during our façade review on September 13, 2019, the exploratory investigation on October 1, 2019, and laboratory brick analysis completed on October 15, 2019, we do not believe repair and/or restoration of the existing brick and brownstone wall is a

ASCENT

feasible or long-term solution. The existing condition of the brick back-up would require full removal and replacement in order to support a new alternative façade material and/or replacement of brownstone elements in-kind, per our previous report recommendations.

Therefore, we recommend demolition of the remaining masonry wall. Prior to demolition, the masonry of adjacent rowhomes must be reviewed by a Professional Engineer to determine the necessary protection and support required. Demolition must be completed by a qualified contractor in accordance with applicable standards. It is understood that the building is designated on the Philadelphia Register of Historic Places and approval would be required prior to obtaining a demolition permit from the City of Philadelphia Department of Licenses and Inspection.

Please let us know if we can be of further assistance.

Ascent Restoration Consultants

Becky Sell, Vice President
E: BSell@ascentresto.com

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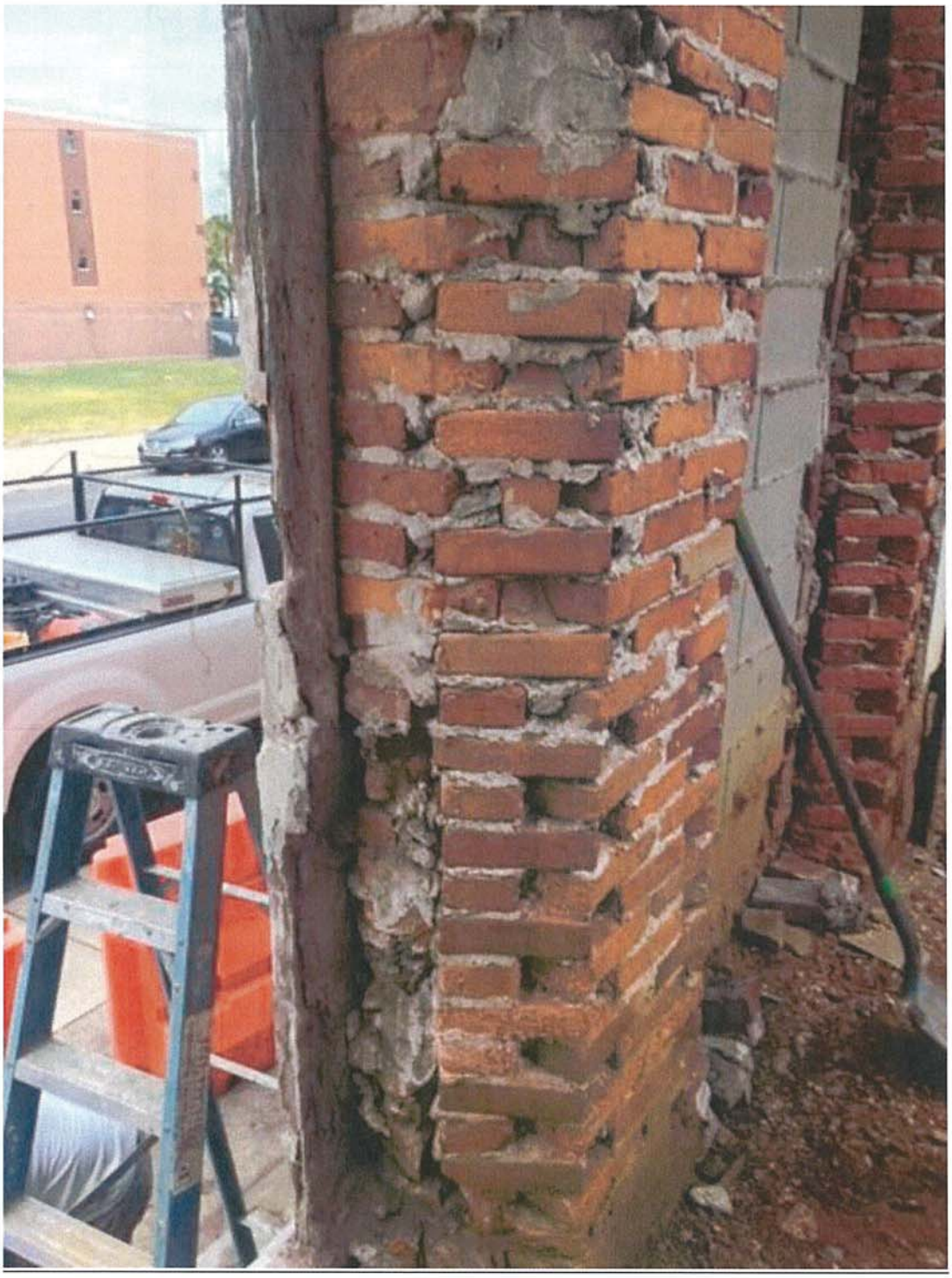


Photo 1

Photo 2

Photo 3

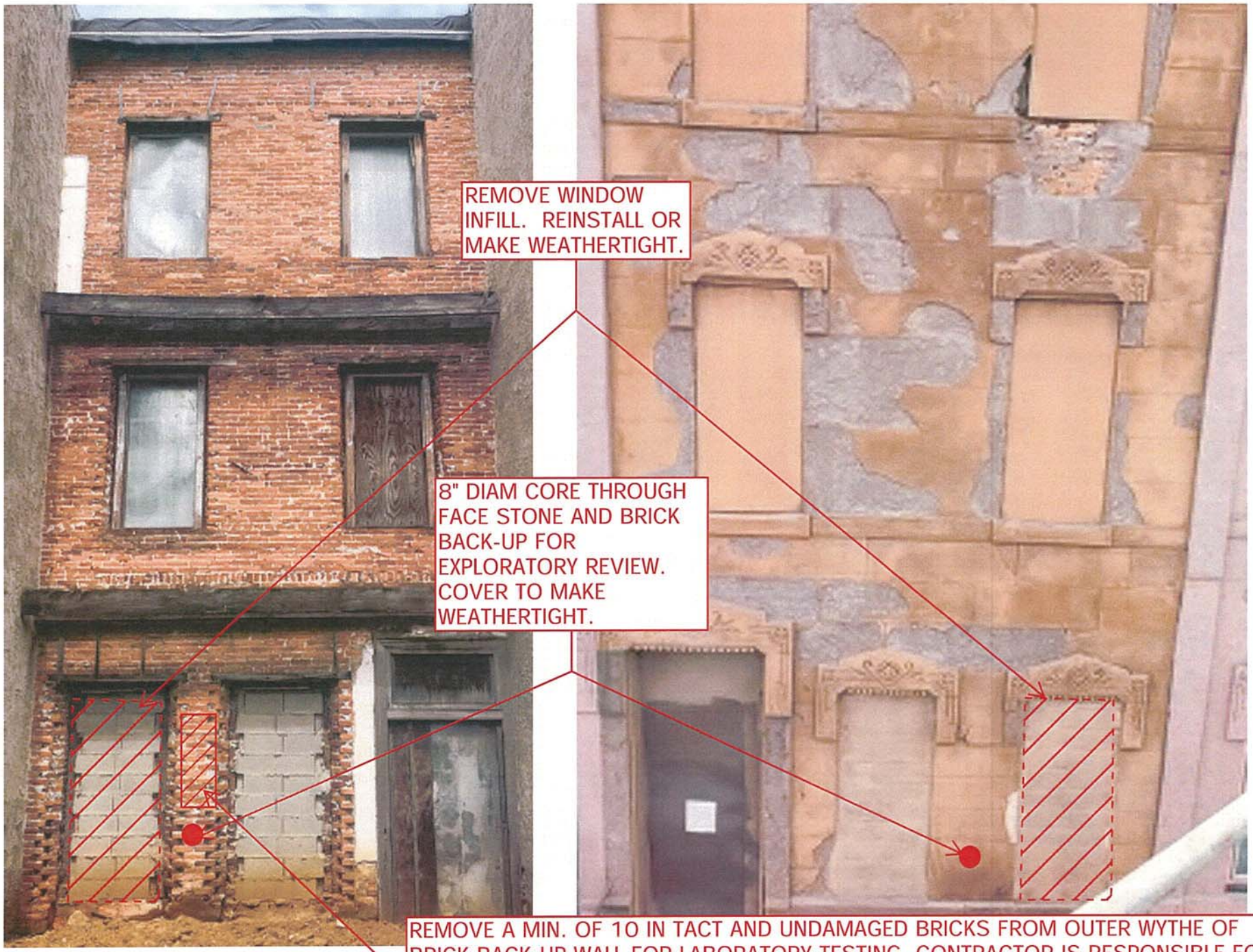
Photo 4

Photo 5

Photo 6

Photo 7

1416 W. DIAMOND STREET - EXPLORATORY REMOVAL SCOPE
9/27/2019



CONSTRUCTION MATERIALS CONSULTANTS, INC.

Laboratory Testing of Brick Masonry Units

1416 W. Diamond Street
Philadelphia, Pennsylvania

Prepared for:
Ascent Restoration Consultants, Inc.

October 15, 2019
CMC 1019158

Construction Materials Consultants, Inc.

Berkshire Center, Suite 104
4727 Route 30
Greensburg, PA 15601 USA
Phone: 724-834-3551
Fax: 724-834-3556
www.cmc-concrete.com

October 15, 2019

Becky Sell
Ascent Restoration Consultants, Inc.
30 S. 15th Street
Suite 800
Philadelphia, PA 19102

RE: 1416 W. Diamond Street, Philadelphia, Pennsylvania

Dear Ms. Sell:

Construction Materials Consultants, Inc. (CMC) is pleased to provide the enclosed comprehensive report on 'Laboratory Testing of Brick Masonry Units," for eleven bricks taken from 1416 W. Diamond Street in Philadelphia, Pennsylvania.

Results, opinions, and conclusions presented herein are based on the information and samples provided at the time of this investigation. We reserve the right to modify the report as additional information becomes available. Neither CMC nor its employees assume any obligation or liability for damages, including, but not limited to, consequential damages arising out of, or in conjunction with the use, or inability to use this resulting information.

Sample residues will be returned after submission of the report as requested. All reports are the confidential property of clients, and information contained herein may not be published or reproduced pending our written approval.

Please feel free to contact us with any additional questions. We look forward to providing our services again for your future projects.

Sincerely Yours,

CONSTRUCTION MATERIALS CONSULTANTS, INC.

Dipayan Jana, PG
President, Petrographer

DJ:jlh

TABLE OF CONTENTS

EXECUTIVE SUMMARY

The present study involves laboratory examination of brick masonry units collected from exposed wythe of a building located at 1416 W. Diamond Street in Philadelphia, PA. The bricks were tested according to the methods of ASTM C 67 for: (a) initial rate of absorption, (b) 24-hour cold-water absorption, (c) 5-hour boiling-water absorption, and (d) compressive strength. Results obtained from these tests were used to evaluate freeze-thaw durability and assess potential conformance to ASTM C 216 facing bricks.

A total of eleven full brick units were received, where Individual whole brick units measure $8^1/_2$ (215 mm) in length × $4^1/_4$ in. (108 mm) in width × $2^1/_4$ in. (57 mm) in thickness. Bricks are reddish-brown fired clay units that show soft, dusty surfaces and visible chipping, microcracking and other artifacts indicating an inherently poor quality from visual examinations.

The eleven brick samples received were sectioned in half, and at least five one-half brick units without any visual cracking or chipping were used for compressive strength. The opposite ends from each brick, after sectioning and initial sample preparation (e.g., removal of all adhering mortars) were weighed in air, then in oven-dry condition (dried at 100°C for 24 hours to constant masses then cooled down to room temperature for measuring oven-dried weights), followed by partial immersion of one (preferably exposed) side of each half-brick unit over metal rods on $^1/_8$ in. thick water for a minute for initial rate of absorption, followed by complete immersion in cold water for 24 hours to determine 24-hour cold water absorption; which was then followed by complete immersion of five visually sound (crack and chip-free) half-units in boiling water for 5 hours to determine the weights after 5-hr. immersion in boiling water and hence the 5-hr boiling water absorption. The initial rate of absorption determines the suction properties of bricks and hence based on high or low suction assessment of appropriate mortar of high or low water retention properties, respectively to be used. The 24-hour cold-water absorption determines the volume of easily fillable void spaces in bricks, whereas the 5-hr. boiling water absorption determines the volume of all fillable pore spaces in bricks.

The initial rate of absorption of all brick units tested are high, i.e., higher than 30 g/min/30 sq. in. indicating a high suction property of all bricks. The high (average 56 g/min/30 sq.in.) initial rate of absorptions of individual brick units require use of a mortar having high water retention properties, which is commonly achieved by using high lime content in the mortars, e.g., by use of a lime mortar or a high-lime cement-lime mortar.

The cold and boiling water absorption values are very high, which is consistent with high initial rate of absorption (suction) of bricks. The average cold-water absorption value is 19.15 percent, which is significantly higher than the ASTM C 216-recommended maximum 8 percent absorption values of facing bricks, indicating an inherently soft, porous, highly absorptive nature of the bricks. The 5-hour boiling absorption values show similar values as the cold-water absorption, with an average value of 19.51 percent, which is higher than the ASTM C 216 recommended maximum value of 17 percent, which indicates not only highly porous nature of the bricks but also of high permeability where almost all fillable pore spaces in the bricks are already filled by water during cold water absorption with not much pore spaces left for forceful filling with the boiling water.

The saturation coefficient, which is the ratio of cold-to-boiling water absorptions, i.e., the measure of easily-filled-to-total-fillable pore space, i.e., relative volume of open space in the brick after free absorption has taken place is also very high in all bricks tested. The individual and average saturation coefficients of bricks are significantly higher than the maximum ASTM C 216 recommended average value of 0.78 (individual bricks show well above 0.80) and hence are considered susceptible to freezing-related damages (cracking, spalling, chipping, etc.) in a moist outdoor environment of cyclic freezing and thawing at critically saturated conditions.

Compressive strengths of bricks are all low, four out of five bricks gave less than 2000 psi strength with an average strength of only 1770 psi, which is noticeably lower than the ASTM C 216-recommended minimum values of 2500 psi and 3000 psi, respectively. Such low strength values are consistent with high water-absorption of bricks.

Comparing industry-recommended values of absorptions, saturation coefficients, and compressive strengths for ASTM C 216 SW grade bricks with the present bricks' results showed gross out-of-conformance in noticeably lower than the minimum requirements of compressive strengths, above the maximum average boiling-water absorption, and above the maximum average and individual saturation coefficient values. The bricks are thus found to have poor freeze-thaw durability in a cold-weather environment in the presence of moisture as anticipated for the reported exposed wythe in Philadelphia, PA. These bricks require use of high-lime jointing mortars of high water retention.

INTRODUCTION

Reported herein are the results of detailed laboratory studies of eleven brick samples, reportedly collected from the exposed wythe of a building located at 1416 W. Diamond Street in Philadelphia, Pennsylvania. Becky Sell of Ascent Restoration Consultants, Inc. provided the samples.

1416 W. DIAMOND STREET, PHILADELPHIA, PA

Figure 1 shows photographs of the front and back of the building, as well as location from which the samples were taken.

Figure 1: Photographs of the front and back of the building showing the location from which the samples were taken, and condition of the bricks in the field.

Based on the above background information, photographs, and samples provided, and the requested laboratory testing, the purposes of the laboratory investigations are to determine:

a) Cold and boiling water absorptions, saturation coefficients, and freeze-thaw durability of bricks;
b) Initial rate of absorption (suction) properties of bricks; and,
c) Compressive strengths of bricks.

BRICKS

Figure 2 shows eleven (1) brick units, as received, and white dashed lines on each brick to saw-cut for absorption and saturation coefficient studies, and/or initial rate of absorption from one end piece of each brick, and compressive strength testing from the opposite piece of five bricks. Individual whole brick units are 8½ (215 mm) in length × 4¼ in. (108 mm) in width × 2¼ in. (57 mm) in thickness.

Figure 2: Shown are eleven brick units identified as Nos. 1 through 11. White dashed lines on bricks indicate locations to cut; portions were used for compressive strength testing, and the opposite portions were used for absorption, etc.

METHODOLOGIES

BRICKS

The brick samples were tested by following the methods of ASTM C 67 "Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile." Four tests done on bricks are: (i) initial rate of absorption (suction); (ii) cold and boiling water absorption, (iii) saturation coefficient, which is the ratio of cold to boiling water absorption, and (iii) compressive strengths of bricks. At least five good size half brick units were selected that do not have any chipping or visible cracking and tested for all the above-mentioned tests.

Initial rate of Absorption (Suction), and Cold and Boiling Water Absorption

According to ASTM C 67 absorption tests for bricks, and, ASTM C 216 specification for facing bricks, brick samples to be analyzed for absorption tests (i.e. a single set of five 'half-brick' samples) must come from one location i.e. five half-bricks per location of each building should be collected, which will constitute one set of sample, from where a five-brick average will be calculated and used for comparison with the ASTM C 216 specification of facing bricks.

The eleven brick samples received were sectioned in half, and at least five one-half brick units without any visual cracking or chipping were used for compressive strength. The opposite ends from each brick, after sectioning and initial sample preparation (e.g., removal of all adhering mortars) were weighed in air, then in oven-dry condition (dried at 100°C for 24 hours to constant masses then cooled down to room temperature for measuring oven-dried weights), followed by partial immersion of one (preferably exposed) side of each half-brick unit over metal rods on $^1/_8$ in. thick water for a minute for initial rate of absorption, followed by complete immersion in cold water for 24 hours to determine 24-hour cold water absorption; which was then followed by complete immersion of five visually sound (crack and chip-free) half-units in boiling water for 5 hours to determine the weights after 5-hr. immersion in boiling water and hence the 5-hr boiling water absorption. The initial rate of absorption determines the suction properties of bricks and hence based on high or low suction assessment of appropriate mortar of high or low water retention properties, respectively to be used. The 24-hour cold-water absorption determines the volume of easily fillable void spaces in bricks, whereas the 5-hr. boiling water absorption determines the volume of all fillable pore spaces in bricks.

Saturation Coefficients

Saturation coefficient is the ratio of cold-to-boiling water absorptions, i.e., the measure of easily-filled-to-total-fillable pore space, i.e., relative volume of open space in the brick after free absorption has taken place. It determines the amount of pore spaces in the bricks that can be easily filled with water; which in turn, determines the ease of reaching the critical degree of saturation and hence, the freeze-thaw durability. Saturation coefficient

is, therefore, the measure of freeze-thaw durability of bricks. Bricks having average saturation coefficients higher than the maximum ASTM C 216 recommended average value of 0.78 (individual bricks above 0.80) are considered susceptible to freezing-related damages (cracking, spalling, chipping, etc.) in a moist outdoor environment of cyclic freezing and thawing at critically saturated conditions.

Compressive Strength

One portion (about half-length sections) of five bricks were used for compressive strength. Each piece was cleaned from all adhering mortars, prepared, sulfur-capped, and tested in air-dry conditions.

ABSORPTIONS AND SATURATION COEFFICIENTS OF BRICKS

The determined initial rate of absorptions, cold-water and boiling-water absorptions, and saturation coefficients of individual brick samples are as follows:

Sample ID	Oven-dried Initial Rate of Absorption (g/min/30 sq. in.)	24-h Cold Water Absorption (%)	5-h Boiling Water Absorption (%)	Saturation Coefficient (Cold-to-Boil Water Absorption Ratio)	Comments
1A	26.67	18.63	-	-	• Very high initial rate of absorption, require jointing mortar having high water retention (e.g., high lime mortar) • Saturation coefficient exceeded the ASTM C 216 recommended maximum average limit of 0.78 with at least one brick exceeding 0.80 value – not durable in a cyclic freezing and thawing environment
1B	38.50	18.72	18.63	1.00	
2A	78.46	18.54	-	-	
3A	44.53	20.30	-	-	
4A	37.92	20.64	-	-	
4B	50.40	20.20	-	-	
5A	100.37	19.39	20.44	0.95	
5B	96.08	18.84	20.62	0.91	
6A	51.12	20.12	-	-	
7A	32.78	18.90	19.59	0.96	
8A	56.42	16.94	18.27	0.93	
10A	63.33	18.74	-	-	
10B	75.38	19.08	-	-	
11	32.76	19.12	-	-	
Average	**56.05**	**19.15**	**19.51**	**0.95**	

Table 1: Initial rate of absorption (suction), cold & boiling water absorptions, and saturation coefficients of bricks. All bricks have failed the requirement in saturation coefficient of ASTM C 216 facing bricks.

The following information can be obtained from the above results of initial rate of absorption and cold and boiling water absorption and saturation coefficient of bricks:

(a) The initial rate of absorption of all brick units tested are high, i.e., higher than 30 g/min/30 sq. in. indicating a high suction property of all bricks. This requires use of jointing mortar having high water retention property, which is commonly attained by using a high lime component in the mortar, preferably a lime mortar or an ASTM C 270 Type O lime-rich cement-lime mortar;

(b) The 24-h cold-water absorption values of individual bricks are very high, which is consistent with the high initial rate of absorption. The average cold-water absorption values is 19.15 percent, which is significantly higher than the ASTM C 216-recommended maximum 8 percent absorption values of facing bricks, indicating an inherently soft, porous, highly absorptive nature of the bricks.

(c) The 5-hour boiling absorption values show similar values as the cold-water absorption, with an average value of 19.51 percent, which indicates not only highly porous nature of the bricks but also of high permeability where almost all fillable pore spaces in the bricks are already filled by water during cold water absorption with not much pore spaces left for forceful filling with the boiling water.

(d) As a result, the saturation coefficient, which is the ratio of cold-to-boiling water absorptions, i.e., the measure of easily-filled-to-total-fillable pore space, i.e., relative volume of open space in the brick after free absorption has taken place is also very high in all bricks tested. It determines the amount of pore spaces in the bricks that can be easily filled with water; which in turn, determines the ease of reaching the critical degree of saturation and hence, the freeze-thaw durability. Saturation coefficient is, therefore, the measure of freeze-thaw durability of bricks. The individual and average saturation coefficients of bricks are significantly higher than the maximum ASTM C 216 recommended average value of 0.78 (individual bricks show well above 0.80) and hence are considered susceptible to freezing-related damages (cracking, spalling, chipping, etc.) in a moist outdoor environment of cyclic freezing and thawing at critically saturated conditions.

Therefore, both absorption and saturation coefficient values of bricks are well above the common ASTM C 216 recommended respective maximum values for facing bricks in a severe weather environment and are thus determined not to be durable in an outdoor environment of cyclic freezing and thawing. All bricks tested are thus determined to have poor freeze-thaw durability.

COMPRESSIVE STRENGTHS OF BRICKS

For compressive strength testing, the bricks were sectioned in half, as mentioned before, prepared according to ASTM C 67, and tested for compression in their air-dry conditions. Individual bricks and the average of five bricks are noticeably lower than the ASTM C 216-recommended minimum values of 2500 psi and 3000 psi, respectively, indicating poor strengths of brick units (which are also consistent with the very high water absorption values).

Brick#	Area (sq.-in.)	Failure Load (lbs.)	Compressive Strength (psi.)
2	18.70	35455	1900
6	17.67	23190	1310
7	17.46	24295	1390
8	16/92	38485	2270
9	18.70	37070	1980
Average			**1770**

Table 2: Compressive strengths of bricks. Average strength results of five bricks are noticeably lower than the ASTM C 216 minimum strength of 3000 psi for facing bricks in a severe weather environment. Strengths of individual bricks are also lower than the ASTM C 216-recommended minimum strength of 2500 psi for facing bricks.

LACK OF CONFORMANCE TO ASTM C 216 SW GRADE BRICKS

The following Table shows the common industry (ASTM C 216) requirements for a facing brick in a severe weather environment, subjected to cyclic freezing and thawing, which is anticipated environment of the reported exposed wythe in Philadelphia:

Grade	Minimum Compressive Strength, psi, gross area		Maximum water absorption by 5-hour boiling		Maximum Saturation Coefficient (Cold/Boil Water absorption)	
SW (Severe Weather Bricks)	Average of 5 bricks	Individual	Average of 5 bricks	Individual	Average of 5 bricks	Individual
	3000	2500	17.0	20.0	0.78	0.80

Table 3: ASTM C 216 requirements for a facing brick in a severe weather environment.

Comparing industry-recommended values of absorptions, saturation coefficients, and compressive strengths for ASTM C 216 SW grade bricks in Table 3 with the present bricks' results in Tables 1 and 2, the present bricks show values that are grossly out-of-conformance in noticeably lower than the minimum requirements of compressive strengths, above the maximum average boiling-water absorption, and above the maximum average and individual saturation coefficient values. The bricks are thus found to have poor freeze-thaw durability in a cold-weather environment in the presence of moisture.

CONCLUSIONS

The high (average 56 g/min/30 sq.in.) initial rate of absorption of individual brick units require use of a mortar having high water retention properties, which is commonly achieved by using high lime content in the mortars, e.g., by use of a lime mortar or a high-lime cement-lime mortar. The average compressive strength of only 1770 psi for bricks indicate use of a mortar having strengths noticeably lower than the brick strength, which, again is achieved by use of a high-lime content in the mortar.

The cold and boiling water absorption values are very high, which is consistent with high initial rate of absorption (suction) of bricks. The average cold-water absorption value is 19.15 percent, which is significantly higher than the ASTM C 216-recommended maximum 8 percent absorption values of facing bricks, indicating an inherently soft, porous, highly absorptive nature of the bricks. The 5-hour boiling absorption values show similar values as the cold-water absorption, with an average value of 19.51 percent, which is higher than the ASTM C 216 recommended maximum value of 17 percent, which indicates not only highly porous nature of the bricks but also of high permeability where almost all fillable pore spaces in the bricks are already filled by water during cold water absorption with not much pore spaces left for forceful filling with the boiling water.

The saturation coefficient, which is the ratio of cold-to-boiling water absorptions, i.e., the measure of easily-filled-to-total-fillable pore space, i.e., relative volume of open space in the brick after free absorption has taken place is also very high in all bricks tested. The individual and average saturation coefficients of bricks are significantly higher than the maximum ASTM C 216 recommended average value of 0.78 (individual bricks show well above 0.80) and hence are considered susceptible to freezing-related damages (cracking, spalling, chipping, etc.) in a moist outdoor environment of cyclic freezing and thawing at critically saturated conditions.

Compressive strengths of bricks are all low, four out of five bricks gave less than 2000 psi strength with an average strength of only 1770 psi, which is noticeably lower than the ASTM C 216-recommended minimum values of 2500 psi and 3000 psi, respectively. Such low strength values are consistent with high water-absorption of bricks.

REFERENCES

ASTM C 67, "Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile," In Annual Book of ASTM Standards, Section Four Construction, Vol. 04.05 Chemical-Resistant Nonmetallic Materials; Vitrified Clay Pipe; Concrete Pipe; Fiber-Reinforced Cement Products; Mortars and Grouts; Masonry; Precast Concrete; ASTM Committee C15.02 on Cement, 2019.

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END OF REPORT[1]

[1] The CMC logo is made using a lapped polished section of a 1930's concrete from an underground tunnel in the U.S. Capitol.