

TOWN OF CHAPEL HILL

2008



# WALLACE PARKING FACILITY

FEASIBILITY STUDY TO BUILD ON THE PLAZA LEVEL

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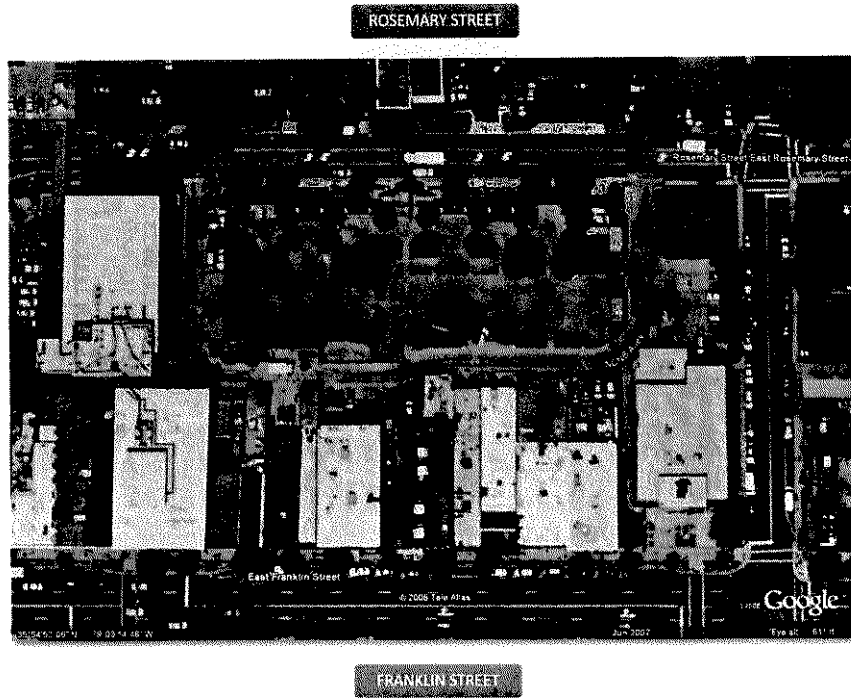


Image 1. AERIAL VIEW OF WALLACE PARKING FACILITY VICINITY

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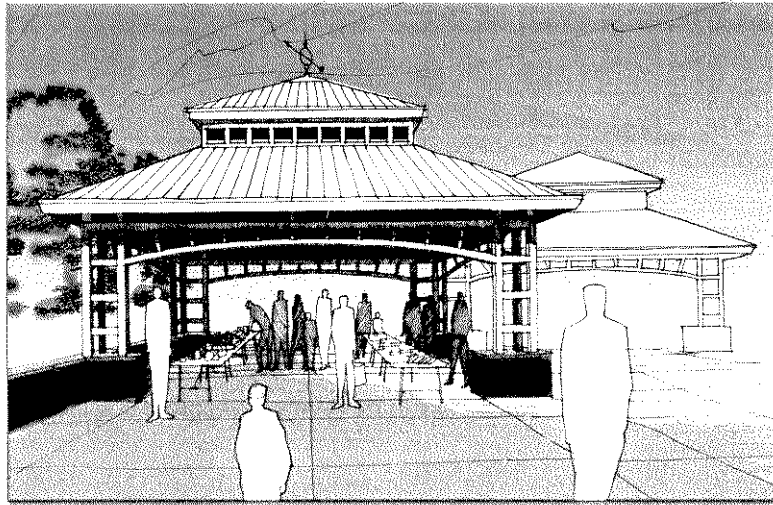
**Image 2. VIEW OF WALLACE PARKING FACILITY FROM  
BANK OF AMERICA BUILDING**

## **I. Introduction**

MHAworks, PA prepared this Feasibility Study for the Town of Chapel Hill (TOCH) in accordance with the tasks outlined in an Agreement between MHAworks, PA and TOCH dated May 22, 2008. The engineering team for this study includes FDH Engineering (Neil Kuplic, PE), Raleigh, NC, for structural engineering and Sigma Engineered Solutions (Massoud Eftekhari, PE), Raleigh, NC, for utility engineering.

The purpose of this study is to identify and evaluate potential buildable area as well as the number of stories that can be added to the top level (plaza level) of the existing Wallace Parking Facility.

This report is intended to provide sufficient information to assist TOCH in future planning for the plaza level.

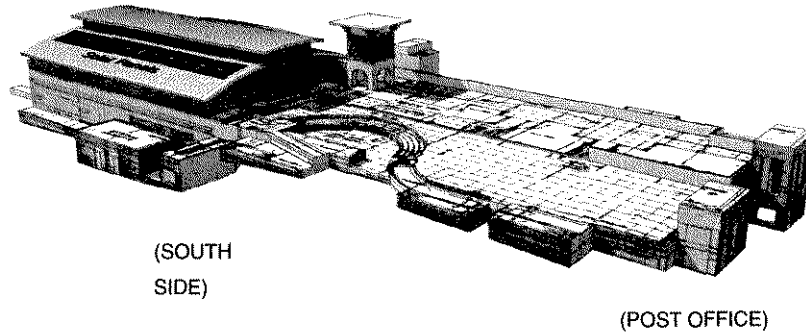
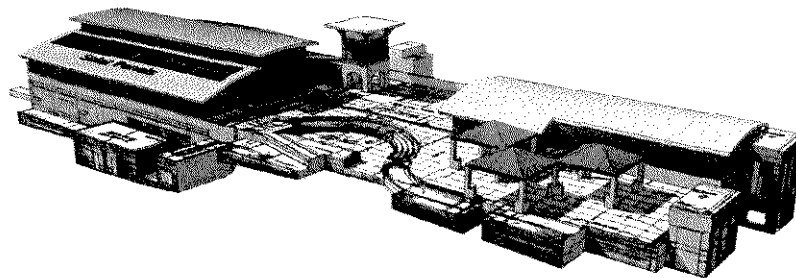


**Image 3. POTENTIAL DEVELOPMENT ON THE  
PLAZA LEVEL OF WALLACE PARKING FACILITY**

## **II. Scope of Work**

Per Agreement between MHAWorks, PA and TOCH, this report is providing:

1. A summary statement of the feasibility of adding one or more stories of enclosed area on the top level of the existing structure. The area limits of construction will be noted.
2. Conceptual plans indicating allowable buildable areas.
3. Analysis of utility system, sewer, water, electrical capabilities and note any upgrades which may need to be made, such as, a larger electrical service box.
4. A structural statement specifically defining the plaza level additional capacity, if any, given current building code requirement. This statement will be relative to the additional capacity that would not require significant structural modification of the existing structure.
5. Additional building code reviews for exit ways, fire separations, mixed use potential and accessibility requirement, both pedestrian and vehicular.
6. A statement of required versus available services such as deliveries of materials and trash removal.
7. A statement of probable construction costs on a per square foot basis.
8. A brief listing of potential "green" energy saving items.
9. Meeting notes from a pre-review conference with the North Carolina Department of Insurance.

(BANK OF  
AMERICA)**Image 4. CONCEPT SKETCH FOR 10,000 SQUARE FOOT ADDITION****Image 5. CONCEPT SKETCH FOR ADDITIONAL EXPANSION**

### III. Executive Summary

This study demonstrates the ability to construct a single or two-story structure on top of the existing Wallace Parking Facility. The study demonstrates that the original 1991 design intent to build a 10,000 -12,000 square foot addition is still valid, as the existing service utilities are adequate and the facility is structurally sound. Conclusions:

1. It is possible to build at least a 10,000 square foot addition on the plaza level of the existing parking facility without modifying existing structure or adding utilities;
2. The existing water and sewer utilities are adequate to build up to 30,000 square feet without major upgrades;
3. Electrical service would require minor modification above 5,000 square feet, but the required capacity is readily available;
4. The existing structure is suitable to build a one story addition over virtually the entire plaza without seismic upgrades;
5. Most existing Life Safety components comply with the current NC State Building Code, although all handrails need to be 2 inches higher and guardrails need to be provided on the stairways between flights;
6. The delivery and trash removal services should not be affected by an addition. The frequency of the services might require an increase in weekly emptying;
7. The probable price of the new construction would be approximately \$200 per square foot depending on amenities provided.

Concept sketches provide ideas of possible Wallace Parking Facility development. Image 4 represents a 10,000 square foot building located on the West side of the plaza and complies with original 1991 design. Image 5 shows additional potential expansion.



## IV. Major Developmental Elements

### 1. ARCHITECTURAL

The Wallace Parking Facility built in 1992 is located on Rosemary Street in Chapel Hill. The Facility is close to public transportation and within walking distance of the UNC campus. This parking facility was designed in 1991 by MHAworks, PA, formerly Michael Hining Architects.

The Facility covers approximately 35,000 square feet of area with five split level parking tiers. The parking levels are connected with vehicular ramps, stairs and an elevator. There are bathroom facilities at the level of the South Alley. An Electrical/Utility room is located beneath the bathrooms. An Elevator Machinery room is adjacent to the elevator shaft located on the North side. The top level serves as a pedestrian plaza connecting the South Alley and Rosemary Street via stairs and elevator.

The open top level (pedestrian plaza) is a structural concrete slab with concrete topping. Trees and shrubs in brick masonry planters complete the landscaping features.

The original 1991 design allowed for the construction of 10,000 to 12,000 square feet of building at the West end of the plaza level (Image 6). This addition would be accommodated by replacing the existing landscaping features with the new structure. Service utility connections for the addition already exist for the sprinkler system. Water and sewer stub-outs are located in the utility room. Electrical service connections are accessible from manholes surrounding the facility. The existing elevator has the capacity to serve the addition.

This study concludes that plumbing and electrical utilities and structural basis are available to build at least a 10,000 square foot building. Additional expansion up to 30,000 square feet will not require major modifications to the existing utility systems, except electrical services. This is discussed in more detail on Section IV-6 of this report.

As noted in the Structural report, Section IV-3, the weight of the existing planters, soil, trees and plants once removed would be replaced with the new conventional metal frame structure. The new weight per square foot cannot exceed the existing removed dead load of the plaza level by more than 5%, unless the structure is brought fully into compliance with current Building Code and structural requirements. Given these added structural, and other requirements, it is recommended that any addition not exceed 2 stories in height.

If the new construction occurs on the West side of the plaza, an additional exit from the plaza level via stair or bridge to the adjacent high rise building would be required to provide sufficient exit access travel distance (per NCSBC T1015.1) and avoid the creation of a dead end condition.

We recommend eliminating the public bathroom facilities located along the alleyway and converting this space into a new utility room to serve the addition. The existing bathrooms are not currently utilized and new toilet facilities could be provided in the addition.

Based on existing design, the Wallace Parking Facility has a Category II Importance Factor (NCSBC T1604.5). That portion of the Code indicates that none of the individual spaces in the new building should exceed 1,500 net square feet or 300 occupants; the total building occupancy should not exceed 5,000. If these numbers are exceeded, the entire structure would need to be upgraded to a stricter seismic category. Those stricter seismic design requirements will vary depending on number of occupants. This does not mean that increased occupancy is out of the question, or even unreasonable, only that it will require additional bracing, etc. Potential strategies to improve seismic design are described in Structural section IV.3 of this report. A final seismic design will require a more established building program, which is beyond the scope of this study.



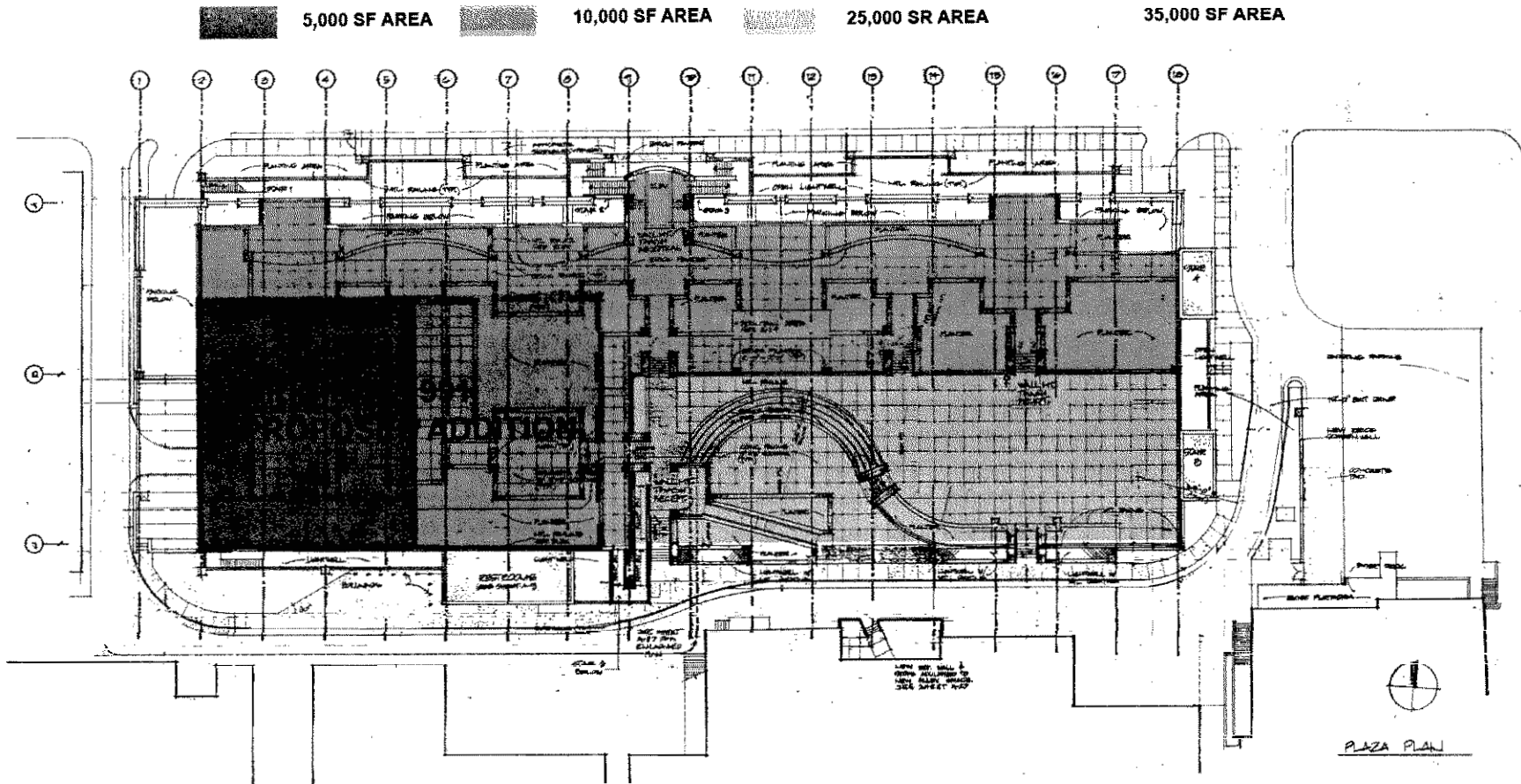


Image 6. ADDITION AND POTENTIAL EXPANSION ON THE PLAZA LEVEL



## 2. LIFE SAFETY

The existing life safety elements appear to comply with the current Building Code, with the exception that the handrails on the stairs and the pedestrian ramps are currently 32 inches high and newer Building Code requires them to be a minimum 34 inches high. The addition of 42 inch guardrails is required in the stairways between the stair flights. The building has a sufficient number of exits, located as required by current Building Code. Fire protection meets current Building Code requirements. The structure is fully sprinklered and equipped with dry stand pipes.

On July 3, 2008 the design team met with the NC Department of Insurance to discuss Building Code issues with an addition to the plaza level. If the addition does not exceed 20,000 square feet and in case of Assembly occupancy, does not exceed 1,000 occupants, then the NC DOI would not review the project. Reviews would be done through the TOCH Building Inspections Division.

Possible building scenarios were discussed - from 10,000 square feet of added space up to 35,000 square feet. Neither of the attending NC DOI Code Consultants expressed any obvious or potential problems. If the addition exceeds 20,000 square feet or 1,000 occupants for Assembly Group, the NC DOI requires submittal of a detailed structural report on both new and existing structures for review.

The 2006 NC State Building Code review showed that the existing parking structure is an S-2 occupancy building and a type IIB construction (NCSBC 311.3, 602.2). The maximum floor area allowed is 50,000 square feet (NCSBC T406.3.5). The existing plaza area is approximately 35,000 square feet.

The fire separation distances from existing buildings to the parking facility were reviewed. The property line is located as shown on Image 4. The fire separation distance varies from 0 to 11 feet along the South Alley; from 0 to 6 feet at Rosemary Street; from 0 to 7 feet at the East end; and it is 5 feet along the West end. According to

NCSBC T602, the fire rating for exterior walls is required to be 1 hour where distance is less than 10 feet. A one hour rating is provided in accordance with the prescription method in the NCSBC T720.1(2) 4. The proposed addition would have no effect on the fire ratings of the existing buildings. Fire truck access route would be maintained as is.

Unlimited unprotected exterior wall openings are permitted per NCSBC T704.8 footnotes "c" & "g". Vertical separation of openings is not required in the existing parking facility (NCSBC 704.9 Exceptions 2&3).

The addition on the plaza level would be considered a change of building use from single occupancy to mixed occupancy (NCSBC 302.3). Section 508.7 in the NCSBC requires provision of a horizontal fire separation between the existing open parking garage and a new building. This separation is required to be 2 hours (NCSBC T302.3.2) and can be reduced to 1 hour per NCSBC 302.3.2 Exception. The existing concrete slab provides the required fire separation. A new addition would have to comply with the area and height limitations in NCSBC Section 503 for the type of occupancy. The type IIB construction for various occupancies would limit the area to the approximate size of the plaza. If the addition is not classified as type IIB construction, the entire building will have to comply with the strictest requirements of the two building types. In addition, the exits from the new building through the existing parking tiers would have to be separated by a 2 hour fire barrier. Additional stair or bridge to the adjacent high rise building would be required to comply with exit requirements.



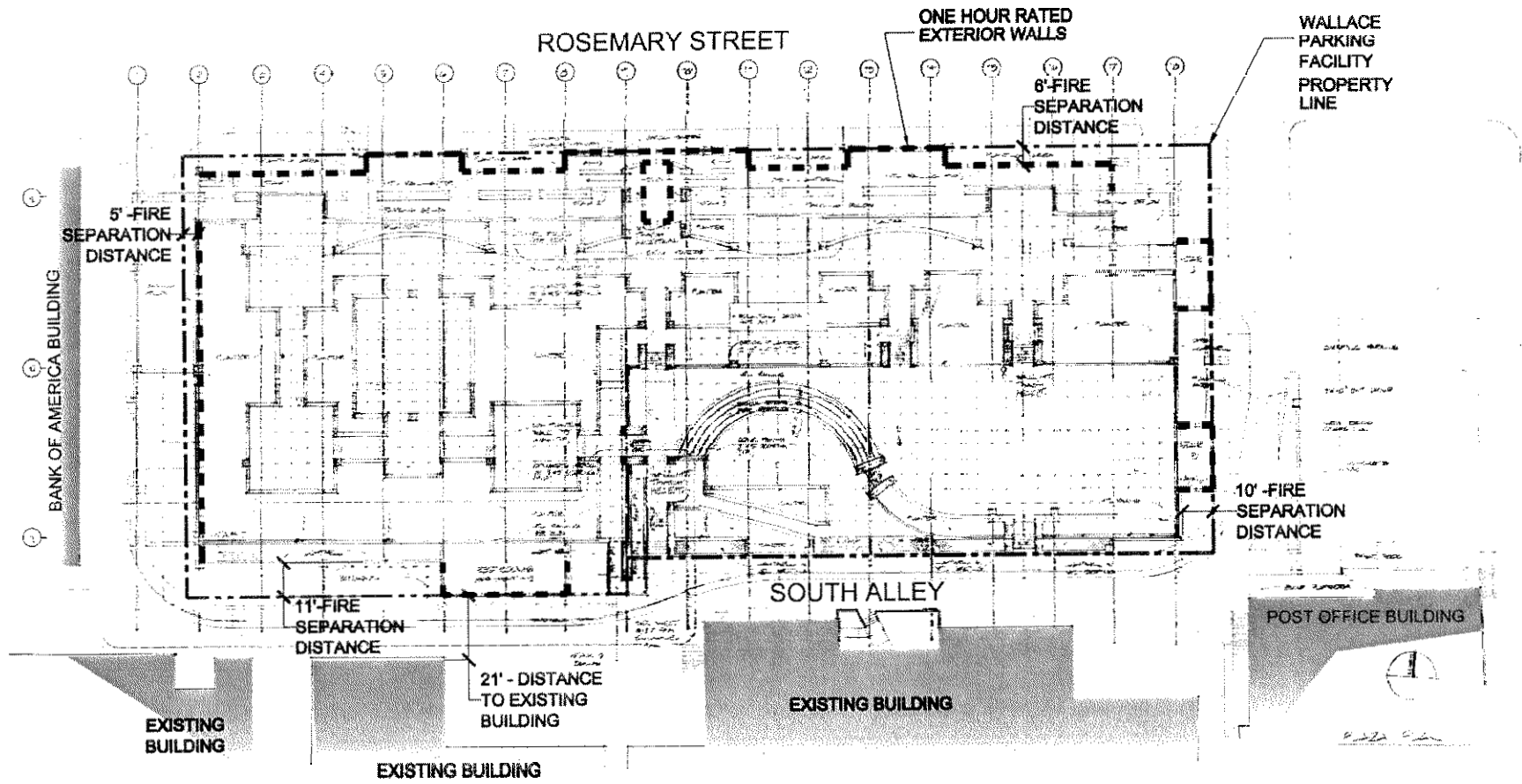


Image 7. LIFE SAFETY PLAN



### 3. STRUCTURAL

The Wallace Parking Facility is constructed of cast-in-place concrete with reinforcing steel and with post-tensioned cables. The structure is in a generally east-west orientation with columns along each side (north and south) and with a column line located at the middle of the structure. There are two on-grade levels, one at 457.0' and one at 462.0' located on either side (north and south) of the center column line. The elevated levels on the north side of the structure are located at 467.0', 477.0' and 489.0' (plaza level). The elevated levels on the south side of the structure are located at 472.0' and 483.0' (plaza level). Expansion joints separate the parking structure from adjoining stair towers, elevator towers and adjoining cast-in-place retaining walls.

The parking structure was designed per the 1978 edition of the North Carolina Building Code (NCBC) and per the 1989 edition of the American Concrete Institute (ACI 318-89). Our current design data analysis is per the 2006 edition of the NCSBC which references the 2002 edition of the ACI and the 2002 edition of the American Society of Civil Engineers (ASCE). No design wind, snow or seismic information was noted on the existing drawings which are dated March 29, 1991. Design live loads which are noted on the drawings consist of a typical live load of 50 psf, a stair live load of 100 psf and a plaza live load of 100 psf.

Cast-in-place reinforced caisson foundations were designed to bear in rock with a 50 kips per square foot (ksf) allowable bearing pressure while the ground supported structural elements were designed for an allowable soil bearing pressure of 4.8 ksf. The structure was designed for a future bridge on the west end, near the north west corner. Typical masonry faced plaza level walls are detailed on existing drawings. Planters with varying depths of soil are also located on the plaza level along with walking areas surfaced with masonry pavers. The design of the concrete beams and slabs on the plaza level should have taken into account the live load of 100 psf and the

dead load of the masonry faced walls, planters and the pavers. The design of each beam line (TB-2, TB-2A, TB-3 and TB-7) accounted for the plaza live load of 100 psf and the worst case dead load of 4,440 pounds per linear foot (plf) of the plaza which occurs at the planter areas.

Removing the existing dead load items on the plaza level noted above (masonry faced walls, planters and pavers) would generate capacity to incorporate new dead loads in their place (see dead load analysis Appendix 2). Any new live load incorporated into the design will be 100 psf or less, therefore no increase and a possible decrease in the design live load will be recognized (see live load analysis Appendix 2). Per NCSBC sections 1614.1.1.2 and 1614.1.1.3, if an addition that is not structurally independent from the existing structure and "the addition does not increase the seismic forces in any structural element of the existing structure by more than 5 percent, unless the element has the capacity to resist the increased forces determined in accordance with Sections 1613 through 1622" and "Additions do not decrease the resistance of any structural element of the existing structure by more than 5 percent cumulative since the original construction, unless the element has the capacity to resist the forces determined in accordance with Sections 1613 through 1622," a seismic analysis of the existing structure is not required. These two sections provide that, under the above assumptions, the existing structure would not be required to be re-designed and modified to resist the effects of earthquake motions as a result of the addition of a one or two-story structure as described.

The building must be reviewed for plan configuration irregularities both horizontally and vertically per NCSBC 1616.5. Presently the horizontal plan is regular per NCSBC Table 1616.5.1.1 and the vertical plan is regular per NCSBC Table 1616.5.1.2.

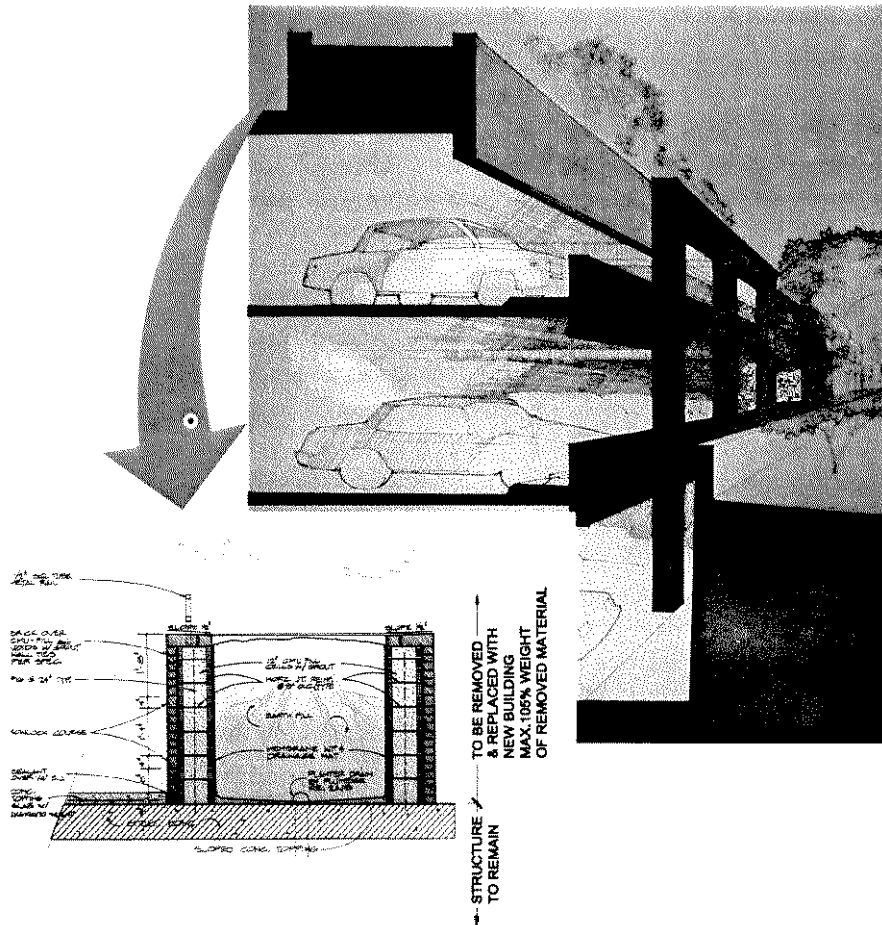


Image 8. REMOVAL OF EXISTING DEAD LOAD

The vertical structure must be reviewed with the addition in place to confirm if a soft story exists (NCSBC Table 1616.5.1.2 items 1a and 1b) where the lateral stiffness of one story is less than either 70 or 60 percent of the story above. The structure must also be reviewed with the addition to confirm if a weight (mass) irregularity exists. This condition exists when "...the effective mass of any story is more than 150 percent of the effective mass of an adjacent story. A roof that is lighter than the floor below need not be considered."

The building must also be analyzed for global strength and stiffness, load paths and component detailing. If deficiencies are found, several rehabilitation techniques can be employed which include adding new elements for shear/lateral loads. This could include adding masonry walls attached to the existing concrete structure or this could also include enhancing the existing structure which requires verifying the existing concrete columns' lateral capacity.

The existing structure appears to have an adequate amount of columns in the east to west direction to resist lateral loads due to wind and/or seismic forces. The existing structure may need to have additional lateral capacity in the north to south direction where there are three columns per bay width. If additional capacity is required in this direction, it can be in the form of shear walls or bracing at specific intervals, most likely not at each column line. The reinforcing detailing of the concrete columns must also be reviewed to confirm it also meets the standards of the new NCSBC and ACI codes.



#### 4. DOMESTIC WATER, FIRE PROTECTION, STORM DRAINAGE SYSTEMS

The existing structure has adequate piping for fire protection, domestic water, and sewer utilities. The available documents show that the 6" main water line also provided for a separate irrigation water system. However, the actual line feeding the irrigation system is connected to the 3" water main. The pipe sizes are sufficient to support a 12,000 square foot addition of office buildings or other assemblies. Maximum additional area that the existing utilities can support is approximately 25,000 - 30,000 square feet using Use Group A3 of Table 403.1 of the 2006 NC Plumbing Code.

Any addition larger than 25,000 square feet and with an occupancy load of more than 800 people would require an upgrade of the domestic water and sewer pipes services.

Existing main water and sewer lines are located in the main entrance to the deck. There is an 8x12 tee in the middle of Rosemary Street. The 8" line comes to the building and it reduces down to a 6" line. This 6" line feeds the existing 3" domestic water pipe and also provides water for the dry sprinkler piping system. The Wallace Deck is equipped with dry pipe sprinkler system as well as a dry stand pipe system.

The 3" domestic water line is equipped with a Double Check Valve back flow preventer. This line is large enough for approximately 300 water fixture units or 20 toilets, 8 urinals, and 10 sinks.

With new fixtures using less water for proper operation, the number of water fixture units or fixture types can easily match the number of drain fixture units listed below.

The 6" main water line through a 1" meter also provides for a separate irrigation water system. The parking deck office has a separate water meter. A 1 1/2" line feeds the bathrooms in this area.

Storm drain piping carries rain water down to the lowest level of the deck and via duplex sump pumps, water is sent to the city main storm system.

There is an existing 5" sewer main where pipes from existing toilets connect. The sewer line from each bathroom is a 4" CI pipe or equivalent of 10 toilets, 5 urinals and 6 sinks. The 5" sewer pipe is large enough for approximately 360 drainage fixture units or approximately 22 toilets, 12 urinals, and about 14 sinks. If total plumbing fixture unit count exceeds 360 drainage fixture units, the sewer and water pipes would need be upgraded

A separate 4" sewer line leaves the bathrooms in the office area on the north side of the parking deck at street level.

#### 5. HVAC AND NATURAL GAS SERVICE

The existing facility does not use natural gas; however, a 2" line in the alleyway on the south side of the deck serves adjacent businesses. Gas is available on Rosemary street, but new service would be required if the new addition requires natural gas.

The only HVAC in the facility is for the existing office area. The office area is heated and cooled via a split system air to air heat pump. The parking deck has enough exterior openings that mechanical ventilation is not required. The elevator machine room is ventilated using a propeller type wall mounted fan and is thermostatically controlled.



## 6. POWER, FIRE ALARM, CLOSED CIRCUIT TELEVISION AND INTERCOM SYSTEMS

The existing structure's power requirements are served by a 300 ampere, 480Y/277 volt main distribution panel fed from a Duke Power pad-mounted transformer which is situated adjacent to the east side of parking facility. This main distribution panel serves the elevator, sump pumps, lighting, fire alarm equipment, existing office space, and all other motors and equipment currently located in the parking facility. Based on record documents, the available capacity in the main distribution panel would be sufficient in size to support an additional 5,000 square feet of conditioned office space or other assemblies without modifications to existing service. There are numerous electrical manholes located in close proximity to the parking structure and it is assumed that additional electrical capacity is readily obtainable should the scope of renovations necessitate additional power. Thus far in our assessment of the available capacity, logistics of getting new primary service to the building and associated cost have not been coordinated with Duke Power.

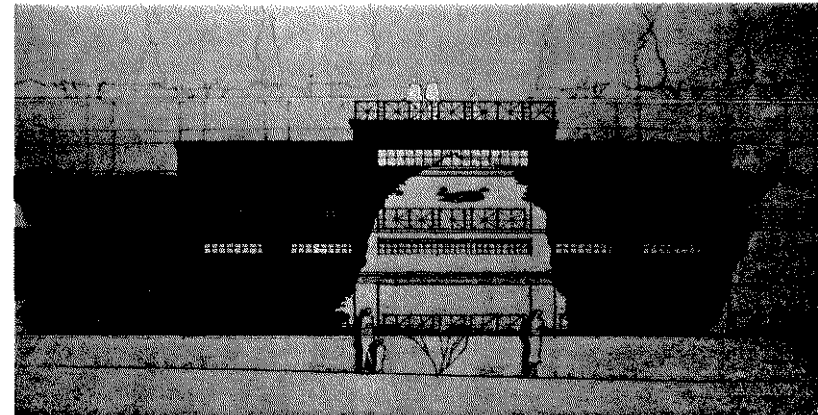
There is an eight zone fire alarm control panel located in the existing office area and a fire alarm system which consists of manual pull stations, horn/strobes, smoke and heat detectors, and elevator controls. While the current system appears to be in good working condition, the existing control panel does not have adequate capacity for expansion beyond its current use. It is recommended that a new addressable fire alarm control panel with compatible devices be installed to accommodate any additional building area and that the new devices and coverage extend into the existing parking structure to replace fire alarm devices currently in use.

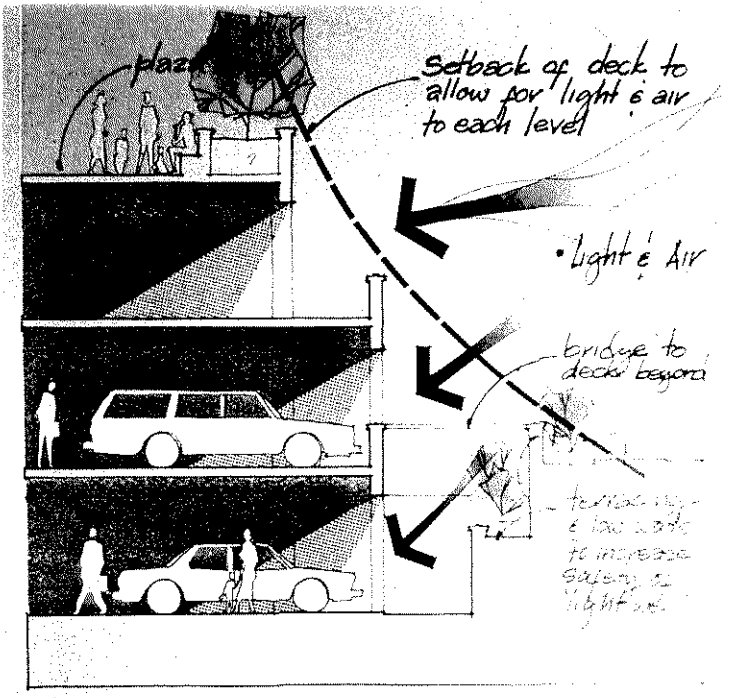
There is a scream alarm/intercom system and CCTV system installed with controls and monitoring capabilities located in the facility supervisor's office. It is

unclear if these systems are expandable to provide coverage to additional square footage of building space. These security measures are typically customized to occupant usage and it is recommended that a new system be designed and installed to meet the Owner's needs in any proposed building space.

## 7. DELIVERY AND TRASH REMOVAL SERVICES

The deliveries to the existing buildings and trash removal services utilize the South Alley. The dumpsters located at south-west of Wallace property are used by owners and tenants of surrounding buildings. The addition to the Wallace parking facility would not change the existing conditions significantly. More frequent service might be required depending on type of occupancy of a new building.





**Image 9. EXISTING PARKING FACILITY  
NATURAL VENTILATION AND DAY LIGHTING  
(CONTRIBUTION TO SUSTAINABLE DESIGN)**

## 8. SUSTAINABLE DESIGN OUTLINE

The building has strong potential for acquiring LEED Certification:

- It is located on a developed site;
- It has access to public transportation routes;
- It is within walking distance to basic services, such as banks, places of worship, fire station, pharmacy, restaurants, museum, major university, Town Hall, etc;
- The credit in Alternative Transportation can be earned by providing bicycle storage and showering/changing facilities;
- The existing parking garage can also contribute by providing preferred parking for low-emitting and fuel-efficient vehicles;
- Open space can be maximized by minimizing the proposed building footprint – point for Maximizing Open Space;
- Heat Island Effect can be reduced as the existing garage is entirely covered parking;
- Heat Island Effect can be also reduced by using high index solar reflective roofing. Existing vegetated parking garage roof would contribute to the reduction if a portion remains on the plaza;
- Light pollution can be reduced by using low interior and exterior light levels at night and avoiding off-site lighting;
- Water efficient landscaping and no potable water use for landscaping are potential points for certification. Also, potable water use can be reduced by utilizing high efficiency plumbing fixtures;
- The building east-west orientation makes it feasible to install various sources of on-site renewable energy, such as solar collectors. Along with the energy savings it may bring the opportunity for people of all ages to explore and study the renewable sources of energy;



- The long northern exposure allows for use of day-lighting as an energy reduction element;
- Existing recycling programs and waste management should be maintained in the proposed and existing buildings;
- It is possible to use rapidly renewable materials such as bamboo, wool, cotton insulation, linoleum and locally grown wood in the new construction, as well as recycled materials;
- Low-emitting VOC materials - paints, adhesives, sealants - would provide a series of credits in the Indoor Environmental Quality category.
- A smoke free facility helps with LEED Certification.





## V. Probable Construction Costs

It is estimated that the probable construction cost would be approximately \$200 per square foot of addition in today's dollars. This will vary depending on building amenities, such as upgraded finishes and details.

The major influence factors affecting the cost are as follow:

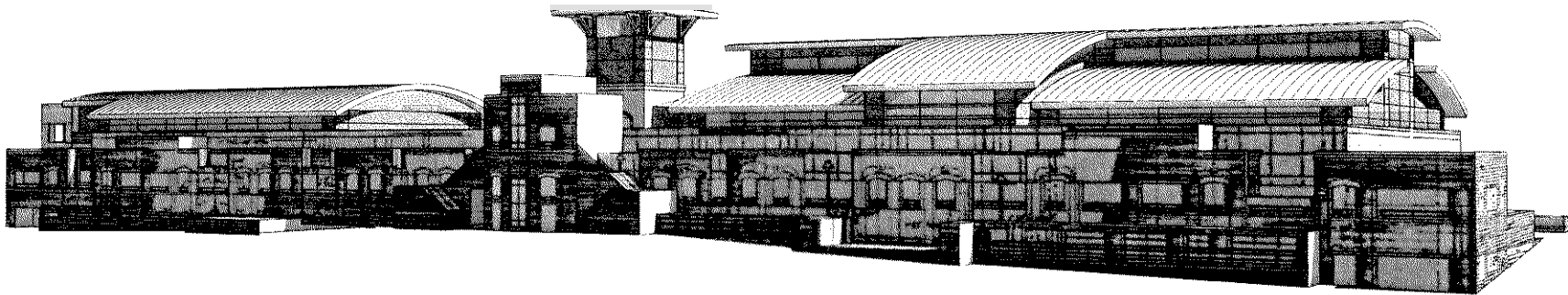
### Increasing Factors:

- a. Tight urban site location;
- b. Traffic management;
- c. Current higher material costs
- d. Public aspect of project

### Decreasing Factors:

- a. Existing structural foundation;
- b. Adequate staging area;
- c. Little site work;
- d. Construction of parking spaces is not required;
- e. Utilities available at site;
- f. Current construction "slow-down" may result in lower labor costs.

These numbers are based on 2008 prices. The inflation factor which would need to be added is estimated to be 8 to 10 percent per year.





## VI. Conclusions

1. It is possible to build at least a 10,000 square foot addition on the plaza level of the existing parking facility without modifying existing structure or adding utilities;
2. The existing water and sewer utilities are adequate to build up to 30,000 square feet without major upgrades;
3. Electrical service would require minor modification above 5,000 square feet, but the required capacity is readily available;
4. The existing structure is suitable to build a one story addition over virtually the entire plaza without seismic upgrades;
5. Most existing Life Safety components comply with the current NC State Building Code, although handrails need to be 2 inches higher and guardrails need to be provided on the stairways between flights;
6. The delivery and trash removal services should not be affected by an addition. The frequency of the services might require an increase;
7. The probable price of the new construction would be approximately \$200 per square foot depending on amenities provided.



## Appendix 1. NCSBC REFERENCES

### STRUCTURAL DESIGN

**TABLE 1004.5**  
CLASSIFICATION OF BUILDINGS AND OTHER STRUCTURES FOR IMPORTANCE FACTORS

CATEGORY <sup>a</sup>	NATURE OF OCCUPANCY	SEISMIC FACTOR, $I_s$	SNOW FACTOR, $I_s$	WIND FACTOR, $I_s$
I	Buildings and other structures that represent a low hazard to human life in the event of failure including, but not limited to: <ul style="list-style-type: none"> <li>Agricultural facilities</li> <li>Certain temporary facilities</li> <li>Minor storage facilities</li> </ul>	1.00	0.8	0.87 <sup>b</sup>
II	Buildings and other structures except those listed in Categories I, III and IV <ul style="list-style-type: none"> <li>Buildings and other structures that represent a substantial hazard to human life in the event of failure including, but not limited to:                             <ul style="list-style-type: none"> <li>Buildings and other structures where more than 300 people congregate in one area</li> <li>Buildings and other structures with elementary school, secondary school or day care facilities with an occupant load greater than 250</li> <li>Buildings and other structures with an occupant load greater than 500 for colleges or adult education facilities</li> </ul> </li> <li>Health care facilities with an occupant load of 50 or more resident patients but not having surgery or emergency treatment facilities</li> <li>Jails and detention facilities</li> <li>Any other occupancy with an occupant load greater than 5,000</li> <li>Power-generating stations, water treatment for potable water, waste water treatment facilities and other public utility facilities not included in Category IV</li> <li>Buildings and other structures not included in Category IV containing sufficient quantities of toxic or explosive substances to be dangerous to the public if released</li> </ul>	1.00	1.0	1.00
III	Buildings and other structures designated as essential facilities including, but not limited to: <ul style="list-style-type: none"> <li>Hospitals and other health care facilities having surgery or emergency treatment facilities</li> <li>Fire, rescue and police stations and emergency vehicle garages</li> <li>Designated earthquake, hurricane or other emergency shelters</li> <li>Designated emergency preparedness, communication, and operation centers and other facilities required for emergency response</li> <li>Power-generating stations and other public utility facilities required as emergency backup facilities for Category IV structures</li> <li>Structures containing highly toxic materials as defined by Section 307 where the quantity of the material exceeds the maximum allowable quantities of Table 307.7(2)</li> <li>Aviation control towers, air traffic control centers and emergency aircraft hangars</li> <li>Buildings and other structures having critical national defense functions</li> <li>Water treatment facilities required to maintain water pressure for fire suppression</li> </ul>	1.25	1.1	1.15
IV	Buildings and other structures designated as essential facilities including, but not limited to: <ul style="list-style-type: none"> <li>Hospitals and other health care facilities having surgery or emergency treatment facilities</li> <li>Fire, rescue and police stations and emergency vehicle garages</li> <li>Designated earthquake, hurricane or other emergency shelters</li> <li>Designated emergency preparedness, communication, and operation centers and other facilities required for emergency response</li> <li>Power-generating stations and other public utility facilities required as emergency backup facilities for Category IV structures</li> <li>Structures containing highly toxic materials as defined by Section 307 where the quantity of the material exceeds the maximum allowable quantities of Table 307.7(2)</li> <li>Aviation control towers, air traffic control centers and emergency aircraft hangars</li> <li>Buildings and other structures having critical national defense functions</li> <li>Water treatment facilities required to maintain water pressure for fire suppression</li> </ul>	1.50	1.2	1.15

a. For the purpose of Section 1016.2, Categories I and II are considered Seismic Use Group I, Category III is considered Seismic Use Group II and Category IV is equivalent to Seismic Use Group III.

b. In hurricane-prone regions with  $V > 100$  miles per hour,  $I_s$  shall be 0.77.

### MEANS OF EGRESS

eries and gridions shall meet the requirements for occupancies in Group F-2.

#### Exceptions:

- A minimum width of 22 inches (559 mm) is permitted for lighting and access catwalks.
- Spiral stairs are permitted in the means of egress.
- Stairways required by this subsection need not be enclosed.
- Stairways with a minimum width of 22 inches (559 mm), ladders, or spiral stairs are permitted in the means of egress.
- A second means of egress is not required from these areas where a means of escape to a floor or to a roof is provided. Ladders, alternating tread devices or spiral stairs are permitted in the means of escape.
- Ladders are permitted in the means of egress.

### SECTION 1015

#### EXIT ACCESS TRAVEL DISTANCE

**1015.1 Travel distance limitations.** Exits shall be so located on each story such that the maximum length of exit access travel, measured from the most remote point within a story to the entrance to an exit along the natural and unobstructed path of egress travel, shall not exceed the distances given in Table 1015.1.

Where the path of exit access includes unenclosed stairways or ramps within the exit access or includes unenclosed exit ramps or stairways as permitted in Section 1019.1, the distance of travel on such means of egress components shall also be included in the travel distance measurement. The measurement along stairways shall be made on a plane parallel and tangent to the stair tread nosings in the center of the stairway.

#### Exceptions:

- Travel distance in open parking garages is permitted to be measured to the closest riser of open stairs.
- In outdoor facilities with open exit access components and open exterior stairs or ramps, travel distance is permitted to be measured to the closest riser of a stair or the closest slope of the ramp.
- Where an exit stair is permitted to be unenclosed in accordance with Exception 8 or 9 of Section 1019.1, the travel distance shall be measured from the most remote point within a building to an exit discharge.

**1015.2 Roof vent increase.** In buildings which are one story in height, equipped with automatic heat and smoke roof vents complying with Section 910 and equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1, the maximum exit access travel distance shall be 400 feet (122 m) for occupancies in Group F-1 or S-1.

**1015.3 Exterior egress balcony increase.** Travel distances specified in Section 1015.1 shall be increased up to an additional 100 feet (30 480 mm) provided the last portion of the exit access leading to the exit occurs on an exterior egress balcony constructed in accordance with Section 1013.5. The length of such balcony shall not be less than the amount of the increase taken.

**TABLE 1015.1**  
EXIT ACCESS TRAVEL DISTANCE<sup>a</sup>

OCCUPANCY	WITHOUT SPRINKLER SYSTEM (feet)	WITH SPRINKLER SYSTEM (feet)
A, E, F-1, I-1, M, R, S-1	200	250 <sup>b</sup>
B	200	300 <sup>c</sup>
F-2, S-2, U	300	400 <sup>d</sup>
H-1	Not Permitted	75 <sup>e</sup>
H-2	Not Permitted	100 <sup>f</sup>
H-3	Not Permitted	150 <sup>g</sup>
H-4	Not Permitted	175 <sup>h</sup>
H-5	Not Permitted	200 <sup>i</sup>
I-2, I-3, I-4	150	200 <sup>j</sup>

For SI: 1 foot = 304.8 mm.

- a. See the following sections for modifications to exit access travel distance requirements:  
Section 402: For the distance limitation in malls.  
Section 404: For the distance limitation through an atrium space.  
Section 1015.2: For increased limitation in Group F-1 and S-1.  
Section 1024.7: For increased limitation in assembly seating.  
Section 1024.7: For increased limitation for assembly open-air seating.  
Section 1018.2: For buildings with one exit.  
Chapter 31: For the limitation in temporary structures.
- b. Buildings equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1 or 903.3.1.2. See Section 903 for occupancies where sprinkler systems according to Section 903.3.1.2 are permitted.
- c. Buildings equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1.

### SECTION 1016

#### CORRIDORS

**1016.1 Construction.** Corridors shall be fire-resistance rated in accordance with Table 1016.1. The corridor walls required to be fire-resistance rated shall comply with Section 708 for fire partitions.

#### Exceptions:

- A fire-resistance rating is not required for corridors in an occupancy in Group E where each room that is used for instruction has at least one door directly to the exterior and rooms for assembly purposes have at least one-half of the required means of egress doors opening directly to the exterior. Exterior doors specified in this exception are required to be at ground level.
- A fire-resistance rating is not required for corridors contained within a dwelling or sleeping unit in an occupancy in Group R.
- A fire-resistance rating is not required for corridors in open parking garages.
- A fire-resistance rating is not required for corridors in an occupancy in Group B which is a space requiring only a single means of egress complying with Section 1014.1.

**1016.2 Corridor width.** The minimum corridor width shall be as determined in Section 1005.1, but not less than 44 inches (1118 mm).



**USE AND OCCUPANCY CLASSIFICATION**

Acrylics, Levels 2 and 3  
Aircraft repair hangar  
Bags; cloth, burlap and paper  
Bamboos and rattan  
Baskets  
Belting; canvas and leather  
Books and paper in rolls or packs  
Boots and shoes  
Buttons, including cloth covered, pearl or bone  
Cardboard and cardboard boxes  
Clothing, woolen wearing apparel  
Cordage  
Furniture  
Furs  
Glues, masticage, pastes and size  
Grains  
Horns and combs, other than celluloid  
Leather  
Linoleum  
Lumber  
Motor vehicle repair garages complying with the maximum allowable quantities of hazardous materials listed in Table 307.7(i) (see Section 406.6)  
Photo engravings  
Resilient flooring  
Silks  
Soaps  
Sugar  
Tires, bulk storage of  
Tobacco, cigars, cigarettes and snuff  
Upholstery and mattresses  
Wax candles

**311.3 Low-hazard storage, Group S-2.** Includes, among others, buildings used for the storage of noncombustible materials such as products on wood pallets or in paper cartons with or without single thickness divisions; or in paper wrappings. Such products are permitted to have a negligible amount of plastic trim, such as knobs, handles or film wrapping. Storage uses shall include, but not be limited to, storage of the following:

Aircraft hangar  
Asbestos  
Beverages up to and including 12-percent alcohol in metal, glass or ceramic containers  
Cement in bags  
Chalk and crayons  
Dairy products in nonwaxed coated paper containers  
Dry cell batteries  
Electrical coils  
Electrical motors  
Empty cans  
Food products  
Foods in noncombustible containers  
Fresh fruits and vegetables in nonplastic trays or containers  
Frozen foods  
Glass  
Glass bottles, empty or filled with noncombustible liquids  
Gypsum board  
Inert pigments  
Ivory  
Meats

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Metal cabinets  
Metal desks with plastic tops and trim  
Metal parts  
Metals  
Mirrors  
Oil-filled and other types of distribution transformers  
Parking garages, open or enclosed  
Porcelain and pottery  
Stoves  
Talc and soapsstones  
Washers and dryers

**SECTION 312**

**UTILITY AND MISCELLANEOUS GROUP U**

**312.1 General.** Buildings and structures of an accessory character and miscellaneous structures not classified in any specific occupancy shall be constructed, equipped and maintained to conform to the requirements of this code commensurate with the fire and life hazard incidental to their occupancy. Group U shall include, but not be limited to, the following:

Agricultural buildings  
Aircraft hangars, accessory to a one- or two-family residence (see Section 412.3)  
Barns  
Carports  
Fences more than 6 feet (1829 mm) high  
Grain silos, accessory to a residential occupancy  
Greenhouses  
Livestock shelters  
Private garages  
Retaining walls  
Sheds  
Stables  
Tanks  
Towers

**CHAPTER 6**

**TYPES OF CONSTRUCTION**

**SECTION 601  
GENERAL**

**601.1 Scope.** The provisions of this chapter shall control the classification of buildings as to type of construction.

**SECTION 602  
CONSTRUCTION CLASSIFICATION**

**602.1 General.** Buildings and structures erected or to be erected, altered or extended in height or area shall be classified in one of the five construction types defined in Sections 602.2 through 602.5. The building elements shall have a fire-resistance rating not less than that specified in Table 601 and exterior walls shall have a fire-resistance rating not less than that specified in Table 602.

**602.1.1 Minimum requirements.** A building or portion thereof shall not be required to conform to the details of a type of construction higher than that type, which meets the minimum requirements based on occupancy even though certain features of such a building actually conform to a higher type of construction.

**602.2 Types I and II.** Type I and II construction are those types of construction in which the building elements listed in Table 601 are of noncombustible materials.

**602.3 Type III.** Type III construction is that type of construction in which the exterior walls are of noncombustible materials and the interior building elements are of any material permitted by this code. Fire-retardant-treated wood framing complying with Section 2303.2 shall be permitted within exterior wall assemblies of a 2-hour rating or less.

**602.4 Type IV.** Type IV construction (Heavy Timber, HT) is that type of construction in which the exterior walls are of noncombustible materials and the interior building elements are of solid or laminated wood without concealed spaces. The details of Type IV construction shall comply with the provisions of this section. Fire-retardant-treated wood framing complying with Section 2303.2 shall be permitted within exterior wall assemblies with a 2-hour rating or less.

**602.4.1 Columns.** Wood columns shall be sawn or glued laminated and shall not be less than 8 inches (203 mm), nominal, in any dimension where supporting floor loads and not less than 6 inches (152 mm) nominal in width and not less than 8 inches (203 mm) nominal in depth where supporting roof and ceiling loads only. Columns shall be continuous or superimposed and connected in an approved manner.

**602.4.2 Floor framing.** Wood beams and girders shall be of sawn or glued laminated timber and shall be not less than 6 inches (152 mm) nominal in width and not less than 10 inches (254 mm) nominal in depth. Framed sawn or glued laminated timber arches, which spring from the floor line and support floor loads, shall be not less than 8 inches

(203 mm) nominal in any dimension. Framed timber trusses supporting floor loads shall have members of not less than 8 inches (203 mm) nominal in any dimension.

**602.4.3 Roof framing.** Wood-frame or glued-laminated arches for roof construction, which spring from the floor line or from grade and do not support floor loads, shall have members not less than 6 inches (152 mm) nominal in width and have less than 8 inches (203 mm) nominal in depth for the lower half of the height and not less than 6 inches (152 mm) nominal in depth for the upper half. Framed or glued-laminated arches for roof construction that spring from the top of walls or wall abutments, framed timber trusses, and other roof framing, which do not support floor loads, shall have members not less than 4 inches (102 mm) nominal in width and not less than 6 inches (152 mm) nominal in depth. Spaced members shall be permitted to be composed of two or more pieces not less than 3 inches (76 mm) nominal in thickness where blocked solidly throughout their intervening spaces or where spaces are tightly closed by a continuous wood cover plate of not less than 2 inches (51 mm) nominal in thickness secured to the underside of the members. Splice plates shall be not less than 3 inches (76 mm) nominal in thickness. Where protected by approved automatic sprinklers under the roof deck, framing members shall be not less than 3 inches (76 mm) nominal in width.

**602.4.4 Floors.** Floors shall be without concealed spaces. Wood floors shall be of sawn or glued-laminated planks, splined or tongue-and-groove, of not less than 3 inches (76 mm) nominal in thickness covered with 1-inch (25 mm) nominal dimension tongue-and-groove flooring, laid crosswise or diagonally, or 0.5-inch (12.7 mm) particleboard or planks not less than 4 inches (102 mm) nominal in width set on edge close together and well spiked and covered with 1-inch (25 mm) nominal dimension flooring or 3/4-inch (12 mm) wood structural panel or 0.5-inch (12.7 mm) particleboard. The lumber shall be laid so that no continuous line of joints will occur except at points of support. Floors shall not extend closer than 0.5 inch (12.7 mm) to walls. Such 0.5-inch (12.7 mm) space shall be covered by a molding fastened to the wall and so arranged that it will not obstruct the swelling or shrinkage movements of the floor. Corbeling of masonry walls under the floor shall be permitted to be used in place of molding.

**602.4.5 Roofs.** Roofs shall be without concealed spaces and wood roof decks shall be sawn or glued laminated, splined or tongue-and-groove plank, not less than 2 inches (51 mm) thick, 1 1/4-inch-thick (32 mm) wood structural panel (exterior glue), or of planks not less than 3 inches (76 mm) nominal in width, set on edge close together and laid as required for floors. Other types of decking shall be permitted to be used if providing equivalent fire resistance and structural properties.



FIRE-RESISTANCE-RATED CONSTRUCTION

TYPES OF CONSTRUCTION

TABLE 720.1(2)  
RATED FIRE-RESISTANCE PERIODS FOR VARIOUS WALLS AND PARTITIONS \*\*\*

MATERIAL	ITEM NUMBER	CONSTRUCTION	MINIMUM FINISHED THICKNESS FACE-TO-FACE <sup>a</sup> (inches)			
			4 hour	3 hour	2 hour	1 hour
1. Brick of clay or shale	1-1.1	Solid brick of clay or shale <sup>c</sup>	6	4.9	3.8	2.7
	1-1.2	Hollow brick, not filled.	5.0	4.3	3.4	2.3
	1-1.3	Hollow brick unit wall, grout or filled with perlite vermiculite or expanded shale aggregate.	6.6	5.5	4.4	3.0
2. Combination of clay brick and load-bearing hollow clay tile	2-1.1	4" solid brick and 4" tile (at least 40 percent solid).	—	8	—	—
	2-1.2	4" solid brick and 8" tile (at least 40 percent solid).	12	—	—	—
3. Concrete masonry units	3-1.1 <sup>d</sup>	Expanded slag or pumice.	4.7	4.0	3.2	2.1
	3-1.2 <sup>e</sup>	Expanded clay, shale or slate.	5.1	4.4	3.6	2.6
	3-1.3 <sup>f</sup>	Limestone, cinders or air-cooled slag.	5.9	5.0	4.0	2.7
	3-1.4 <sup>g</sup>	Calcareous or siliceous gravel.	6.2	5.3	4.2	2.8
4. Solid concrete <sup>h</sup>	4-1.1	Siliceous aggregate concrete.	7.0	6.2	5.0	3.5
	4-1.2	Carbonate aggregate concrete.	6.6	5.7	4.6	3.2
	4-1.3	Sand-lightweight concrete.	5.4	4.6	3.8	2.7
	4-1.4	Lightweight concrete.	5.1	4.4	3.6	2.5
5. Glazed or unglazed facing tile, nonload-bearing	5-1.1	One 2" unit cored 15 percent maximum and one 4" unit cored 25 percent maximum with 1/2" mortar-filled collar joint. Unit positions reversed in alternate courses.	—	6 1/4	—	—
	5-1.2	One 2" unit cored 15 percent maximum and one 4" unit cored 40 percent maximum with 1/2" mortar-filled collar joint. Unit positions side with 1/4" gypsum plaster. Two wythes tied together every fourth course with No. 22 gage corrugated metal ties.	—	6 1/4	—	—
	5-1.3	One unit with three cells in wall thickness, cored 29 percent maximum.	—	—	6	—
	5-1.4	One 2" unit cored 22 percent maximum and one 4" unit cored 41 percent maximum with 1/2" mortar-filled collar joint. Two wythes tied together every third course with 0.030" (No. 22 galvanized sheet steel gage) corrugated metal ties.	—	—	6	—
	5-1.5	One 4" unit cored 25 percent maximum with 1/4" gypsum plaster on one side.	—	—	4 1/4	—
	5-1.6	One 4" unit with two cells in wall thickness, cored 22 percent maximum.	—	—	—	4
	5-1.7	One 4" unit cored 30 percent maximum with 1/2" vermiculite gypsum plaster on one side.	—	—	4 1/2	—
	5-1.8	One 4" unit cored 39 percent maximum with 1/2" gypsum plaster on one side.	—	—	—	4 1/2

(continued)

TABLE 601  
FIRE-RESISTANCE RATING REQUIREMENTS FOR BUILDING ELEMENTS (hours)

BUILDING ELEMENT	TYPE I		TYPE II		TYPE III		TYPE IV		TYPE V	
	A	B	A'	B'	A''	B''	m	n	m'	n'
Structural frame <sup>a</sup> Including columns, girders, trusses	3 <sup>b</sup>	2 <sup>b</sup>	1	0	1	0	HT	1	0	0
Bearing walls										
Exterior <sup>c</sup>	3	2	1	0	2	2	2	1	0	0
Interior	3 <sup>b</sup>	2 <sup>b</sup>	1	0	1	0	1/HT	1	0	0
Nonbearing walls and partitions										
Exterior	See Table 602									
Interior	0	0	0	0	0	0	See Section 602.4.6	0	0	0
Floor construction Including supporting beams and joists	2	2	1	0	1	0	HT	1	0	0
Roof construction Including supporting beams and joists	1 1/2 <sup>c</sup>	1 <sup>c</sup>	1 <sup>c</sup>	0 <sup>c</sup>	1 <sup>c</sup>	0	HT	1 <sup>c</sup>	0	0

For SI: 1 foot = 304.8 mm.

a. The structural frame shall be considered to be the columns and the girders, beams, trusses and spandrels having direct connections to the columns and bracing members designed to carry gravity loads. The members of floor or roof panels which have no connection to the columns shall be considered secondary members and not a part of the structural frame.

b. Roof supports: Fire resistance ratings of structural frame and bearing walls are permitted to be reduced by 1 hour where supporting a roof only.

c. 1. Except in Factory-Industrial (F-1), Hazardous (H), Mercantile (M) and Moderate-Hazard Storage (S-1) occupancies, fire protection of structural members shall not be required, including protection of roof framing and decking where every part of the roof construction is 20 feet or more above any floor immediately below. Fire-retardant-treated wood members shall be used for such unprotected members.

2. In all occupancies, heavy timber shall be allowed where a 1-hour or less fire-resistance rating is required.

3. In Type I and II construction, fire-retardant-treated wood shall be allowed in buildings including girders and trusses as part of the roof construction when the building is:

- i. Two stories or less in height;
- ii. Type II construction over two stories; or
- iii. Type I construction over two stories and the vertical distance from the upper floor to the roof is 20 feet or more.

d. An approved automatic sprinkler system in accordance with Section 903.3.1.1 shall be allowed to be substituted for 1-hour fire-resistance-rated construction, provided such system is not otherwise required by other provisions of the code or used for an allowable area increase in accordance with Section 506.3 or an allowable height increase in accordance with Section 504.2. The 1-hour substitution for the fire resistance of exterior walls shall not be permitted.

e. Not less than the fire-resistance rating required by other sections of this code.

f. Not less than the fire-resistance rating based on fire separation distance (see Table 602).

TABLE 602  
FIRE-RESISTANCE RATING REQUIREMENTS FOR EXTERIOR WALLS BASED ON FIRE SEPARATION DISTANCE<sup>a</sup>

FIRE SEPARATION DISTANCE (feet)	TYPE OF CONSTRUCTION	OCCUPANCY GROUP H	OCCUPANCY GROUP F-1, M, S-1	OCCUPANCY GROUP A, B, E, F-2, I, R <sup>b</sup> , S-2, U
< 5 <sup>c</sup>	All	3	2	1
≥ 5 to < 10	IA	3	2	1
	Others	2	1	1
≥ 10 to < 30	IA, IB	2	1	1
	IIA, VB	1	0	0
	Others	1	1	1
≥ 30	All	0	0	0

For SI: 1 foot = 304.8 mm.

a. Load-bearing exterior walls shall also comply with the fire-resistance rating requirements of Table 601.

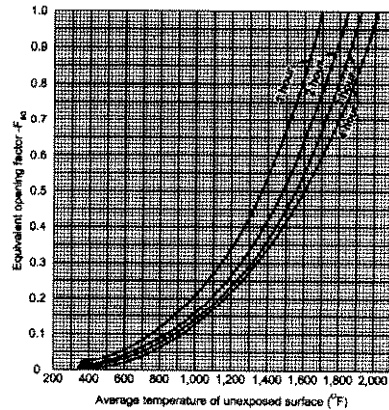
b. Group R-3 and Group U when used as accessory to Group R-3, as applicable in Section 101.2 shall not be required to have a fire-resistance rating where the fire separation distance is 3 feet or more.

c. See Section 503.2 for party walls.





FIRE-RESISTANCE-RATED CONSTRUCTION



For SI: °C = (°F - 32) / 1.8

FIGURE 704.7  
EQUIVALENT OPENING FACTOR

**704.8 Allowable area of openings.** The maximum area of unprotected or protected openings permitted in an exterior wall in any story shall not exceed the values set forth in Table 704.8. Where both unprotected and protected openings are located in the exterior wall in any story, the total area of the openings shall comply with the following formula:

$$\frac{A_p + A_u}{a_p + a_u} \leq 1.0 \quad \text{(Equation 7-2)}$$

where:

- A<sub>p</sub> = Actual area of protected openings, or the equivalent area of protected openings, A<sub>e</sub> (see Section 704.7).
- a<sub>p</sub> = Allowable area of protected openings.
- A<sub>u</sub> = Actual area of unprotected openings.
- a<sub>u</sub> = Allowable area of unprotected openings.

**704.8.1 Automatic sprinkler system.** In buildings equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1, the maximum allowable area of unprotected openings in occupancies other than Groups H-1, H-2 and H-3 shall be the same as the tabulated limitations for protected openings.

**704.8.2 First story.** In occupancies other than Group V, unlimited unprotected openings are permitted in the first story of exterior walls facing a street that have a fire separation distance of greater than 15 feet (4572 mm), or facing an unoccupied space. The unoccupied space shall be on the

same lot or dedicated for public use, shall not be less than 30 feet (9144 mm) in width, and shall have access from a street by a posted fire lane in accordance with the *International Fire Code*.

**704.9 Vertical separation of openings.** Openings in exterior walls in adjacent stories shall be separated vertically to protect against fire spread on the exterior of the buildings where the openings are within 5 feet (1524 mm) of each other horizontally and the opening in the lower story is not a protected opening in accordance with Section 715.4.8. Such openings shall be separated vertically at least 3 feet (914 mm) by spandrel girders, exterior walls or other similar assemblies that have a fire-resistance rating of at least 1 hour or by flame barriers that extend horizontally at least 30 inches (762 mm) beyond the exterior wall. Flame barriers shall also have a fire-resistance rating of at least 1 hour. The unexposed surface temperature limitations specified in ASTM E 119 shall not apply to the flame barriers or vertical separation unless otherwise required by the provisions of this code.

**Exceptions:**

1. This section shall not apply to buildings that are three stories or less in height.
2. This section shall not apply to buildings equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1 or 903.3.1.2.
3. Open parking garages.

FIRE-RESISTANCE-RATED CONSTRUCTION

TABLE 704.8  
MAXIMUM AREA OF EXTERIOR WALL OPENINGS\*

CLASSIFICATION OF OPENING	FIRE SEPARATION DISTANCE (feet)							
	0 to 3 <sup>a</sup>	Greater than 3 to 5 <sup>b</sup>	Greater than 5 to 10 <sup>c,d</sup>	Greater than 10 to 15 <sup>e,f,g</sup>	Greater than 15 to 20 <sup>h</sup>	Greater than 20 to 25 <sup>i</sup>	Greater than 25 to 30 <sup>i</sup>	Greater than 30
Unprotected	Not Permitted <sup>d</sup>	Not Permitted <sup>d</sup>	10% <sup>a</sup>	15% <sup>a</sup>	25% <sup>a</sup>	45% <sup>a</sup>	70% <sup>a</sup>	No Limit
Protected	Not Permitted	15%	25%	45%	75%	No Limit	No Limit	No Limit

For SI: 1 foot = 304.8 mm.

- a. Values given are percentage of the area of the exterior wall.
- b. For occupancies in Group R-3, as applicable in Section 101.2, the maximum percentage of unprotected and protected exterior wall openings shall be 25 percent.
- c. The area of openings in an open parking structure with a fire separation distance of greater than 10 feet shall not be limited.
- d. For occupancies in Group H-2 or H-3, unprotected openings shall not be permitted for openings with a fire separation distance of 15 feet or less.
- e. For requirements for fire walls for buildings with differing roof heights, see Section 705.6.1.
- f. The area of unprotected and protected openings is not limited for occupancies in Group R-3, as applicable in Section 101.2, with a fire separation distance greater than 5 feet.
- g. Buildings whose exterior bearing wall, exterior nonbearing wall and exterior structural frame are not required to be fire-resistance rated shall be permitted to have unlimited unprotected openings.
- h. Includes accessory buildings to Group R-3 as applicable in Section 101.2.

**704.10 Vertical exposure.** For buildings on the same lot, approved protectives shall be provided in every opening that is less than 15 feet (4572 mm) vertically above the roof of an adjoining building or adjacent structure that is within a horizontal fire separation distance of 15 feet (4572 mm) of the wall in which the opening is located.

**Exception:** Opening protectives are not required where the roof construction has a fire-resistance rating of not less than 1 hour for a minimum distance of 10 feet (3048 mm) from the adjoining building and the entire length and span of the supporting elements for the fire-resistance-rated roof assembly has a fire-resistance rating of not less than 1 hour.

**704.11 Parapets.** Parapets shall be provided on exterior walls of buildings.

**Exceptions:** A parapet need not be provided on an exterior wall where any of the following conditions exist:

1. The wall is not required to be fire-resistance rated in accordance with Table 602 because of fire separation distance.
2. The building has an area of not more than 1,000 square feet (93 m<sup>2</sup>) on any floor.
3. Walls that terminate at roofs of not less than 2-hour fire-resistance-rated construction or where the roof, including the deck and supporting construction, is constructed entirely of noncombustible materials.
4. One-hour fire-resistance-rated exterior walls that terminate at the underside of the roof sheathing, deck or slab, provided:

- 4.1. Where the roof/ceiling framing elements are parallel to the walls, such framing and elements supporting such framing shall not be of less than 1-hour fire-resistance-rated construction for a width of 4 feet (1220 mm) measured from the interior side of the wall for Groups R and U and 10 feet (3048 mm) for other occupancies.

4.2. Where roof/ceiling framing elements are not parallel to the wall, the entire span of such framing and elements supporting such framing shall not be of less than 1-hour fire-resistance-rated construction.

4.3. Openings in the roof shall not be located within 5 feet (1524 mm) of the 1-hour fire-resistance-rated exterior wall for Groups R and U and 10 feet (3048 mm) for other occupancies.

4.4. The entire building shall be provided with not less than a Class B roof covering.

5. In occupancies of Groups R-2 and R-3 as applicable in Section 101.2, both provided with a Class C roof covering, the exterior wall shall be permitted to terminate at the roof sheathing or deck in Type III, IV and V construction provided:

- 5.1. The roof sheathing or deck is constructed of approved noncombustible materials or of fire-retardant-treated wood, for a distance of 4 feet (1220 mm); or
  - 5.2. The roof is protected with 0.625-inch (15.88 mm) Type X gypsum board directly beneath the underside of the roof sheathing or deck, supported by a minimum of nominal 2-inch (51 mm) ledgers attached to the sides of the roof framing members, for a minimum distance of 4 feet (1220 mm).
6. Where the wall is permitted to have at least 25 percent of the exterior wall areas containing unprotected openings based on fire separation distance as determined in accordance with Section 704.8.

**704.11.1 Parapet construction.** Parapets shall have the same fire-resistance rating as that required for the supporting wall, and on any side adjacent to a roof surface, shall have noncombustible faces for the uppermost 18 inches (457 mm), including counterflashing and coping materials.





**406.2 Parking garages.**

**406.2.1 Classification.** Parking garages shall be classified as either open, as defined in Section 406.3, or enclosed and shall meet the appropriate criteria in Section 406.4. Also see Section 508 for special provisions for parking garages.

**406.2.2 Clear height.** The clear height of each floor level in vehicle and pedestrian traffic areas shall not be less than 7 feet (2134 mm). Vehicle and pedestrian areas accommodating van-accessible parking required by Section 1106.5 shall conform to ICC A117.1.

**406.2.3 Guards.** Guards shall be provided in accordance with Section 0112 at exterior and interior vertical openings on floor and roof areas where vehicles are parked or moved and where the vertical distance to the ground or surface directly below exceeds 30 inches (762 mm).

**406.2.4 Vehicle barriers.** Parking areas shall be provided with exterior or interior walls or vehicle barriers, except at pedestrian or vehicular accesses, designed in accordance with Section 1607.7. Vehicle barriers not less than 2 feet (607 mm) high shall be placed at the ends of drive lanes, and at the end of parking spaces where the difference in adjacent floor elevation is greater than 1 foot (305 mm).

**406.2.5 Ramps.** Vehicle ramps shall not serve as an exit element.

**406.2.6 Floor surface.** Parking surfaces shall be of concrete or similar noncombustible and nonabsorbent materials.

**Exception:** Asphalt parking surfaces are permitted at ground level.

The area of floor used for parking of automobiles or other vehicles shall be sloped to facilitate the movement of liquids to a drain or toward the main vehicle entry doorway.

**406.2.7 Mixed separation.** Parking garages shall be separated from other occupancies in accordance with Section 302.3.

**406.2.8 Special hazards.** Connection of a parking garage with any room in which there is a fuel-fired appliance shall be by means of a vestibule providing a two-doorway separation.

**Exception:** A single door shall be allowed provided the sources of ignition in the appliance are at least 18 inches (457 mm) above the floor.

**406.2.9 Attached to rooms.** Openings from a parking garage directly into a room used for sleeping purposes shall not be permitted.

**406.3 Open parking garages.**

**406.3.1 Scope.** Except where specific provisions are made in the following subsections, other requirements of this code shall apply.

**406.3.2 Definitions.** The following words and terms shall, for the purposes of this chapter and as used elsewhere in this code, have the meanings shown herein.

**SPECIAL DETAILED REQUIREMENTS BASED ON USE AND OCCUPANCY**

**MECHANICAL-ACCESS OPEN PARKING GARAGES.** Open parking garages employing parking machines, lifts, elevators or other mechanical devices for vehicles moving from and to street level and in which public occupancy is prohibited above the street level.

**OPEN PARKING GARAGE.** A structure or portion of a structure with the openings as described in Section 406.3.3.1 on two or more sides that is used for the parking or storage of private motor vehicles as described in Section 406.3.4.

**RAMP-ACCESS OPEN PARKING GARAGES.** Open parking garages employing a series of continuously rising floors or a series of interconnecting ramps between floors permitting the movement of vehicles under their own power from and to the street level.

**406.3.3 Construction.** Open parking garages shall be of Type I, II or IV construction. Open parking garages shall meet the design requirements of Chapter 16. For vehicle barriers, see Section 406.2.4.

**406.3.3.1 Openings.** For natural ventilation purposes, the exterior side of the structure shall have uniformly distributed openings on two or more sides. The area of such openings in exterior walls on a tier must be at least 20 percent of the total perimeter wall area of each tier. The aggregate length of the openings considered to be providing natural ventilation shall constitute a minimum of 40 percent of the perimeter of the tier. Interior walls shall be at least 20 percent open with uniformly distributed openings.

**Exception:** Openings are not required to be distributed over 40 percent of the building perimeter where the required openings are uniformly distributed over two opposing sides of the building.

**406.3.4 Uses.** Mixed uses shall be allowed in the same building as an open parking garage subject to the provisions of Sections 302.3, 402.7.1, 406.3.13, 508.3, 508.4 and 508.7.

**406.3.5 Area and height.** Area and height of open parking garages shall be limited as set forth in Chapter 5 for Group S-2 occupancies and as further provided for in Section 302.3.

**406.3.5.1 Single use.** When the open parking garage is used exclusively for the parking or storage of private motor vehicles, with no other uses in the building, the area and height shall be permitted to comply with Table 406.3.5, along with increases allowed by Section 406.3.6.

**Exception:** The grade-level tier is permitted to contain an office, waiting and toilet rooms having a total combined area of not more than 1,000 square feet (93 m<sup>2</sup>). Such area need not be separated from the open parking garage.

In open parking garages having a spiral or sloping floor, the horizontal projection of the structure at any cross section shall not exceed the allowable area per parking tier. In the case of an open parking garage having a continuous spiral floor, each 9 feet 6 inches (2896 mm) of height, or portion thereof, shall be considered a tier.

The clear height of a parking tier shall not be less than 7 feet (2134 mm), except that a lower clear height is permitted in mechanical-access open parking garages where approved by the building official.

**406.3.6 Area and height increases.** The allowable area and height of open parking garages shall be increased in accordance with the provisions of this section. Garages with sides open on three-fourths of the building perimeter are permitted to be increased by 25 percent in area and one tier in height. Garages with sides open around the entire building perimeter are permitted to be increased 50 percent in area and one tier in height. For a side to be considered open under the above provisions, the total area of openings along the side shall not be less than 50 percent of the interior area of the side at each tier, and such openings shall be equally distributed along the length of the tier.

Allowable tier areas in Table 406.3.5 shall be increased for open parking garages constructed to heights less than the table maximum. The gross tier area of the garage shall not exceed that permitted for the higher structure. At least three sides of each such larger tier shall have continuous horizontal openings not less than 30 inches (762 mm) in clear height extending for at least 80 percent of the length of the sides, and no part of such larger tier shall be more than 200 feet (60 960 mm) horizontally from such an opening. In addition,

each such opening shall face a street or yard accessible to a street with a width of at least 30 feet (9144 mm) for the full length of the opening, and standpipes shall be provided in each such tier.

Open parking garages of Type IB and II construction, with all sides open, shall be unlimited in allowable area where the height does not exceed 75 feet (22860 mm). For a side to be considered open, the total area of openings along the side shall not be less than 50 percent of the interior area of the side at each tier, and such openings shall be equally distributed along the length of the tier. All portions of tiers shall be within 200 feet (60 960 mm) horizontally from such openings.

**406.3.7 Location on property.** Exterior walls and openings in exterior walls shall comply with Tables 601 and 602. The distance from an adjacent lot line shall be determined in accordance with Table 602 and Section 704.

**406.3.8 Means of egress.** Where persons other than parking attendants are permitted, open parking garages shall meet the means of egress requirements of Chapter 10. Where no persons other than parking attendants are permitted, there shall not be less than two 36-inch-wide (914 mm) exit stairways. Lifts shall be permitted to be installed for use of employees only, provided they are completely enclosed by noncombustible materials.

**406.3.9 Standpipes.** Standpipes shall be installed where required by the provisions of Chapter 9.

**406.3.10 Sprinkler systems.** Where required by other provisions of this code, automatic sprinkler systems and standpipes shall be installed in accordance with the provisions of Chapter 9.

**406.3.11 Enclosure of vertical openings.** Enclosure shall not be required for vertical openings except as specified in Section 406.3.8.

**406.3.12 Ventilation.** Ventilation, other than the percentage of openings specified in Section 406.3.3.1, shall not be required.

**406.3.13 Prohibitions.** The following uses and alterations are not permitted:

1. Vehicle repair work.
2. Parking of buses, trucks and similar vehicles.
3. Partial or complete closing of required openings in exterior walls by tarpaulins or any other means.
4. Dispensing of fuel.

**406.4 Enclosed parking garages.**

**406.4.1 Heights and areas.** Enclosed vehicle parking garages and portions thereof that do not meet the definition of open parking garages shall be limited to the allowable heights and areas specified in Table 503. Roof parking is permitted.

**406.4.2 Ventilation.** A mechanical ventilation system shall be provided in accordance with the *International Mechanical Code*.

**TABLE 406.3.5  
OPEN PARKING GARAGES AREA AND HEIGHT**

TYPE OF CONSTRUCTION	AREA PER TIER (square feet)	Ramp access	HEIGHT (in tiers)	
			Mechanical access	
			No	Yes
IA	Unlimited	Unlimited	Unlimited	Unlimited
IB	Unlimited	12 tiers	12 tiers	18 tiers
IIA	50,000	10 tiers	10 tiers	15 tiers
IIB	50,000	8 tiers	8 tiers	12 tiers
IV	50,000	4 tiers	4 tiers	4 tiers

For SF: 1 square foot = 0.0929 m<sup>2</sup>



GENERAL BUILDING HEIGHTS AND AREAS

GENERAL BUILDING HEIGHTS AND AREAS

1. The basement and/or the first story above grade plane is of Type IA construction and is separated from the building above with a horizontal assembly having a minimum 3-hour fire-resistance rating.
2. Shaft, stairway, ramp or escalator enclosures through the horizontal assembly shall have not less than a 2-hour fire-resistance rating with opening protectives in accordance with Table 715.3.

**Exception:** Where the enclosure walls below the horizontal assembly have not less than a 3-hour fire-resistance rating with opening protectives in accordance with Table 715.3, the enclosure walls extending above the horizontal assembly shall be permitted to have a 1-hour fire-resistance rating provided:

1. The building above the horizontal assembly is not required to be of Type I construction;
  2. The enclosure connects less than four stories, and
  3. The enclosure opening protectives above the horizontal assembly have a minimum 1-hour fire protection rating.
3. The building above the horizontal assembly contains only Group A having an assembly room with an occupant load of less than 300, or Group B, M or R.
  4. The building below the horizontal assembly is a Group S-2 enclosed parking garage, used for the parking and storage of private motor vehicles.

**Exceptions:**

1. Entry lobbies, mechanical rooms and similar uses incidental to the operation of the building shall be permitted.
2. Group A having an assembly room with an occupant load of less than 300, or Group B or M shall be permitted in addition to those uses incidental to the operation of the building (including storage areas), provided that the entire structure below the horizontal assembly is protected throughout by an approved automatic sprinkler system.
5. The maximum building height in feet shall not exceed the limits set forth in Table 503 for the least restrictive type of construction involved.

**508.3 Group S-2 enclosed parking garage with Group S-2 open parking garage above.** A Group S-2 enclosed parking garage located in the basement or first story below a Group S-2 open parking garage shall be classified as a separate and distinct building for the purpose of determining the type of construction when the following conditions are met:

1. The allowable area of the structure shall be such that the sum of the ratios of the actual area divided by the allowable area for each separate occupancy shall not exceed 1.0.

2. The Group S-2 enclosed parking garage is of Type I or II construction and is at least equal to the fire-resistance requirements of the Group S-2 open parking garage.
3. The height and the number of the floors above the basement shall be limited as specified in Table 406.3.5.
4. The floor assembly separating the Group S-2 enclosed parking garage and Group S-2 open parking garage shall be protected as required for the floor assembly of the Group S-2 enclosed parking garage. Openings between the Group S-2 enclosed parking garage and Group S-2 open parking garage, except exit openings, shall not be required to be protected.
5. The Group S-2 enclosed parking garage is used exclusively for the parking or storage of private motor vehicles, but shall be permitted to contain an office, waiting room and toilet room having a total area of not more than 1,000 square feet (93 m<sup>2</sup>), and mechanical equipment rooms incidental to the operation of the building.

**508.4 Parking beneath Group R.** Where a maximum one-story above grade plane Group S-2 parking garage, enclosed or open, or combination thereof, of Type I construction or open of Type IV construction, with grade entrance, is provided under a building of Group R, the number of stories to be used in determining the minimum type of construction shall be measured from the floor above such a parking area. The floor assembly between the parking garage and the Group R above shall comply with the type of construction required for the parking garage and shall also provide a fire-resistance rating not less than the mixed occupancy separation required in Section 302.3.2.

**508.5 Group R-2 buildings of Type IIIA construction.** The height limitation for buildings of Type IIIA construction in Group R-2 shall be increased to six stories and 75 feet (22 860 mm) where the first-floor construction above the basement has a fire-resistance rating of not less than 3 hours and the floor area is subdivided by 2-hour fire-resistance-rated fire walls into areas of not more than 3,000 square feet (279 m<sup>2</sup>).

**508.6 Group R-2 buildings of Type IIA construction.** The height limitation for buildings of Type IIA construction in Group R-2 shall be increased to nine stories and 100 feet (30 480 mm) where the building is separated by not less than 50 feet (15 240 mm) from any other building on the lot and from property lines, the exits are segregated in an area enclosed by a 2-hour fire-resistance-rated fire wall and the first-floor construction has a fire-resistance rating of not less than 1 1/2 hours.

**508.7 Open parking garage beneath Groups A, I, B, M and R.** Open parking garages constructed under Groups A, I, B, M and R shall not exceed the height and area limitations permitted under Section 406.3. The height and area of the portion of the building above the open parking garage shall not exceed the limitations in Section 503 for the upper occupancy. The height, in both feet and stories, of the portion of the building above the open parking garage shall be measured from grade plane and shall include both the open parking garage and the portion of the building above the parking garage.

**508.7.1 Fire separation.** Fire separation assemblies between the parking occupancy and the upper occupancy

shall correspond to the required fire-resistance rating prescribed in Table 302.3.2 for the uses involved. The type of construction shall apply to each occupancy individually, except that structural members, including main bracing within the open parking structure, which is necessary to support the upper occupancy, shall be protected with the more restrictive fire-resistance-rated assemblies of the groups involved as shown in Table 601. Means of egress for the upper occupancy shall conform to Chapter 10 and shall be separated from the parking occupancy by fire barriers having at least a 2-hour fire-resistance rating as required by Section 706, with self-closing doors complying with Section 715. Means of egress from the open parking garage shall comply with Section 406.3.



**Appendix 2. DESIGN LOADS**

Occupancy Category II (NCSBC Table 1604.5) (Structure with congregate load less than 300, occupant load less than 5,000)

Importance Factors (NCSBC Table 1604.5)

Wind 1.00  
Snow 1.00  
Seismic 1.00

Roof Live Load: 20 psf (NCSBC 1607.11.2.1)

Design Roof Live Load: 20 psf

Wind:

Basic wind speed: 90 mph (NCSBC Figure 1609)  
Exposure: B (NCBC 1609.4.2)

Snow:

Ground snow load (pg): 15 psf (NCSBC Figure 1608.2)  
Design snow load (pf): 11 psf (ASCE 7.3)  
Design snow load (ps): 11 psf (ASCE7.4)

Floor Live Loads: (NCBC Table 1607.1)

Lobbies: 100 psf  
Movable seating: 100 psf  
Fixed seating: 60 psf  
Office: 50 psf  
Retail (2nd floor): 75 psf  
Corridors: 100 psf

Basic Structural System: (NCSBC 1617.6.2)

Ordinary reinforced concrete moment frames R=3 (Existing) (3G)  
Special reinforced masonry shear walls R=5 (New) (1F)  
Ordinary reinforced concrete shear walls R=5 (New) (2F)

Seismic Use Group: I (NCBC 1616.2.2) (ASCE Table 9.1.3)

Spectral Response Acceleration: S<sub>ms</sub> = 0.361 S<sub>m1</sub> = 0.251

Seismic Design Category: C (NCSBC Table 1616.3.2)

Site Classification: D (NCSBC Table 1615.1.1)

Analysis Procedure: Equivalent (NCSBC 1617.4) (ASCE 9.5.5) V = CsW

Lateral design Control: Seismic Wind

Architectural Components required to be anchored per 1621.1 (9.6.1.2.; 9.6.2)

(If I<sub>p</sub> is > 1.0) component anchorage design is required

Mech. and Elect. Components required to be anchored per 1621.1 (9.6.1.4; 9.6.3)

(If I<sub>p</sub> is > 1.0) component anchorage design is required

**SOIL BEARING CAPACITIES:**

Field Test: N/A  
Presumptive Bearing Capacity: 4800 psf  
Pile size, type, and capacity: N/A

**WIND ANALYSIS:**

BASIC DESIGN WIND PRESSURE q = 20.2 PSF



The sample area (**11,800 SF**) of the plaza was used below for load calculations. The collected data was extrapolated on the entire plaza

**Existing Dead Load Analysis****Planters**

Assume 2.5' earth fill  
 Assume 2.5" lightweight topping slab  
     30" soil x 80 psf = 200 psf  
     2.5" LW conc. = 2.5/12 x 110 = 22 psf  
 Total dead load = 222 psf

**Paved Areas**

Assume 2.5" lightweight topping slab  
 Brick pavers : 2.625/4 x 39 = 26 psf  
     2.5" LW conc. = 22 psf  
     Pavers = 26 psf  
 Total dead load = 48 psf

**Brick Knee Walls**

Assume 3' High, 12" cmu grout solid = 123 psf  
 4" brick, 3' high = 120 plf one side only at planters  
     CMU = 123 plf  
     Brick = 120 plf  
     Topping slab = 0  
 Total Dead load = 243 plf

**New Dead Load Analysis****New first level dead load**

2" LW Topping slab                      2/12 x 110 = 18 psf  
 Marble flooring = 20 psf  
 Misc/Furnishings = 20 psf  
 Total = 58 psf  
 Total = 58 psf x 20' o.c. = 1160 plf

**New Roof Dead Load**

Metal deck, no ballast, bar joists, MPE (7 psf) = ~25 psf

**New Second Floor level Load**

1" 26 ga deck, 3" LW conc. = 24 psf  
 Joists = ~ 3 psf  
 MPE = ~ 8 psf  
 DL = ~ 15 psf  
 Total Dead Load = 50 psf

**New Live Load Analysis****New Live Load per NCSBC**

Assembly/Lobbies = 100 psf  
 Assembly- Fixed Seats = 60 psf



<i>Additional dead load onto beams @ 20' on center</i>		<i>Net Dead Load plf (exist - new)</i>	<i>Net Dead Load psf</i>	<i>Net Second Level Live Load (net dl - roof dl - floor dl)</i>	<i>(PT Force)</i>
<b>Column Lines 7/8</b>					
A Planter 222 psf x 20 = 4440 plf	4440	<b>3280</b> plf	<b>164</b> psf	<b>89</b> psf	<b>TB2 1134K</b>
B Pavers/Planter Pavers = 13.67 x 48 = 416 plf Planter = 5 x 222 = 1110 plf Wall = 243 plf  Total = 2009 plf	2009	<b>849</b> plf	<b>42</b> psf	<b>33</b> psf	
<b>Column Lines 5/6</b>					
C Pavers 18.67 x 48 = 896 plf wall = 213 plf  Total = 1109 plf	1109	<b>-51</b> plf	<b>-3</b> psf	<b>78</b> psf	<b>TB2 1134K</b>
D Pavers/Wall/Planter Pavers = 8.67 x 48 = 416 plf Wall = 243 plf Planter = 10 x 222 = 2220 plf Total = 2879 plf	2879	<b>1719</b> plf	<b>86</b> psf	<b>11</b> psf	

**Column Lines 3/4****E Planter/Pavers**Planter =  $15 \times 222 = 3330$  plfPavers =  $4 \times 48 = 192$ 

Wall = 243

Total = 3546 plf

3546

2386 plf

119 psf

44 psf

TB2A

1134K

**F Pavers/Planting**Pavers =  $14 \times 48 = 672$ 

Wall = 243

Planting =  $4.67 \times 222 = 1037$ 

Total = 1952 plf

1952

792 plf

40 psf

35 psf

Note: Even though there is a low net dead load or low net live load, there is adequate capacity since beam Post Tension (PT) force is the same as the beam at column lines 7/8 which has a net second level live load of 89 psf. There most likely is more available net second floor live load which can be determined upon further analytical evaluation.