



**WALKER**  
RESTORATION CONSULTANTS

CAPITAL IMPROVEMENT AND  
PROTECTION PROGRAM

CITY OF MANHATTAN  
BEACH PARKING  
STRUCTURES  
LOTS 2, 3 & 4



LOT 2 PARKING STRUCTURE



LOT 3 PARKING STRUCTURE



LOT 4 PARKING STRUCTURE

Prepared for:  
CITY OF MANHATTAN BEACH



LOT 2 PARKING STRUCTURE



LOT 3 PARKING STRUCTURE



LOT 4 PARKING STRUCTURE

CAPITAL IMPROVEMENT AND  
PROTECTION PROGRAM

## CITY OF MANHATTAN BEACH LOTS 2, 3 & 4 PARKING STRUCTURES

Prepared for:  
CITY OF MANHATTAN BEACH  
PROJECT NO. 37-8377.00

SEPTEMBER 2013



**MANHATTAN BEACH LOTS 2, 3, 4 PARKING STRUCTURES**  
CAPITAL IMPROVEMENT AND PROTECTION PROGRAM



SEPTEMBER 2013

PROJECT #37-8377.00

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# MANHATTAN BEACH LOTS 2, 3, 4 PARKING STRUCTURES

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The purpose of this report is to provide the City of Manhattan Beach (City) with a management tool that offers the recommendations needed to make informed, cost-effective decisions regarding capital improvements and maintenance work for the Parking Structures at Lots 2, 3 & 4.

The three parking structures are in fair condition. The Capital Improvement Protection Programs (CIPP) outlined in this report will help the City plan for the funding needed for current and future restoration/maintenance work in order to keep the structures operating safely for another 10 to 20 years. Over the next ten years (starting in 2014) we recommend budgeting \$2,117,000 in 2013 dollars (\$2,344,200 in future value dollars) for restoration capital improvements for the three structures. We recommend prioritizing Lot 2 repairs first, followed by Lot 3 and Lot 4.

As an immediate concern, the existing vehicular barriers in the three structures were noted to not meet current code. While the barriers have been in place since the original construction and may be grandfathered in under the current code, we recommend the City take a proactive approach by installing a new vehicular barrier system on the upper levels. This would minimize any potential hazards that exist with the current systems and bring them up to current code.

As an additional immediate concern, no height restraint bars were noted at the entries to the supported levels at any of the structures. This allows for over-sized vehicles to access the upper levels and possibly overload the structure. This is of particular concern in Lot 2, where several Post-Tensioning strands in the elevated slab were noted to be de-stressed. We recommend installing height restraint bars at the entries to the upper levels in all three garages to prevent the access of over-sized vehicles.

We recognize that one of the biggest challenges for property owners is to fund annual capital improvement projects with limited budgets. This CIPP will help the City prioritize annual capital maintenance work in order to maximize both the dollars spent and life expectancy of each structure.

Please note that the recommended budget outlined in this report is based on our condition assessment of each parking

## PROGRAM EXECUTIVE SUMMARY

### 10-yr Budget Breakdown

Lot 2:	\$457,000
Lot 3:	\$1,291,000
Lot 4:	\$368,500
Total:	\$2,117,000

### Immediate Concerns

- Vehicular barriers
- Height restraint bars



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## Combined Parking Structures 2, 3, 4 Executive Summary - 10 year Budget Forecast



NO.	WORK DESCRIPTION	TOTAL COST	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Executive Work Description Summary												
1	Concrete	\$ 327,000	\$ 128,000	\$ 169,500	\$ -	\$ -	\$ -	\$ 15,500	\$ 9,000	\$ -	\$ -	\$ 5,000
2	Waterproofing	\$ 639,800	\$ -	\$ 309,000	\$ 85,000	\$ -	\$ -	\$ -	\$ 49,500	\$ 7,000	\$ -	\$ 187,500
3	Stairs	\$ 7,500	\$ 1,000	\$ 1,500	\$ 1,000	\$ -	\$ -	\$ -	\$ -	\$ 2,500	\$ -	\$ -
4	Drainage/Lighting	\$ 22,000	\$ -	\$ 16,000	\$ -	\$ -	\$ -	\$ -	\$ 4,500	\$ -	\$ -	\$ -
5	Miscellaneous/Architectural Repairs	\$ 479,000	\$ 288,000	\$ 98,000	\$ 81,500	\$ -	\$ -	\$ -	\$ 4,000	\$ 7,500	\$ -	\$ -
6	Enhancements	\$ 161,500	\$ -	\$ 27,500	\$ 111,500	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 22,500
7	Mobilization	\$ 171,000	\$ 43,000	\$ 64,000	\$ 29,000	\$ -	\$ -	\$ 2,000	\$ 8,000	\$ 2,000	\$ -	\$ 23,000
7	Engineering and Construction Administration Allowance	\$ 157,000	\$ 43,000	\$ 64,000	\$ 15,000	\$ -	\$ -	\$ 2,000	\$ 8,000	\$ 2,000	\$ -	\$ 23,000
7	Construction Contingency	\$ 157,000	\$ 43,000	\$ 64,000	\$ 15,000	\$ -	\$ -	\$ 2,000	\$ 8,000	\$ 2,000	\$ -	\$ 23,000
11	Opinion of Annual Budget (2013 Dollars)	\$ 2,117,000	\$ 546,000	\$ 813,500	\$ 338,000	\$ -	\$ -	\$ 21,500	\$ 91,000	\$ 23,000	\$ -	\$ 284,000
12	Opinion of Annual Budget (Adjusted Future Value)	\$ 2,344,200	\$ 562,600	\$ 863,200	\$ 369,400	\$ -	\$ -	\$ 25,800	\$ 112,100	\$ 29,300	\$ -	\$ 381,800
Combined Structure Totals												
1	Parking Structure 2	\$ 457,000	\$ 135,000	\$ 138,500	\$ 49,500	\$ -	\$ -	\$ 5,000	\$ 11,500	\$ 6,000	\$ -	\$ 111,500
2	Parking Structure 3	\$ 1,291,500	\$ 270,500	\$ 605,500	\$ 150,500	\$ -	\$ -	\$ 12,000	\$ 69,000	\$ 11,500	\$ -	\$ 172,500
3	Parking Structure 4	\$ 368,500	\$ 140,500	\$ 69,500	\$ 138,000	\$ -	\$ -	\$ 4,500	\$ 10,500	\$ 5,500	\$ -	\$ -
7	Combined Ramp Annual Budget (2013 Dollars)	\$ 2,117,000	\$ 546,000	\$ 813,500	\$ 338,000	\$ -	\$ -	\$ 21,500	\$ 91,000	\$ 23,000	\$ -	\$ 284,000
8	Combined Ramp Annual Budget (Adjusted Future Value)	\$ 2,344,200	\$ 562,600	\$ 863,200	\$ 369,400	\$ -	\$ -	\$ 25,800	\$ 112,100	\$ 29,300	\$ -	\$ 381,800
9	Combined Ramp Opinion of 10-Year Budget	\$ 2,344,200										

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LOT 2 PARKING STRUCTURE

## CITY OF MANHATTAN BEACH

MANHATTAN BEACH, CA

Prepared for:  
CITY OF MANHATTAN BEACH  
PROJECT NO. 37-8377.00

SEPTEMBER 2013



LOT 2 PARKING STRUCTURE



# MANHATTAN BEACH LOT 2 PARKING STRUCTURE

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### EXECUTIVE SUMMARY

The Lot 2 Parking Structure is 34 years old and considered to be in fair condition for its age. Over the next ten years (starting in 2014) we recommend budgeting \$457,000 in 2013 dollars (\$518,000 in future value dollars) for capital improvements and repair/maintenance work.

The Capital Improvement and Protection Program (CIPP) contained in this report is based upon the results of our condition assessment and recommendations for the City in performing budgeted capital improvements and routine maintenance on the Lot 2 Parking Structure over the next 10 years.

We recommend the following components of this budget be given first priority ("Priority-1"):

- Concrete Repairs (floor, beams and stairs): \$22,500
- New Vehicular Barrier System: \$26,500
- Post-Tension Strand Repair and Protection: \$45,000
- Height Restraint Bar at Upper Level Entry: \$8,000

Total recommended budget for "Priority-1" repairs in Lot 2 Parking Structure: \$102,000\*

If the City of Manhattan Beach (City) were to elect to rebuild the upper level of this structure (maintain the columns and foundations), we estimate the replacement cost, including demolition, to range between \$500,000 and \$600,000.

The existing vehicular barriers in this structure have been in place since the original construction and may be grandfathered in under the current code. We recommend the City take a proactive approach by installing a new vehicular barrier system on the upper level that would meet current code requirements and minimize any potential hazards that exist with the current system.

Additionally, no height restraint bar was noted at the entry to the upper level from 12<sup>th</sup> Street. This allows for over-sized vehicles to access the upper level and possibly overload the structure. This is of particular concern in this structure because several PT tendons in the elevated slab were noted to be broken. In addition to repairing the broken PT tendons,

*\*This cost estimate does not include contractor mobilization, engineering and construction administration, and contingency fees.*

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we recommend installing a height restraint bar at the entry to the upper level to avoid possible overloading.

Partial depth spalls and failed patchwork were noted on the upper level. Spalls were also noted in the cast-in-place concrete stairs and at the exposed ends of the beams. We recommended the failed patchwork and spalled concrete be removed, underlying reinforcement and exposed PT tendons cleaned and protected, and the areas patched with a high quality mortar to stop further deterioration.

Concrete testing showed poor durability characteristics, increasing the susceptibility to deterioration due to moisture infiltration. To help mitigate this deterioration, routing and sealing all floor cracks in addition to installing a protective urethane topping over the floor area of the upper level are a large portion of the "Priority-2" waterproofing repairs.

A Tier 1 seismic evaluation was completed to rapidly identify potential deficiencies in the design of the structure. Though the Tier 1 screening phase identified this structure to be non-compliant for torsion and redundancy requirements as defined by ASCE 31-03, results of "quick check" calculations indicate that the lateral-force-resisting shear walls in this structure have enough strength to resist calculated seismic forces. As such, we do not recommend pursuing a Tier 2 evaluation to further investigate the potential deficiencies identified in the Tier 1 screening phase.

Budgeting for capital improvements will help the City plan for the necessary funding needed for the recommended work required to maintain the structural integrity and keep the garage operating safely for another 10 to 20 years.

Please see the CIPP table on page 2-8 for a prioritized recommended annual budget breakdown through 2023.

### OBJECTIVE

This ten-year budget for the outlined CIPP is based on the understanding that the City plans to maintain the Lot 2 Parking Structure based on the recommended program for at least the next 10 years of the structure's service life.

### INTRODUCTION

# MANHATTAN BEACH LOT 2 PARKING STRUCTURE

## CAPITAL IMPROVEMENT AND PROTECTION PROGRAM



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The objectives of this CIPP are to provide the City with an asset management tool for planning and budgeting, and to recommend restoration improvements and work items in order to maximize the service-life of this parking facility while planning for an adequate amount of capital funding. The benefit for the City is the ability to plan and budget in confidence for each year thus allowing the maximization of dollars spent. This CIPP is specific to the Lot 2 Parking Structure. If desired, our plan has the flexibility to defer certain work items to future years of the repair program.

### FACILITY DESCRIPTION/ BACKGROUND INFORMATION

The Lot 2 Parking Structure is located at 222 12<sup>th</sup> Street in Manhattan Beach, California. The parking facility was built in 1979 and is constructed of one way cast-in-place post-tensioned (PT) slabs and beams supported on cast-in-place concrete columns. The facility has one supported level with two separated slab-on-grade levels on either side of 12<sup>th</sup> street. The lateral load resisting system consists of two shear walls in the east-west direction and one shear wall in the north-south direction. The facility was designed for a parking capacity of 66 vehicles. The focus of our investigation was on the portion of this parking facility located on the south side of 12<sup>th</sup> street.

A vehicular entrance to the upper level is provided on 12<sup>th</sup> Street and access to the lower level is gained from the Center Place alleyway on the south side of the structure. Vehicles park in 2-hour metered spaces, which are enforced daily from 8am-9pm. Vehicles that have purchased permits may park in the facility for longer durations. The parking facility serves patrons of the nearby shops, restaurants, and businesses in the downtown Manhattan Beach area.

### IMMEDIATE CONCERNS

The existing vehicular barriers in this structure do not appear to meet current code requirements for maximum spacing and load resistance. This could pose a potential hazard to the users of this structure. While the existing barriers may be grandfathered in under the current code, we recommend the City take a proactive approach and install a new vehicular barrier system that would replace the existing system and meet current code.

### RECOMMENDATIONS

Additionally, no restrictions are currently placed on over-sized vehicles parking in the structure. This could induce greater loads on the upper level than it was designed for. We recommend the City install a height restraint bar at the upper level entry to restrict larger vehicles from using the parking structure.

These items and our corresponding recommendations are further discussed in this report.

### RECOMMENDED CAPITAL IMPROVEMENTS

The following capital improvements for the Lot 2 Parking Structure are recommended over the next ten years:

- Repair concrete spalls, delaminations and failed patchwork identified on the floor and ceilings of the supported slab and slab soffit.
- Replace de-stressed PT tendons that have been exposed on top of the upper level. Functional PT tendons that are uncovered during the partial or full-depth concrete repair work should be protected with new sheathing to mitigate deterioration.
- Repair damaged curbs located on the upper level.
- Repair damaged concrete at ends of beams to protect and prevent corrosion and deterioration of the PT anchors.
- Repair spalls in the concrete walls and repair damaged stucco where necessary.
- Repair concrete as necessary in conjunction with routine maintenance performed in 2019 and 2023.
- Rout and seal typical floor cracks and install cove sealants at cold joints to prevent ingress of water and other environmental contaminants.
- Apply a new urethane traffic topping on the floor of the upper level.
- Inject epoxy in large cracks identified in ceiling, beams and walls to prevent deterioration from infiltrating water and maintain structural integrity.
- Inject chemical grout at the joint between the walls and slab to reduce the possibility of water infiltration through the joint.
- Repair the large spall identified in the top tread of the cast-in-place concrete stairs.

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- Repair identified non-working light fixtures.
- Clean the existing floor drain.
- Repair identified cracking in the masonry wall.
- Install a concrete cap along the top of the masonry wall on the east side of the structure to prevent water from collecting.
- Repair the stucco skim coat at de-bonded areas.
- Clean staining from walls and repaint to improve the aesthetics of the facility.
- Repaint traffic markings to eliminate conflicts that exist with old striping.
- Replace existing signage at the south entry into the lower level.
- Remove unused and non-functional fire hose cabinet, as it is not required by code.

### PREVENTIVE ITEMS

We recommend the following preventative work items over the next ten years for the Lot 2 Parking Structure:

- Cut a drip edge into the ceiling on the western side of the structure. This will help to keep water from entering the lower level of the garage.
- Maintain sealants and urethane traffic topping every five to seven years to prevent premature deterioration from water intrusion into the concrete. Once the sealants are installed in 2015 we recommend replacing the most critical areas in 2020 as they will be nearing the end of their useful service life. We have recommended the traffic topping be replaced in 2023 if originally installed in 2015.

### ENHANCEMENT OPTIONS

Painting the ceilings will brighten the appearance of the parking facility. This can be completed when your budget allows.

Lighting in the parking structure is provided by fluorescent T5 light fixtures, with embedded conduit. Light level measurements were not part of the scope of this project. A number of light bulbs at select locations were not functional. Corrosion damage was noted on the lighting fixtures at select locations.

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Replacing the fixtures with more energy efficient LED lighting will reduce the energy costs, and have a longer bulb life, which can contribute to further savings. A lighting study is recommended to determine actual light levels and provide a present value cost of implementing energy efficient lighting.

### OPINION OF PROBABLE COSTS

The Lot 2 Parking Structure CIPP anticipates a total budget of \$457,000 in 2013 dollars (\$518,000 in future value dollars) to perform capital improvements over the next ten years. Future value dollars were determined using an annual inflation rate of 3% and include estimated General Conditions and Contingencies.

The primary cost components of this budget are:

#### "Priority-1":

Concrete:

- Repairs of delamination and spalls in the upper level floor and curbs in 2014: \$21,500.

Miscellaneous Repair:

- Post-Tension strand repair and protection in 2014: \$45,000.
- Installation of a new vehicular barrier system in 2014: \$26,500.
- Addition of height restraint bar in 2014: \$8,000.

#### "Priority-2":

Waterproofing:

- Traffic topping application in 2015: \$57,000.
- Routing/Sealing Floor cracks in 2015: \$6,000

#### "Priority-3":

Waterproofing:

- Epoxy and chemical grout injection in 2016: \$23,000.

### OPINION OF PROBABLE COSTS

# MANHATTAN BEACH LOT 2 PARKING STRUCTURE

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Please note that the "Contingency and General Conditions" in the CIPP table are strictly for budgeting purposes. Actual Contingency and General Conditions will be determined when contractor bids are received for the work performed by a qualified restoration contractor.

It is our experience that the repairs we have recommended on a structure of this age would extend its service life for another 10-20 years. As such, we suggest considering the option of demolishing the existing structure, while salvaging the columns and foundations, and constructing a new elevated parking slab of a similar design. The cost of this option, including demolition, would amount to approximately \$58.00-\$70.00/s.f., or about \$500,000-\$600,000 for the 8,650s.f. elevated slab. Pursuing this option would reduce the potential for continuous and costly maintenance repairs resulting from durability issues, which makes up the majority of this CIPP. Further information on this option can be discussed if the City so chooses.



## Parking Structure 2 10 Year Budget Forecast



LEGEND	
Priority-1	
Priority-2	
Priority-3	

NO.	WORK DESCRIPTION	TOTAL COST	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
<b>1</b>	<b>Concrete</b>	<b>\$ 36,000</b>	<b>\$ 21,500</b>	<b>\$ 4,500</b>	<b>\$ -</b>	<b>\$ -</b>	<b>\$ -</b>	<b>\$ 3,500</b>	<b>\$ 1,500</b>	<b>\$ -</b>	<b>\$ -</b>	<b>\$ 5,000</b>
1.1	Floor Repair - Partial Depth	\$ 17,000	\$ 14,000					\$ 1,500				\$ 1,500
1.2	Floor Repair - Full Depth	\$ 3,000	\$ 2,000					\$ 500				\$ 500
1.3	Floor Repair - Curbs	\$ 2,500	\$ 1,500					\$ 500				\$ 500
1.4	Ceiling Repair - Partial Depth	\$ 4,000		\$ 2,000					\$ 1,000			\$ 1,000
1.5	Beam Repair - Partial Depth	\$ 6,000	\$ 4,000					\$ 1,000				\$ 1,000
1.6	Wall Repair - Partial Depth	\$ 3,500		\$ 2,500					\$ 500			\$ 500
<b>2</b>	<b>Waterproofing</b>	<b>\$ 153,000</b>	<b>\$ -</b>	<b>\$ 65,500</b>	<b>\$23,000</b>	<b>\$ -</b>	<b>\$ -</b>	<b>\$ -</b>	<b>\$ 4,500</b>	<b>\$ 3,000</b>	<b>\$ -</b>	<b>\$ 57,000</b>
2.1	Cove Sealant	\$ 4,000		\$ 2,500					\$ 1,500			
2.2	Rout/Seal Floor Cracks	\$ 9,000		\$ 6,000					\$ 3,000			
2.3	Traffic Topping	\$ 114,000		\$ 57,000								\$ 57,000
2.4	Chemical Grout Injection	\$ 4,000			\$ 2,500					\$ 1,500		
2.5	Epoxy Injection - Walls	\$ 8,500			\$ 8,000					\$ 500		
2.6	Epoxy Injection - Ceilings	\$ 12,500			\$ 12,000					\$ 500		
2.7	Epoxy Injection - Beams	\$ 1,000			\$ 500					\$ 500		
<b>3</b>	<b>Stairs</b>	<b>\$ 1,000</b>	<b>\$ 1,000</b>	<b>\$ -</b>	<b>\$ -</b>	<b>\$ -</b>	<b>\$ -</b>	<b>\$ -</b>	<b>\$ -</b>	<b>\$ -</b>	<b>\$ -</b>	<b>\$ -</b>
3.1	Concrete Stair Tread Repair	\$ 1,000	\$ 1,000									
<b>4</b>	<b>Drainage/Lighting</b>	<b>\$ 4,000</b>	<b>\$ -</b>	<b>\$ 2,500</b>	<b>\$ -</b>	<b>\$ -</b>	<b>\$ -</b>	<b>\$ -</b>	<b>\$ 1,500</b>	<b>\$ -</b>	<b>\$ -</b>	<b>\$ -</b>
4.1	Clean Existing Drain	\$ 1,000		\$ 500					\$ 500			
4.2	Electrical Allowance	\$ 1,000		\$ 500					\$ 500			
4.3	Repair Light Fixtures	\$ 2,000		\$ 1,500					\$ 500			
<b>5</b>	<b>Miscellaneous/Architectural Repairs</b>	<b>\$ 102,000</b>	<b>\$ 79,500</b>	<b>\$ 5,500</b>	<b>\$14,500</b>	<b>\$ -</b>	<b>\$ -</b>	<b>\$ -</b>	<b>\$ 1,000</b>	<b>\$ 1,500</b>	<b>\$ -</b>	<b>\$ -</b>
5.1	New Vehicular Barrier System	\$ 26,500	\$ 26,500									
5.2	Post Tension Strand Repair	\$ 40,000	\$ 40,000									
5.3	Post Tension Protection	\$ 5,000	\$ 5,000									
5.4	Masonry Wall Repair	\$ 1,000		\$ 500					\$ 500			
5.5	Add Concrete Masonry Cap	\$ 2,500		\$ 2,500								
5.6	Wall Repair - Skim Coat	\$ 3,000		\$ 2,500					\$ 500			
5.7	Paint Interior Walls	\$ 7,000			\$ 7,000							
5.8	Repaint Stall Striping	\$ 3,000			\$ 1,500					\$ 1,500		
5.9	Entry/Exit Signage Updates	\$ 1,000			\$ 1,000							
5.10	Flatten Transition at Upper Level Entry	\$ 4,000			\$ 4,000							
5.11	Cut Drip Edge in Ceiling	\$ 1,000			\$ 1,000							
5.12	Add Height Restriction Bar at Upper Level Vehicular Entry	\$ 8,000	\$ 8,000									
<b>6</b>	<b>Enhancements</b>	<b>\$ 50,000</b>	<b>\$ -</b>	<b>\$ 27,500</b>	<b>\$ -</b>	<b>\$ -</b>	<b>\$ -</b>	<b>\$ -</b>	<b>\$ -</b>	<b>\$ -</b>	<b>\$ -</b>	<b>\$ 22,500</b>
6.1	Clean and Paint Ceilings	\$ 45,000		\$ 22,500								\$ 22,500
6.2	Lighting Study	\$ 5,000		\$ 5,000								
<b>Sub Total</b>		<b>\$ 346,000</b>	<b>\$ 102,000</b>	<b>\$ 105,500</b>	<b>\$37,500</b>	<b>\$ -</b>	<b>\$ -</b>	<b>\$ 3,500</b>	<b>\$ 8,500</b>	<b>\$ 4,500</b>	<b>\$ -</b>	<b>\$ 84,500</b>
Mobilization		\$ 37,000	\$ 11,000	\$ 11,000	\$ 4,000	\$ -	\$ -	\$ 500	\$ 1,000	\$ 500	\$ -	\$ 9,000
Engineering and Construction Administration Allowance		\$ 37,000	\$ 11,000	\$ 11,000	\$ 4,000	\$ -	\$ -	\$ 500	\$ 1,000	\$ 500	\$ -	\$ 9,000
Construction Contingency		\$ 37,000	\$ 11,000	\$ 11,000	\$ 4,000	\$ -	\$ -	\$ 500	\$ 1,000	\$ 500	\$ -	\$ 9,000
<b>Opinion of Annual Budget (2013 Dollars)</b>		<b>\$ 457,000</b>	<b>\$135,000</b>	<b>\$ 138,500</b>	<b>\$49,500</b>	<b>\$ -</b>	<b>\$ -</b>	<b>\$ 5,000</b>	<b>\$11,500</b>	<b>\$ 6,000</b>	<b>\$ -</b>	<b>\$ 111,500</b>
<b>Opinion of Annual Budget (Adjusted Future Value)</b>			<b>\$139,100</b>	<b>\$ 147,000</b>	<b>\$54,100</b>	<b>\$ -</b>	<b>\$ -</b>	<b>\$ 6,000</b>	<b>\$14,200</b>	<b>\$ 7,700</b>	<b>\$ -</b>	<b>\$ 149,900</b>
<b>Opinion of Total 10-Year Budget (Adjusted Future Value)</b>		<b>\$ 518,000</b>		Note: Future value cost based on inflation; 3% annually								

Note 1: Contingency based on 10% of Sub Total rounded up to the nearest \$500.

Note 2: General Conditions based on 10% of Sub Total rounded up to the nearest \$500.

Note 3: Consulting & Engineering Fees based on 10% of Sub Total rounded up to the nearest \$500.

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The Walker team visited the structure on July 25, 2013 to review the existing conditions of the parking structure. Based on our condition appraisal, the parking structure was found to be in fair condition. It was noted that the existing vehicular barrier rails are non-compliant with the current building code requirements and could pose a potential liability risk to the owner. Typical signs of deterioration in the structure consistent with its age were also noted. Specifically, cracked and deteriorated concrete walls, floors and ceilings were observed at select locations. Several post-tensioned (PT) tendons were noted to be exposed and a few tendons were noted to be de-stressed during our review.

It has been our experience that owners who address durability and maintenance issues for their parking structures can expect to receive a maximized service life and less costly future repairs as compared to a structure that does not receive proper preventative maintenance.

### Vehicular Barriers

The vehicular barriers consist of metal rails supported on cast-in-place concrete curbs. The spacing between the horizontal members does not meet the current code. Current code limits this spacing to a maximum of 4 inches in order to prevent the possibility of small objects and children passing through. Existing spacing between the horizontal members was measured to be 8".

In addition, current code requires vehicular barriers to be designed to resist a load of 6000 lbs. Although a detailed review of the capacity of the existing barrier system was not a part of the current scope, it appears (by experience) that the existing barrier system will not be able to withstand a vehicular impact.

Further, a number of the posts were noted to be bent from vehicular impact and many of the embedded connections at the curb were loose and corroded. In general, the existing barrier rail system is in poor condition.

While the existing vehicular barriers in this structure have been in place since the original construction and may be grandfathered in under the current code, we recommend

## DISCUSSION



Photo 38: Vehicular Barriers on Upper Level

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the City take a proactive approach by installing a new vehicular barrier system on the upper level. This would ensure that the vehicular barriers would meet current code requirements and minimize any potential hazards that exist with the current system.

### Concrete Structure

The main structural system of the Lot 2 Parking Structure is composed of a one-way post-tensioned (PT) concrete slab supported on long span PT beams that cantilever out approximately 15-feet on the west side of the structure. Reinforced concrete shear walls on north, east and south sides of the structure along with columns on the west side of the structure provide the vertical and lateral load resisting system. A seismic retrofit was noted on the south side of the building. While no drawings were obtained, it appeared that the retrofit was aimed at strengthening the connection between a PT beam and a reinforced concrete shear wall.

Based on visual review and sounding observations on the floor deck along with selective material tests, the concrete in the structure is noted to be in fair condition.

### Elevated Slab

- Prior concrete patchwork was noted on the top surface of the supported slab. A large number of these patches were located along PT tendon runs. Many of the patches were noted to be failed and delaminated. In order to stop further deterioration to the concrete and the underlying PT, it is recommended that the delaminated patches be removed, underlying reinforcement and PT tendons cleaned and protected, and the areas re-patched with high quality repair mortar.
- Concrete spalls were visually observed and located by sounding at isolated locations on the floor and ceiling surfaces. The majority of the spalling was minor in size at less than 5 square feet. In order to stop further deterioration to the embedded reinforcing steel and PT from moisture intrusion, it is recommended that these spalled areas be removed, underlying reinforcement and PT strands cleaned and



Photo 44: Deteriorating vehicular rail base plate



Photo 54: Evidence of a past seismic retrofit.



Photo 26: Typical cracking and previous patchwork in elevated slab.

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protected, and area patched with good quality repair mortar.

- Several PT tendons were noted to be exposed through the top surface of the deck. This has caused the sheathing of the tendons to break. Moisture intrusion into the PT strands has caused corrosion and subsequent deterioration of the PT strands and a number of these strands were identified to be de-stressed. This compromises the structural integrity and reduces the overall load capacity of the slab. We recommend that all de-stressed PT tendons be replaced.
- Above average floor cracks were noted throughout the elevated deck. The cracks were most often aligned with the post-tensioned beams below. We recommend these cracks be routed and sealed to prevent accelerated deterioration of embedded reinforcing steel and PT tendons from water and other chemicals/environmental contaminants (see Waterproofing/Protection).

### Walls/Beams/Curbs

- Spalled areas were noted at select locations in the concrete walls. We recommend these spalls be removed, underlying reinforcement cleaned, and area patched with a high quality repair mortar.
- The concrete at the end of the beams on the west face of the structure was noted to be damaged due to impact, possibly from tall trucks passing by. This has exposed the PT anchor pockets at one location allowing for the intrusion of moisture and other environmental contaminants. In order to avoid an accelerated rate of deterioration of the PT anchors, we recommend removing the damaged concrete at the ends of the beams, cleaning the PT anchor pockets, and patching the area with a high quality mortar.
- Several small areas in the concrete curbs were noted to be damaged. We recommend these areas be removed and patched with a high quality mortar.



Photo 30: Exposed PT tendon



Photo 34: Concrete spall and corroded reinforcement in wall.



Photo 35: Spalling at the end of a beam exposing PT anchor pockets.

### Waterproofing Systems

Sealants were generally absent in this garage. In this type of structure, sealants are typically placed along perimeter wall cove joints to prevent the ingress of moisture into the structure through the cold joints in the concrete. Corrosion of steel reinforcement due to moisture infiltration is a primary reason for concrete deterioration and possible structural issues. Sealants should be installed at these locations and replaced upon reaching the end of their useful service life, about every five years. This plan should become part of the ongoing improvement strategy to increase the longevity of the structure.

We recommend the following waterproofing repairs be implemented to stop further deterioration of the concrete and embedded PT tendons and reinforcement:

- Cracks that were noted on top of the deck are providing avenues for water to infiltrate into the structure. This leaves the embedded steel reinforcement and PT tendons susceptible to corrosion, which could lead to a loss of strength in the slab. To minimize the ingress of water and other contaminants into the structure, we recommend routing and sealing all floor cracks.
- Large cracks with signs of active leakage were noted on the ceiling. This indicates infiltration of moisture through the full depth of the slab. In order to avoid further deterioration from moisture penetration and maintain the structural integrity of the deck, cracks in the ceiling should be repaired with epoxy injection.
- Large cracks with signs of active leakage were noted in the concrete walls. The retaining wall on the east side of the structure exhibited cracks extending from beams that were framed into the wall. Moisture seeping in from the soil behind the wall can lead to deterioration of the concrete and embedded steel reinforcement. Cracks were also noted extending from the concrete drain enclosure in the north wall. Moisture from the nearby drain has the potential to infiltrate these cracks and accelerate deterioration of



Photo 13: Cracking in wall extending away from a beam.

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the concrete and embedded steel reinforcement. In order to restore their structural integrity and increase the resistance to moisture penetration, we recommend repairing all cracks in the concrete walls with epoxy injection.

- Several cracks with stains indicating signs of active leakage were noted in the PT beams. A full depth beam crack was noted to be previously repaired by epoxy injection. In order to resist moisture ingress and maintain structural integrity, we recommend all beam cracks be repaired with epoxy injection.
- Stains indicating active leakage were noted along the joint between the concrete walls and elevated slab. We recommend sealing these joints with a chemical grout injection. This would resist moisture penetration while allowing both surfaces to move independently of one another.
- Cove sealant was not noted at the cold joints between the horizontal and vertical surfaces in this structure. This sealant is recommended to prevent water and other contaminants from seeping into the joint, causing corrosion of the embedded steel reinforcement and deterioration of the surrounding concrete.
- Testing of the concrete indicated weak durability characteristics (see Material Testing section). This can lead to accelerated amounts of chloride induced deterioration of the concrete. As an added layer of protection against this type of deterioration, we recommend installing a urethane traffic topping over the entire floor area of the upper level. This will provide greater resistance to moisture intrusion and help mitigate deterioration of the concrete and embedded steel reinforcing and PT tendons.

### Stairs

One set of cast-in-place concrete stairs located on the south side of the structure was noted to serve as a pedestrian access point to the upper level from the Center Place alleyway.



Photo 14: Cracking in wall extending away from drain enclosure.



Photo 14: Signs of active leakage through beam crack.



Photo 21: Active leakage noted along the joint between the walls and the ceiling.

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A large spall was noted in the top tread and could potentially pose as a tripping hazard. As such, we consider these stairs to be in poor condition and recommend this spall be removed and area repaired with a high quality mortar.

### Drainage/Lighting

One floor drain was noted on the upper level near the vehicular entry from 12th street. This drain seems to be in working condition. We recommend regular cleaning and maintenance to reduce the potential for ponding to occur on the elevated decks.

Lighting in the parking structure is provided by fluorescent T5 light fixtures, with embedded conduit. The light level measurements were not part of the scope of this project, though the overall lower level lighting appeared to be low. A number of fixtures appeared to be not functional and one fixture was noted to be missing. Corrosion damage was noted on the fixtures at select locations.

We recommend an electrical allowance to address necessary repairs of the existing fluorescent fixtures; however we recommend as an enhancement initiating a lighting study to determine the cost feasibility of replacing the existing florescent fixtures with efficient LED fixtures (see Enhancements).

### Miscellaneous/Architectural

During our field review we observed a number of potential repairs that do not classify as concrete or waterproofing related. Although a detailed review of the capacity of the existing barrier system was not a part of the current scope, it appears based on our experience that the existing barrier system will not be able to withstand a vehicular impact. As such, we recommend the installation of a new barrier cable system (see Vehicular Barriers section).

Other miscellaneous/architectural observations and recommendations are as follows:



Photo 45: Large spall in the top tread of cast-in-place stairs.



Photo 50: Upper level floor drain



Photo 54: Typical T5 florescent light fixture.

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- A small amount cracking was noted in the CMU blocks on the east side of the garage. We recommend these areas be patched to avoid deterioration of the embedded reinforcement due to moisture intrusion.
- The top surface of the masonry wall on the east side of the structure was noted to be constructed without a concrete cap. The existing flat surface creates an area conducive to ponding, which can lead to infiltration of water into the wall and subsequent deterioration of the embedded reinforcement. We recommend installing an angled concrete masonry cap to divert water over the edges of the wall.
- Several areas of stucco/skim coat were noted to be de-bonded from the underlying concrete at isolated locations throughout the structure. The largest was noted on the 12<sup>th</sup> Street side of the north wall near the drain enclosure. We recommend these areas be repaired with a new skim coat and painted to match existing condition.
- In order to enhance and brighten the appearance of the structure, we recommend repainting of all wall surfaces, as they have undergone a significant amount of staining due to efflorescence and other environmental effects.
- Parking stall striping in this structure has reached the end of its useful service life. We recommend that all markings be removed and restriped, and done so routinely every five years, or as needed.
- Entry/Exit signage at the vehicular entry from the Center Place alleyway was noted to be faded. We recommend this signage to be replaced.
- We noted one fire hose cabinet in the structure. The cabinet component was heavily damaged and the water line feeding into it was noted to be non-functional. A fire cabinet assembly is not required by the California Building Code in this type of structure. We recommend removing the cabinet and water line



Photo 51: Large area of de-bonded stucco



Photo 53: Typical ADA stall showing conflicting striping.



Photo 4: Faded signage outside of lower level entry.

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assembly to prevent patrons from using it as an area to leave trash.

- During our visit we observed the bottoms of several vehicles scrape against the pavement as they entered or exited the upper level. This is due to a steep transition slope at the entry from 12<sup>th</sup> Street. We recommend adding a concrete wash to slightly flatten out the slope in order to prevent further damage to the pavement and to the vehicles that use the parking structure.
- A drip edge along the exposed western edge of the structure was not provided during construction. In order to prevent water from running along the ceiling and cause staining, we recommend cutting a drip edge into the ceiling along the west side of the structure.
- **Currently there are no height or weight restrictions placed on vehicles that can park on the upper level. This makes the elevated deck susceptible to high loads from over-sized vehicles that can access the structure. In order to stop the potential of overloading, we recommend installing a height restriction bar at the upper level entry ramp from 12<sup>th</sup> Street.**

### Enhancements

The ceilings are not painted in this structure. Painting the ceilings will provide better light reflectance and enhance passive security and user comfort.

Upgrading the lower level lighting to a more energy efficient LED system will reduce energy costs and contribute to further savings because of a longer bulb life. A lighting study is recommended to determine compliance of the existing lighting system with current lighting industry standards and provide a present value cost of replacing the existing florescent fixtures with efficient LED fixtures.



Photo 48: Trash collecting in fire cabinet.



Photo 53: Entry to upper level from 12<sup>th</sup> Street showing signs of vehicular scraping.

## **TIER 1 SEISMIC REVIEW**

The purpose of a Tier 1 screening phase is to quickly identify buildings that comply with the provisions of ASCE 31-03. A Tier 1 screening familiarizes the design professional with the inherent weaknesses and potential deficiencies in the structure. The process consists of conducting basic seismic calculations to determine the seismicity of the area and the potential for damage to the main structural and lateral load resisting elements.

The evaluation was completed per the guidelines of the ASCE 31-03 Seismic Evaluation of Existing Buildings (ASCE 31) Tier 1 Screening Phase in order to determine if the building's elements, including its lateral force resisting system, meets the Life Safety (LS) Seismic Performance Level.

The Tier 1 screening phase consists of three sets of checklists that allow rapid evaluation of the structural, nonstructural, and foundation/geologic hazard elements of the building and site conditions. In some cases, "Quick Checks" may be required during a Tier 1 Evaluation; however, the level of analysis necessary is minimal.

The documents used to conduct the Tier 1 screening include original structural drawings prepared by South Bay Engineering Corporation in 1979. In general, these drawings together with our site visit formed the basis of our Tier 1 evaluation.

The lateral force resisting system in this structure consists of cast-in-place concrete shear walls, which makes it Building Type C2 (Concrete Shear Walls with Stiff Diaphragms) according to ASCE 31. It must be noted that we observed evidence of a seismic retrofit that likely took place following the 1994 Northridge Earthquake, but the contribution of this retrofit was not considered as a part of this seismic analysis.

This structure is located in an area with a high level of seismicity, as defined by Table 2-1 of ASCE 31-03. Per Table 3-2 of ASCE 31-03 the required Tier 1 checklists for a structure located in a high level of seismicity being checked for life safety are: Basic Structural, Supplemental Structural, Geologic Site Hazard and Foundation, Basic Nonstructural and Intermediate Nonstructural.

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For reference, the checklists are included in Appendix B2 of this report. Supporting structural calculations required for certain Tier 1 “quick checks” are also included in Appendix B2.

The Tier 1 screening phase identified the following structural items below as “non-compliant” from the Basic Structural checklist:

- **Torsion:** ASCE 31 requires the distance between the story center of mass and the story center of rigidity to be less than 20% of the building width in either direction. The estimated distance between the center of mass and the center of rigidity of this structure is 30’ in the east-west direction. This is greater than 20% of the width of the building in the east-west direction (20% of 90’ = 18’).
- **Redundancy:** ASCE 31 requires at least two lines of shear walls in each principal direction. According to ASCE 31, a shear wall is a wall that resists lateral forces applied parallel with its plane. This structure has two shear walls in the east-west direction, but only one shear wall in the north-south direction.

Whenever deficiencies are identified in the Tier 1 screening phase, the design professional may choose to perform a Deficiency-Only Tier 2 Evaluation that addresses only the deficiencies identified in Tier 1. For Tier 2, a complete analysis of the building that addresses the deficiencies identified in Tier 1 must be performed.

Torsion was identified as a potential deficiency because the center of gravity of this structure is near the center of the diaphragm (elevated slab), while the center of rigidity is close to the east wall. Under longitudinal loading, the eccentricity between the center of gravity and the center of rigidity would cause a torsional moment. The entire earthquake force would be resisted directly by the east wall and the torsional moment would be resisted by a couple consisting of equal and opposite forces in the north and south walls. The north and south walls would have displacements in opposite directions, causing the diaphragm to want to rotate. In a rigid diaphragm structure

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such as this one, the torsional forces would be transmitted back to the walls.

Redundancy is important in a structure because it ensures that if an element in the lateral-force-resisting system fails for any reason, there is another element present that can provide lateral force resistance. Redundancy also provides multiple locations for potential yielding, distributing inelastic activity and improving ductility and energy absorption. Typical characteristics of redundancy include multiple lines of resistance to distribute the lateral forces uniformly and multiple bays in each line of resistance to reduce the shear and axial demands on any one element. This structure did not pass the Tier 1 checklist for redundancy because it does not have more than one line of shear walls in the north-south direction. That is not to say that one line in that direction is not enough for this structure. In other words, a lack of redundancy does not always equate to a lack of adequacy.

As a part of the Tier 1 "quick checks", the average shear stress was calculated for each wall. This provides a quick assessment of the overall level of demand on the structure. Results revealed that the average shear stresses in the walls in this structure comply with the shear stress limits set forth by the ASCE 31-03. This can largely be attributed to the widths of the walls, particularly the east wall which spans the entire length of the building in the north-south direction. Further, we found no non-compliant items on the geologic and non-structural checklists. Thus, the level of demand on the walls based on calculated seismic forces is acceptable and the current configuration of the lateral-force-resisting system is adequate. As such, we do not feel that the potential deficiencies identified in the Tier 1 screening phase warrant a Tier 2 analysis.

### CONCRETE TESTING

Concrete cores were extracted from two locations on the supported slab of the parking area and sent to a Universal Construction Testing (UCT) laboratory to establish a base-line for chloride ion content, determine the compressive strength of the concrete, and determine microscopic characteristics through a petrographic examination.

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### CHLORIDE-ION CONTENT

Since concrete is a naturally porous material, chloride ions penetrate into concrete, and subsequent accumulation, occurs readily on surfaces exposed to marine salts, wetting and drying. Research indicates that corrosion begins when chloride accumulation exceeds 280 to 410 parts per million (ppm) in the concrete at the depth of reinforcing steel. Once the reinforcing bars corrode they will typically begin to cause delaminations and spalls in the concrete slabs.

Tracking the rate of chloride ion intrusion helps in establishing the potential for corrosion of the reinforcing steel in the concrete; thus, potentially leading to the accelerated deterioration of the concrete both structurally and aesthetically. The highest chloride ion content in the slab was determined to be 120 parts per million (ppm) located in the first inch of the top surface. Since the chloride levels in the concrete are low, chloride induced corrosion of the steel is not likely.

### COMPRESSIVE STRENGTH

Compressive strength was also tested in one of the cores extracted from the concrete floor slab. The compressive strength of the cores extracted was measured to be 3,040 pounds per square inch (psi). This is a reasonable compressive strength for the concrete in this construction application.

### CARBONATION

Carbonation of concrete occurs when the carbon dioxide in the atmosphere reacts with hydrated cement minerals to produce calcium carbonate. Carbonation can be detrimental because it neutralizes the alkalinity present in the concrete. If it travels deep enough, carbonation can make the embedded reinforcement more susceptible to corrosion.

We measured the extent of carbonation in this structure on-site by spraying a freshly exposed surface of the concrete (where the cores were extracted) with a phenolphthalein solution. The calcium hydroxide is colored pink while the carbonated portion remains uncolored. In one of the two



Photo 55: Carbonation testing using a phenolphthalein solution. The pink region indicates no carbonation at the top of the slab.



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locations we tested, we found carbonation to have penetrated upwards 1" from the bottom surface of the slab and found no evidence of carbonation at the top surface. In the second location, we found carbonation up to 1-3/8" from the bottom surface and no carbonation at the top. UCT's carbonation test showed as much as 2" of carbonation from the bottom surface and about 1.3" from the top surface. This indicates that carbonation in this slab could be reaching the level of both the top and bottom reinforcement, which can lead to an accelerated rate of corrosion.

### PETROGRAPHIC EXAMINATION

A petrographic examination was conducted to determine the microscopic characteristics of the concrete. A petrographic examination can provide valuable information on the depth and nature of cracks and the presence of other distress that may affect repairs.

Results for this structure revealed a moderately high water-to-cement ratio of approximately 0.55. The water-to-cement ratio currently specified for use in parking facilities as recommended in the ACI 362 report is 0.40 to 0.45. The petrographic analysis also revealed moderately weak paste-aggregate bond. This indicates that the concrete lacks strong durability characteristics and is susceptible to chloride and carbonation induced concrete deterioration.

### CONCRETE COVER

Using appropriate concrete cover is a key factor in corrosion protection. Adequate cover together with good concrete quality can delay chloride ion penetration thereby prolonging any substantial deterioration to the embedded steel reinforcement. The minimum concrete cover for this type of structure specified by the ACI Building Code is 1".

An independent GPR contractor was utilized to assist us in determining the concrete cover and as-built PT tendon profiles in the elevated slab. Any notable discrepancy between the as-built tendon profiles and the engineered design could lead to a loss of strength and integrity of the slab. The structural drawings indicated a 1" cover at the highest point of the tendon profile. The results of the GPR

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showed the actual concrete cover at the highest points of the parabolic tendon profile in the north-south direction to be less than the design, in some cases 0" from the top surface. This was visually evident with the PT tendons protruding out from the floor. Lower cover increases the susceptibility for the PT tendons to corrode, which could lead to de-stressing of the tendons and reduced structural capacity. These tendons must be replaced and adequate cover should be provided in order to prevent such deterioration occurring in the future (see Concrete Structure discussion).

Please refer to Appendix C for more information related to materials testing performed by UCT.

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LOT 3 PARKING STRUCTURE

## CITY OF MANHATTAN BEACH

MANHATTAN BEACH, CA

Prepared for:  
CITY OF MANHATTAN BEACH  
PROJECT NO. 37-8377.00

SEPTEMBER 2013



LOT 3 PARKING STRUCTURE



# MANHATTAN BEACH LOT 3 PARKING STRUCTURE

## CAPITAL IMPROVEMENT AND PROTECTION PROGRAM



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The Lot 3 Parking Structure is 42 years old and is considered to be in fair condition for its age. Over the next ten years (starting in 2014) we recommend budgeting \$1,291,500 in 2013 dollars (\$1,432,000 in future value dollars) for capital improvements and repair/maintenance work.

The Capital Improvement and Protection Program (CIPP) contained in this report is based upon the results of our condition assessment and recommendations for the City in performing budgeted capital improvements and routine maintenance on the Lot 3 Parking Structure over the next 10 years.

We recommend the following components of this budget be given first priority ("Priority-1"):

- Concrete Repairs (floors): \$73,000
- New Vehicular Barrier System: \$80,000
- Height Restraint Bar at Entries: \$4,500
- Tier-2 Seismic Evaluation: \$50,000

Total recommended budget for "Priority-1" repairs in Lot 3 Parking Structure: \$207,500\*

The existing vehicular barriers in this structure have been in place since the original construction and may be grandfathered in under the current code. We recommend the City take a proactive approach by installing a new vehicular barrier system on the upper level that would meet current code requirements and minimize any potential hazards that exist with the current system.

Additionally, no height restraint bars were noted at any of the entries. This allows for over-sized vehicles to access the upper levels and possibly overload the structure. We recommend installing a height restraint bars at the entry lanes to avoid possible overloading.

Partial depth spalls were noted on the upper level ceilings and floors. We recommended the spalled concrete be removed, underlying reinforcement and exposed PT tendons cleaned and protected, and the areas patched with a high quality mortar to stop further deterioration.

## EXECUTIVE SUMMARY

*\*This cost estimate does not include contractor mobilization, engineering and construction administration, and contingency fees.*

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Concrete testing showed poor durability characteristics, increasing the susceptibility to deterioration due to moisture infiltration. To help mitigate this deterioration, routing and sealing all floor cracks and joints in addition to installing a protective urethane topping on the roof level and a concrete siloxane sealer on the second level make up a large portion of the "Priority-2" waterproofing repairs.

A Tier 1 seismic evaluation was completed to rapidly identify potential deficiencies in the design of the structure. This structure was identified as non-compliant per ASCE-31 Tier-1 requirements due to the vertical discontinuity that exists in the lateral-load resisting system. Further, this structure utilizes mixed lateral-force-resisting systems (reinforced masonry shear walls and steel braced frames). As such, we recommend pursuing a Tier 2 evaluation to further investigate the potential deficiencies identified in the Tier 1 screening phase.

Budgeting for capital improvements will help the City plan for the necessary funding needed for the recommended work required to maintain the structural integrity and keep the garage operating safely for another 10 to 20 years.

Please see the CIPP table on page 3-7 for a prioritized recommended annual budget breakdown through 2023.

### OBJECTIVE

This ten-year budget for the outlined CIPP is based on the understanding that the City plans to maintain the Lot 3 Parking Structure based on the recommended program for at least the next 10 years of the structure's service life.

The objectives of this CIPP are to provide the City with an asset management tool for planning and budgeting, and to recommend restoration improvements and work items in order to maximize the service-life of this parking facility while planning for an adequate amount of capital funding. The benefit for the City is the ability to plan and budget in confidence for each year thus allowing the maximization of dollars spent. This CIPP is specific to the Lot 3 Parking Structure. If desired, our plan has the flexibility to defer certain work items to future years of the repair program.

### INTRODUCTION

# MANHATTAN BEACH LOT 3 PARKING STRUCTURE

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### FACILITY DESCRIPTION/ BACKGROUND INFORMATION

Lot 3 Parking Structure is located at 1155 Morningside Drive in Manhattan Beach, California. The parking facility was built in 1971 and is constructed of cast-in-place reinforced concrete slabs supported on wide flange steel beams and steel pipe columns. The facility has two supported levels and one slab-on-grade level. The facility was designed for a parking capacity of 135 vehicles.

Vehicular entrances to the ground level are provided from 12<sup>th</sup> Street on the north and from Center Place on the south. Entry to the second level is gained from a ramp that is accessed from 12<sup>th</sup> street. No direct vehicular access is provided from the first level to the second level. Access to the roof level is gained from a ramp on the second level. One continuous exit ramp to 12<sup>th</sup> street is provided from the upper two levels along the east side of the structure. The ground level exit is located on the east side of the structure onto Morningside Drive. Vehicles park in 2-hour metered spaces on the ground and second levels, and at 10-hour metered spaces on the roof level. All meters are enforced daily from 8am-9pm. The parking facility mainly serves the nearby shops, restaurants, and offices.

### IMMEDIATE CONCERNS

The existing vehicular barriers in this structure do not appear to meet current code requirements for maximum spacing and load resistance. This could pose a potential hazard to the users of this structure. While the existing barriers may be grandfathered in under the current code, we recommend the City take a proactive approach and install a new vehicular barrier system that would replace the existing system and meet current code.

Additionally, no height restrictions are currently placed at the entry lanes. This allows over-sized vehicles to enter the upper levels, which could cause damage to the structure and to the vehicles. We recommend the City install height restraint bars to restrict larger vehicles from using the parking structure.

We noted several areas where there is an imminent potential of falling concrete. This could pose a potential risk

### RECOMMENDATIONS

# MANHATTAN BEACH LOT 3 PARKING STRUCTURE

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if one of these falling pieces strikes a pedestrian or a vehicle. We recommend removing the areas of loose concrete in the ceilings.

These items and our corresponding recommendations are further discussed in this report.

### RECOMMENDED CAPITAL IMPROVEMENTS

The following repairs and capital improvements for the Lot 3 Parking Structure are recommended over the next ten years:

- Repair concrete spalls, delaminations and failed patchwork identified on the upper levels.
- Repair damaged curbs.
- Repair damaged concrete at the top of the east stair connection.
- Repair concrete as necessary in conjunction with routine maintenance performed in 2019 and 2023.
- Rout and seal typical floor cracks and install cove sealants at cold joints to prevent ingress of water and other environmental contaminants.
- Apply a new urethane traffic topping on the floor area of the roof level.
- Apply a concrete floor sealer on the floor area of the second level.
- Wash prefabricated metal stairs and paint handrails.
- Clean the existing floor drains.
- Repair damaged and non-functioning light fixtures.
- Install galvanic sheets for cathodic corrosion protection.
- Repair identified cracks and damage in masonry walls.
- Patch areas of deteriorated steel with epoxy coating.
- Add steel jackets to strengthen select columns at their base.
- Install concrete enclosure to protect select columns at their base.
- Clean and paint existing column concrete enclosures.
- Replace the expansion joint located on the west side of the second level. This work would require cooperation of the neighboring property owner.
- Clean and paint gate anchors at second floor opening to adjacent lot.

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- Repair and repaint existing pedestrian handrails at or near the stairs.
- Restripe parking stalls.
- Perform a Tier 2 seismic evaluation to analyze potential deficiencies identified in Tier 1 screening.

### PREVENTIVE ITEMS

As a preemptive measure, we recommend maintaining sealants every five to seven years to prevent premature deterioration from water intrusion into the concrete. Once the sealants are installed in 2015 we recommend replacing the most critical areas in 2020 as they will be nearing the end of their useful service life.

### ENHANCEMENT OPTIONS

Painting the ceilings will brighten the appearance of the parking facility. This can be completed when your budget allows.

Lighting on the second level is provided by fluorescent T5 light fixtures, with embedded conduit. The light level measurements were not part of the scope of this project; however the overall lighting appeared to be low on the second level. A number of light bulbs at select locations appeared non-functional and were missing in some cases. Extensive corrosion damage was noted on the lighting fixtures at select locations.

Replacing the fixtures on the second level with more energy efficient lighting will reduce the energy costs, and have a longer bulb life, which can contribute to further savings. A lighting study is recommended as an enhancement to determine actual light levels and provide a present value cost of implementing energy efficient lighting.

### OPINION OF PROBABLE COSTS

Our Lot 3 Parking Structure CIPP anticipates a total budget of \$1,291,500 in 2013 dollars (\$1,432,000 in future value dollars) to perform repairs and capital improvements over the next ten years. Future value dollars were determined using an annual inflation rate of 3% and include estimated General Conditions and Contingencies.

### OPINION OF PROBABLE COSTS

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The primary cost components of this budget are:

### "Priority-1":

Concrete:

- Repairs of delamination and spalls in the upper level floors in 2014: \$73,000.

Miscellaneous Repairs:

- Installation of a new vehicular barrier system in 2014: \$80,000.
- Addition of height restraint bars in 2014: \$4,500.
- Tier-2 Seismic evaluation: \$50,000

### "Priority-2":

Concrete:

- Repairs of delamination and spalls in the upper level ceilings and curbs in 2015: \$152,000.

Waterproofing:

- Urethane traffic topping on roof level in 2015: \$120,500.
- Siloxane concrete sealer on second level in 2015: \$10,000.
- Routing/Sealing Floor cracks in 2015: \$65,000

Miscellaneous Repairs:

- Galvanic corrosion protection in 2015 and 2016: \$125,000.
- Epoxy paint patch on beams in 2015: \$12,500.
- Expansion joint replacement in 2015: \$4,000.

Please note that the "Contingency and General Conditions" in the CIPP table are strictly for budgeting purposes. Actual Contingency and General Conditions will be determined when contractor bids are received for the work performed by a qualified restoration contractor.



## Parking Structure 3 10 Year Budget Forecast



LEGEND	
Priority-1	
Priority-2	
Priority-3	

NO.	WORK DESCRIPTION	TOTAL COST	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
<b>1</b>	<b>Concrete</b>	\$ 241,000	\$ 73,000	\$ 152,000	\$ -	\$ -	\$ -	\$ 9,000	\$ 7,000	\$ -	\$ -	\$ -
1.1	Floor Repair - Partial Depth	\$ 56,000	\$ 49,000					\$ 7,000				
1.2	Floor Repair - Full Depth	\$ 26,000	\$ 24,000					\$ 2,000				
1.3	Floor Repair - Curbs	\$ 2,000		\$ 1,500					\$ 500			
1.4	Ceiling Repair - Partial Depth	\$ 156,500		\$ 150,000					\$ 6,500			
1.5	Slab Edge Repair at Stair Connection	\$ 500		\$ 500								
<b>2</b>	<b>Waterproofing</b>	\$ 380,300	\$ -	\$ 208,500	\$ -	\$ -	\$ -	\$ -	\$ 39,500	\$ -	\$ -	\$ 130,500
2.1	Cove Sealant	\$ 13,300		\$ 7,500					\$ 4,000			
2.2	Rout/Seal Floor Cracks	\$ 97,500		\$ 65,000					\$ 32,500			
2.3	Tool/Seal Construction Joints	\$ 8,500		\$ 5,500					\$ 3,000			
2.4	Traffic Topping (Roof Level)	\$ 241,000		\$ 120,500								\$ 120,500
2.5	Concrete Floor Sealer (Second Level)	\$ 20,000		\$ 10,000								\$ 10,000
<b>3</b>	<b>Stair Towers</b>	\$ 6,500	\$ -	\$ 1,500	\$ 1,000	\$ -	\$ -	\$ -	\$ -	\$ 2,500	\$ -	\$ -
3.1	Clean and Repair Stair Tread Connections	\$ 1,500		\$ 1,500								
3.2	Paint Stair Handrails	\$ 3,000			\$ 1,500					\$ 1,500		
3.3	Wash Stair Treads	\$ 2,000			\$ 1,000					\$ 1,000		
<b>4</b>	<b>Drainage/Lighting</b>	\$ 14,500	\$ -	\$ 11,500	\$ -	\$ -	\$ -	\$ -	\$ 3,000	\$ -	\$ -	\$ -
4.1	Mechanical Allowance	\$ 2,500		1,500					\$ 1,000			
4.2	Clean Existing Drain and Lines	\$ 2,000		1,000					\$ 1,000			
4.3	Electrical Allowance	\$ 3,500		2,500					\$ 1,000			
4.4	Repair Light Fixtures	\$ 9,000		8,000					\$ 1,000			
<b>5</b>	<b>Miscellaneous/Architectural Repairs</b>	\$ 297,500	\$ 134,500	\$ 91,000	\$ 64,500	\$ -	\$ -	\$ -	\$ 1,500	\$ 6,000	\$ -	\$ -
5.1	New Vehicular Barrier System	\$ 80,000	\$ 80,000									
5.2	Galvanic Corrosion Protection	\$ 125,000		\$ 67,000	\$ 58,000							
5.3	Masonry Wall Repair	\$ 2,500		\$ 2,000					\$ 500			
5.4	Epoxy Paint Patch on Beams and Anchor Plates	\$ 13,500		\$ 12,500					\$ 1,000			
5.5	Steel Jacket at Perimeter Column Base	\$ 500		\$ 500								
5.6	Concrete Enclosures at Column Base	\$ 5,000		\$ 5,000								
5.7	Paint Existing Concrete Enclosures at Columns	\$ 5,000			\$ 2,500					\$ 2,500		
5.8	Expansion Joint Replacement	\$ 4,000		\$ 4,000								
5.9	Clean and Paint Gate Anchors	\$ 500			\$ 500							
5.10	Repair/Repaint Pedestrian Handrails	\$ 1,000			\$ 500					\$ 500		
5.11	Repaint Stall Striping	\$ 6,000			\$ 3,000					\$ 3,000		
5.12	Height Restriction Bar at Vehicular Entries	\$ 4,500	\$ 4,500									
5.13	Tier 2 Seismic Evaluation	\$ 50,000	\$ 50,000									
<b>6</b>	<b>Enhancements</b>	\$ 71,000	\$ -	\$ -	\$ 71,000	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
6.1	Clean and Paint Ceilings	\$ 66,000			\$ 66,000							
6.2	Lighting Study	\$ 5,000			\$ 5,000							
<b>Sub Total</b>		\$ 1,007,500	\$ 207,500	\$ 464,500	\$ 136,500	\$ -	\$ -	\$ 9,000	\$ 51,000	\$ 8,500	\$ -	\$ 130,500
Mobilization		\$ 104,000	\$ 21,000	\$ 47,000	\$ 14,000	\$ -	\$ -	\$ 1,000	\$ 6,000	\$ 1,000	\$ -	\$ 14,000
Engineering and Construction Administration Allowance		\$ 90,000	\$ 21,000	\$ 47,000	\$ -	\$ -	\$ -	\$ 1,000	\$ 6,000	\$ 1,000	\$ -	\$ 14,000
Construction Contingency		\$ 90,000	\$ 21,000	\$ 47,000	\$ -	\$ -	\$ -	\$ 1,000	\$ 6,000	\$ 1,000	\$ -	\$ 14,000
<b>Opinion of Annual Budget (2013 Dollars)</b>		\$ 1,291,500	\$ 270,500	\$ 605,500	\$ 150,500	\$ -	\$ -	\$ 12,000	\$ 69,000	\$ 11,500	\$ -	\$ 172,500
<b>Opinion of Annual Budget (Adjusted Future Value)</b>			\$ 278,700	\$ 642,400	\$ 164,500	\$ -	\$ -	\$ 14,400	\$ 84,900	\$ 14,600	\$ -	\$ 231,900
<b>Opinion of Total 10-Year Budget (Adjusted Future Value)</b>		\$ 1,432,000										

Note 1: Contingency based on 10% of Sub Total rounded up to the nearest \$500.

Note 2: General Conditions based on 10% of Sub Total rounded up to the nearest \$500.

Note 3: Consulting & Engineering Fees based on 10% of Sub Total rounded up to the nearest \$500.

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The Walker team visited the structure on July 26, 2013 to review the existing conditions of the parking structure. Based on our condition appraisal, the parking structure was found to be in fair condition. It was noted that the existing vehicular barrier rails are non-compliant with the current building code requirements and could pose a potential liability risk to the City. The potential for spalling concrete in the ceilings to fall on pedestrians and vehicles using the structure presents an additional liability risk to the City. Cracked and deteriorated concrete in the floors and curbs in addition to corrosion in the steel elements was also observed.

It has been our experience that owners who address durability and maintenance issues for their parking structures can expect to receive a maximized service life and less costly future repairs as compared to a structure that does not receive proper preventative maintenance.

## Vehicular Barriers

The vehicular barriers consist of metal rails supported on cast-in-place concrete curbs. The spacing between the horizontal members does not meet the current code. Current code limits this spacing to a maximum of 4 inches in order to prevent the possibility of small objects and children passing through. Existing clear space between the horizontal members was measured to be 6".

In addition, current code requires vehicular barriers to be designed to resist a bumper load of 6000 lbs. Although a detailed review of the capacity of the existing barrier system was not part of the current scope, it appears (by experience) that the existing barrier system will not be able to withstand a 6000 lb. vehicular impact.

Further, a number of the posts were noted to be bent from vehicular impact and many of the embedded connections at the curb were loose and corroded. In general, the existing barrier rail system is in poor condition.

While the existing vehicular barriers in this structure have been in place since the original construction and may be grandfathered in under the current code, we recommend the City take a proactive approach by installing a new

## DISCUSSION



Photo 13: Vehicular Barriers on the Second Level



Photo 16: Cracked Curb at Perimeter Barrier Rail Mount

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vehicular barrier system on the upper levels and ramps. This would ensure that the vehicular barriers would meet current code requirements and minimize any potential hazards that exist with the current system.

## Building Structure

The main structural system of the Lot 3 Parking Structure is composed of one-way cast-in-place lightweight concrete slabs supported on wide-flange steel beams and steel pipe columns. This structure has three full-height masonry shear walls running in the north-south direction on its east and west faces in addition to two single-story masonry shear walls running in the east-west direction on the ground floor. Three interior steel braced frames also run in the east-west direction on the second level. The steel braced frames on the second level and the east-west masonry shear walls on the first level are vertically discontinuous from one another (see Tier 1 Seismic Review section).

## Steel Structure

The steel framework was visually reviewed and noted to be in overall good condition. A protective epoxy coating was noted on all exposed surfaces of the steel beams and columns. Several isolated areas of deterioration were noted in the coating and need to be patched. In general, the coating was observed as effective in protecting the steel beams and columns from corrosion.

Areas that were not protected with an epoxy coating, such as the top surfaces of the beams at the interface with the concrete soffits (ceiling), were showing signs of corrosion. In addition to repairing the concrete that has spalled at these locations, we recommend implementing a galvanic corrosion protection system to help stop the steel deterioration taking place at these locations (see Miscellaneous/Architectural section).

## Concrete Structure

Based on visual review and sounding observations on the floor decks along with selective material tests, the concrete in the structure is noted to be in fair condition.

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### Elevated Slabs

- Concrete spalls were visually observed and located by sounding at isolated locations on the floor and ceiling surfaces on both elevated decks. The spalling ranged in size from 3 square feet to 20 square feet. **The active spalling in the ceilings presents a possible hazard because of the likelihood of concrete popouts striking pedestrians or vehicles.** In order to stop the ongoing spalling in these areas, it is recommended that the deteriorated concrete be removed, underlying reinforcement cleaned, and the areas re-patched with high quality repair mortar.
- A pattern of spalling was observed at the interface of the ceilings and the top flange of steel beams in many areas. This behavior is a result of moisture intruding the slab from above and corroding the unprotected top surface of the steel beams. We recommend these spalls be removed and the areas re-patched with high quality mortar. In order to stop corrosion where the steel beams are unprotected, we recommend installing galvanic protection sheets to the concrete surface adjacent to the beams (see Miscellaneous/Architectural section).
- Above average amounts of floor cracks were identified throughout the roof and second levels. These cracks are providing avenues of moisture intrusion and should be sealed as a part of the base repairs (see Waterproofing Systems section).
- Spalling was noted at the edge of the third level slab at the east stair connection. This could accelerate deterioration of the surrounding concrete and steel elements and compromise the stair connection. We recommend the spall be removed, the stair connection elements cleaned, and the area patched with high quality mortar.

### Concrete Curbs

- A pattern of concrete spalling and previous patchwork was noted in the curbs at each location where pedestrian handrails are anchored. This



Photo 20: Typical spalling in the ceiling.



Photo 24: Typical spalling at interface of steel beam and deck.



Photo 29: Typical cracking on top of elevated slab.



Photo 36: Previously patched curb at rail anchorage.

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behavior is likely due to failed sealant at the rail embedments, allowing moisture to infiltrate the area and corrode the embedded steel. In order to prevent future spalling, the embedded steel should be cleaned or replaced prior to repairing the damaged curbs. The damaged curbs at these locations should be repaired with high quality mortar and the steel embedment properly sealed to prevent future moisture intrusion.

## Waterproofing Systems

Maintaining an effective waterproofing system is key to ensuring this structure's durability and longevity. Signs of corrosion and significant concrete spalling was noted throughout the structure, much of which can be attributed to cracked sealants in the construction joints that have lost their servicability and allow moisture intrusion.

The reason for sealants at cold and construction joints is to prevent water from accessing embedded steel reinforcement and external steel framework. Corrosion of steel due to moisture infiltration is a primary reason for concrete deterioration and possible structural issues. Sealants should be installed at these locations and replaced upon reaching the end of their useful service life, about every five years. This plan should become part of the ongoing improvement strategy to increase the longevity of the structure.

We recommend the following waterproofing repairs be implemented to stop further deterioration of the concrete, embedded steel reinforcement and external steel framework:

- Cove sealant was absent at the cold joints between the horizontal and vertical surfaces in this structure. We recommend installing cove sealant at these locations to prevent water and other contaminants from seeping into the joint, causing corrosion of the embedded steel reinforcement and deterioration of the surrounding concrete.

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- Above average amounts of floor cracks were noted on the elevated slabs. Staining in the ceilings indicated moisture penetration through the full depth of the slabs. To minimize the ingress of water and other contaminants into the structure that could cause reinforcement and concrete deterioration, we recommend routing and sealing all floor cracks.
- Construction joints were identified on the elevated slabs and were noted to have been previously sealed. The sealant at these joints were cracked and no longer serve their function. We recommend all construction joints be re-sealed to stop further infiltration of moisture through the slab and mitigate deterioration of the embedded reinforcing and external steel framework.
- Testing of the concrete indicated weak durability characteristics, which included high levels of chlorides and carbonation in the upper level slab (see Material Testing section). This can lead to accelerated amounts of concrete deterioration. In order to protect the top surface against chlorides and other environmental contamination, we recommend installing a urethane traffic topping over the entire floor area of the upper level. This will provide greater resistance to contamination from environmental effects and help mitigate deterioration of the concrete and embedded steel reinforcing from moisture intrusion. On the second level, we recommend applying a concrete floor sealer. This will help fill the air voids detected in concrete and work against moisture infiltrating through the full depth of the slab.

### Stairs

Two sets of prefabricated metal stairs were noted in this structure. One, on the west side of the structure, provides access from the second level to the third level. The other, located on the east side of the structure, provides access from the ground level up to the roof level.

Concrete spalling was noted at the edge of the third level slab near the top tread of the east stairs. The corrosion of



Photo 48: Efflorescence seen in the ceiling.



Photo 46: Deteriorated control joint sealant.



Photo 55: Deteriorated steel stair components.



Photo 56: Damaged concrete at stair connection.

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the surrounding steel elements could compromise the stair connection to the slab. We recommend this area be repaired with high quality mortar and that all corroded steel surfaces be cleaned (see Concrete Structure section).

In general, the stairs were noted to be in fair condition. Several of the connections between the metal treads and supporting steel stringers were noted to be showing signs of corrosion and deterioration. If left untreated, these connections may fail and lead to the treads disconnecting from the stringers. We recommend all stair connection elements be cleaned and repaired as needed. We further recommend a wash-down of the metal treads and painting the handrails to improve aesthetics and user comfort.

## Drainage/Lighting

One floor drain each was noted on the second and third level, respectively. An 8"-dia. down spout served both floor drains and carried the water to the ground level where it was discharged onto Center Place alleyway. These drains appeared to be in working condition. We recommend regular cleaning and maintenance to reduce the potential for ponding to occur on the elevated floors.

Lighting on the ground level has been recently upgraded to LED fixtures. Lighting on the second level is provided by fluorescent T5 light fixtures, with embedded conduit. Light level measurements were not part of the scope of this project; however the overall lighting appeared to be low on the second level. A number of light bulbs at select locations appeared non-functional and were missing in some cases. Extensive corrosion damage was noted on the lighting fixtures at select locations. The roof level lights are mounted on poles. The poles are generally in good condition. The lights at the roof level were turned off during the day to conserve energy.

We recommend an electrical allowance to address necessary repairs of the existing fluorescent fixtures; however we recommend as an enhancement initiating a lighting study to determine the cost feasibility of replacing the existing florescent fixtures with efficient LED fixtures (see Enhancements).



Photo 64: Typical floor drain.



Photo 60: Corroded light fixture.



Photo 60: Typical roof level light post.

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Two-inch diameter wet standpipes were noted on both the west and east sides of the structure. The standpipe located on the west side of the structure appeared to be non-operational, but should be verified by city personnel.

## Miscellaneous/Architectural

During our field review we observed a number of potential repairs that do not classify as concrete or waterproofing related. Although a detailed review of the capacity of the existing barrier system was not a part of the current scope, it appears based on our experience that the existing barrier system will not be able to withstand a minor vehicular impact. As such, we recommend the installation of a new barrier system (see Vehicular Barriers section).

Other miscellaneous/architectural observations and recommendations are as follows:

- Corrosion of the embedded steel and shear studs were noted to be causing a significant amount of the spalling observed in the ceilings. As a measure to help control the amount of on-going corrosion and to prevent the initiation of new corrosion activity in the concrete, we recommend installing high purity zinc anode sheets throughout the garage. Once installed, the zinc anode corrodes preferentially to the surrounding rebar and steel elements, thereby providing galvanic corrosion control to the adjacent steel.
- Several CMU blocks were noted to be cracked in a number of the masonry shear walls. The cracks serve as avenues of moisture intrusion, which can lead to deterioration of the embedded steel reinforcement in the shear walls. We recommend all damaged masonry blocks be repaired to stop infiltration of moisture and other environmental contaminants.
- All exposed steel elements were noted to be painted with an epoxy coating to protect against corrosion. It was observed in some areas that the coating has deteriorated and no longer protects the steel. This was particularly evident at the rail anchor plates in addition to isolated areas on the steel beams and



Photo 34: Large crack in masonry wall.



Photo 67: Corroded anchor plate at base of railing.

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columns. To stop further deterioration and the potential for structural issues, we recommend these corroded areas be cleaned and recoated with high quality epoxy coating.

- Two of the steel pipe columns along the south perimeter of the second level were noted to have undergone a considerable amount of deterioration at their base. This has led to a loss of section and is compromising their strength. It was noted that this issue was previously addressed in other perimeter columns by installing a 5" long steel jacket at the base. We recommend steel jackets be installed at the base of the corroded columns to restore the loss of section. In order to protect against this deterioration occurring in the future, we recommend adding a concrete enclosure at the base of the perimeter columns.
- Concrete enclosures were noted on all of the interior columns. These enclosures serve as bumpers and have been damaged over time by vehicular impact and tire marks. We recommend these concrete enclosures be cleaned and repainted to improve the overall aesthetics of the structure.
- One expansion joint was noted in this structure. It separated the second level parking deck in this structure with a neighboring elevated parking deck. The expansion joint was noted to have undergone a significant amount of deterioration and has surpassed its useful service life. Moisture is infiltrating the unsealed joint and reaching the embedded steel reinforcement and external steel framework below. We recommend a full expansion joint replacement at this location. This work would have to be coordinated with the adjoining property owner.
- A gate located on the second level at the access point to an adjacent parking deck on the west side of the structure was noted to be showing signs of deterioration. While the gate itself is likely not owned by the city, there are several anchors that are tied into the parking structure that have corroded and could lead to the deterioration of the masonry wall



Photo 69: Base of perimeter column showing signs of corrosion.



Photo 74: Deteriorated expansion joint.

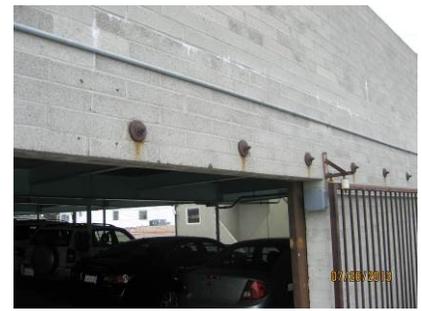


Photo 76: Gate anchors showing signs of corrosion.

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they are anchored into. We recommend these anchors be replaced.

- The pedestrian handrails were noted to be in poor condition throughout the garage. A number of the posts were noted to be bent from vehicular impact and many of the embedded connections to the curbs were loose. This has caused water to enter and corrode the embedded steel, which has spalled the concrete at many of these locations. We recommend all spalled concrete in the curbs at these locations be removed, the embedded steel connections cleaned, and the handrails be reshaped and repainted to extend their useful service life.
- Parking stall striping in this structure has faded and reached the end of its useful service life. We recommend that all markings be removed and restriped, and done so routinely every five years, or as needed.
- **Currently there are no height or weight restrictions placed on vehicles that can park on the upper levels. This makes the elevated decks susceptible to high loads from over-sized vehicles that can access the structure. In order to stop the potential of overloading, we recommend installing height restraint bars at every entry lane into the structure.**



Photo 79: Pedestrian handrails damaged from vehicle impact.

## Enhancements

The ceilings are not painted in this structure. Painting the ceilings will provide better light reflectance and enhance passive security and user comfort.

Upgrading the second level lighting to a more energy efficient LED system will reduce energy costs and contribute to further savings because of a longer bulb life. A lighting study is recommended to determine compliance of the existing lighting system with current lighting industry standards and provide a present value cost of replacing the existing florescent fixtures with efficient LED fixtures.

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## TIER-1 SEISMIC REVIEW

The overall purpose of the seismic evaluation is to investigate and identify inherent weaknesses and quickly identify potential deficiencies in the design of the structure. The evaluation was completed per the guidelines of the ASCE 31-03 Seismic Evaluation of Existing Buildings (ASCE 31) Tier 1 Screening Phase in order to determine if the building's elements, including its lateral force resisting system, meets the Life Safety (LS) Seismic Performance Level.

The Tier 1 screening phase consists of three sets of checklists that allow rapid evaluation of the structural, nonstructural, and foundation/geologic hazard elements of the building and site conditions. In some cases, "Quick Checks" may be required during a Tier-1 Evaluation; however, the level of analysis necessary is minimal.

The documents used to conduct this work include original structural drawings prepared by Treadway Schwab & Engel in 1971. In general, these drawings together with our site visit formed the basis of this evaluation.

This structure has two different lateral force resisting systems. Full height masonry shear walls located on the east and west sides of the building serve to resist lateral loads in the north-south direction, while three one-story masonry walls on the ground floor resist forces in east-west direction. This structure also features three interior steel braced frames running in the east-west direction on the second level. This structure is located in an area with a high level of seismicity, as defined by Table 2-1 of ASCE 31-03. Per Table 3-2 of ASCE 31-03 the required Tier 1 checklists for a structure located in a high level of seismicity being checked for life safety are: Basic Structural, Supplemental Structural, Geologic Site Hazard and Foundation, Basic Nonstructural and Intermediate Nonstructural. These checklists were done for both types of lateral force resisting systems (Building Type S2: Steel Braced Frames with Stiff Diaphragms and Building Type RM2: Reinforced Masonry Bearing Walls with Still Diaphragms).

For reference, the checklists are included in Appendix B3 of this report. Supporting structural calculations required for certain Tier 1 "quick checks" are also included in Appendix B3.

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The Tier 1 screening phase identified the following structural items below as “non-compliant”:

- Steel Braced Frames with Stiff Diaphragms:
  - **Vertical Discontinuities:** Vertical elements in the brace frame are not continuous to the foundation.
  - **Steel Columns:** The steel brace frames are located only on the second level and its columns are not anchored to the building foundation.

The Reinforced Masonry Bearing Walls with Stiff Diaphragms checklists showed no non-compliant items.

The vertical discontinuity relating from the steel columns in the steel brace frames on the second floor not being continuous to the foundation causes a potential local strength and ductility issue below the discontinuous elements. The concern is that the braced frame may have more shear capacity than considered in the design. These capacities impose overturning forces that could overwhelm the columns. While the connecting diaphragm may be adequate to transfer the shear forces to the adjacent masonry shear walls below, the columns that support the vertical loads are most critical.

Steel columns that are a part of the lateral-force-resisting system must be connected for the transfer of uplift and shear forces at the foundation. The absence of a substantial connection between the columns and the foundation may allow the column to uplift or slide off bearing supports, which may limit the ability of the columns to support vertical loads or resist lateral forces.

A Tier 2 analysis is recommended to check if the supporting columns have adequate capacity to resist the overturning forces generated by the shear capacity of the discontinuous elements.

Beyond the potential efficiencies identified by the Tier 1 checklists, this structure qualifies for further analysis because it has a mixed lateral-load resisting system. As such, the capacities of all lateral-force-resisting elements need to be examined. We recommend a full Tier 2 Evaluation, which is

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a complete analysis of the building that addresses the deficiencies identified in Tier 1 Screening. A Tier 2 Evaluation will include an analysis using one of the following linear methods: Linear Static Procedure, Linear Dynamic Procedure, or Special Procedure.

## CONCRETE TESTING

Concrete cores were extracted from two locations on the roof level of the parking area and sent to a Universal Construction Testing (UCT) laboratory to establish a base-line for chloride ion content, determine the compressive strength of the concrete, and determine microscopic characteristics through a petrographic examination.

## CHLORIDE-ION CONTENT

Since concrete is a naturally porous material, chloride ions penetrate into concrete, and subsequent accumulation, occurs readily on surfaces exposed to marine salts, wetting and drying. Research indicates that corrosion begins when chloride accumulation exceeds 280 to 410 parts per million (ppm) in the concrete at the depth of reinforcing steel. Once the reinforcing bars corrode they will typically begin to cause delaminations and spalls in the concrete slabs.

Tracking the rate of chloride ion intrusion helps in establishing the potential for corrosion of the reinforcing steel in the concrete; thus, potentially leading to the accelerated deterioration of the concrete both structurally and aesthetically. The chloride ion content in the slab was determined to be 320 parts per million (ppm) in the first inch of the top surface and 300 ppm in the second inch. This indicates a moderate to high likelihood of chloride induced corrosion taking place.

## COMPRESSIVE STRENGTH

Compressive strength was also tested in one of the cores extracted from the concrete roof slab. The compressive strength of the cores extracted was measured to be 3,970 pounds per square inch (psi). This is a reasonable compressive strength for the concrete in this construction application.

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## CARBONATION

Carbonation of concrete occurs when the carbon dioxide in the atmosphere reacts with hydrated cement minerals to produce calcium carbonate. Carbonation can be detrimental because it neutralizes the alkalinity present in the concrete. If it travels deep enough, carbonation can make the embedded reinforcement more susceptible to corrosion.

We measured the extent of carbonation in this structure by spraying a freshly exposed surface of the concrete (where the cores were extracted) with a phenolphthalein solution. The calcium hydroxide is colored pink while the carbonated portion is uncolored. In one of the two locations we tested, we found carbonation to have penetrated upwards 1/2" from the bottom surface of the slab and found 1" of carbonation at the top surface of the slab. In the second location, we found 1-3/4" from the bottom surface of the slab and 1" of carbonation at the top surface of the slab. This indicates that carbonation in this slab has reached the bottom and top reinforcement, which is consistent with the amount of spalling and delaminated concrete we observed in the elevated decks.

## PETROGRAPHIC EXAMINATION

A petrographic examination was conducted to determine the microscopic characteristics of the concrete. A petrographic examination can provide valuable information on the depth and nature of cracks and the presence of other chemical materials that may affect repairs.

Results for this structure revealed a moderately high water-to-cement ratio of approximately 0.50. The water-to-cement ration of the concrete currently specified for use in parking facilities by the ACI Building code is 0.40 to 0.45. The petrographic analysis also revealed moderately tight paste-aggregate bond. This indicates that the concrete has moderate durability characteristics and is susceptible to chloride or carbonation-induced concrete deterioration.

Please refer to Appendix C for more information related to materials testing performed by UCT.



Photo 53: Carbonation testing using a phenolphthalein solution. The colorless region indicates carbonation on top and bottom of the slab.

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PROTECTION PROGRAM

LOT 4 PARKING STRUCTURE

## CITY OF MANHATTAN BEACH

MANHATTAN BEACH, CA

Prepared for:  
CITY OF MANHATTAN BEACH  
PROJECT NO. 37-8377.00

SEPTEMBER 2013



LOT 4 PARKING STRUCTURE



# MANHATTAN BEACH LOT 4 PARKING STRUCTURE

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The Lot 4 Parking Structure is 34 years old and considered to be in fair condition for its age. Over the next ten years (starting in 2014) we recommend budgeting \$368,000 in 2013 dollars (\$395,000 in future value dollars) for capital improvements and repair/maintenance work.

The Capital Improvement and Protection Program (CIPP) contained in this report is based upon the results of our condition assessment and recommendations for the City in performing budgeted capital improvements and routine maintenance on the Lot 4 Parking Structure over the next 10 years.

We recommend the following components of this budget be given first priority ("Priority-1"):

- Concrete Repairs (floor, columns and ceiling): \$33,500
- New Vehicular Barrier System: \$42,000
- Post-Tension Strand Repair and Protection: \$22,500
- Height Restraint Bar at Upper Level Entry: \$8,000
- Removing Trip Hazard: \$1,500

Total recommended budget for "Priority-1" repairs in Lot 4 Parking Structure: \$107,500\*

If the City of Manhattan Beach (City) were to elect to rebuild the upper level of this structure (maintain the columns and foundations), we estimate the replacement cost, including demolition, to range between \$800,000 and \$1,300,000.

The existing vehicular barriers in this structure have been in place since the original construction and may be grandfathered in under the current code. We recommend the City take a proactive approach by installing a new vehicular barrier system on the upper level that would meet current code requirements and minimize any potential hazards that exist with the current system.

Additionally, no height restraint bar was noted at the entry to the upper level from 38<sup>th</sup> Street. This allows for over-sized vehicles to access the upper level and possibly overload the structure. We recommend installing a height restraint bar at the entry to the upper level to avoid possible overloading.

## EXECUTIVE SUMMARY

*\*This cost estimate does not include contractor mobilization, engineering and construction administration, and contingency fees.*

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Partial depth spalls and failed patchwork were noted on the upper level. Spalls were also noted in the ceilings and concrete columns. We recommended the failed patchwork and spalled concrete be removed, underlying reinforcement and exposed PT tendons cleaned and protected, and the areas patched with a high quality mortar to stop further deterioration.

A Tier 1 seismic evaluation was completed to rapidly identify potential deficiencies in the design of the structure. Though the Tier 1 screening phase identified this structure to be non-compliant for torsion and redundancy requirements as defined by ASCE 31-03, results of "quick check" calculations indicate that the lateral-force-resisting shear walls in this structure have enough strength to resist calculated seismic forces. As such, we do not recommend pursuing a Tier 2 evaluation to further investigate the potential deficiencies identified in the Tier 1 screening phase.

Budgeting for capital improvements will help the City plan for the necessary funding needed for the recommended work required to maintain the structural integrity and keep the garage operating safely for another 10 to 20 years.

Please see the CIPP table on page 4-7 for a prioritized recommended annual budget breakdown through 2023.

### OBJECTIVE

This ten-year budget for the outlined CIPP is based on the understanding that the City plans to maintain the Lot 4 Parking Structure based on the recommended program for at least the next 10 years of the structure's service life.

The objectives of this CIPP are to provide the City with an asset management tool for planning and budgeting, and to recommend restoration improvements and work items in order to maximize the service-life of this parking facility while planning for an adequate amount of capital funding. The benefit for the City is the ability to plan and budget in confidence for each year thus allowing the maximization of dollars spent. This CIPP is specific to the Lot 4 Parking Structure. If desired, our plan has the flexibility to defer certain work items to future years of the repair program.

### INTRODUCTION

# MANHATTAN BEACH LOT 4 PARKING STRUCTURE

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### FACILITY DESCRIPTION/ BACKGROUND INFORMATION

The Lot 4 Parking Structure is located at 3714 Highland Avenue in Manhattan Beach, California. The parking facility was built in 1980 and is constructed of one way cast-in-place post-tensioned (PT) slabs supported on wide-shallow PT beams and cast-in-place concrete columns. The facility has one supported level and one slab-on-grade level. The lateral load resisting system consists of three shear walls in the east-west direction and two shear walls in the north-south direction. The facility was designed for a parking capacity of 78 vehicles.

A vehicular entrance to the upper level is provided on 38<sup>th</sup> Street and access to the lower level is gained from Highland Avenue. Vehicles park in 2-hour metered spaces, which are enforced daily from 8am-9pm. The parking facility mainly serves patrons of the nearby shops, restaurants, offices and beach.

### IMMEDIATE CONCERNS

The existing vehicular barriers in this structure do not appear to meet current code requirements for maximum spacing and load resistance. This could pose a potential hazard to the users of this structure. While the existing barriers may be grandfathered in under the current code, we recommend the City take a proactive approach and install a new vehicular barrier system that would replace the existing system and meet current code.

Additionally, no restrictions are currently placed on oversized vehicles parking in the structure. This could induce greater loads on the upper level than it was designed for. We recommend the City install a height restraint bar at the upper level entry to restrict larger vehicles from using the parking structure.

The uneven transition between the sidewalk and the upper level at the pedestrian access point from Rosecrans Ave. is a trip hazard. We recommend this transition be flattened to eliminate the risk to pedestrians.

We noted several areas where there is an imminent potential of falling concrete. This could pose a potential risk

### RECOMMENDATIONS

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if one of these falling pieces strikes a pedestrian or a vehicle. We recommend removing the areas of loose concrete in the ceilings.

These items and our corresponding recommendations are further discussed in this report.

### RECOMMENDED CAPITAL IMPROVEMENTS

The following capital improvements and repairs for the Lot 4 Parking Structure are recommended over the next ten years:

- Repair concrete spalls, delaminations and failed patchwork identified on the upper level.
- Repair concrete spalls identified in the columns.
- Repair damaged curbs located on the upper level.
- Repair spalls in the concrete walls and repair damaged stucco where necessary.
- Remove and reconstruct concrete drain enclosure.
- Repair concrete as necessary in conjunction with routine maintenance performed in 2019 and 2023.
- Inject typical floor cracks that run parallel to the PT drop panels with epoxy.
- Inject epoxy in large floor cracks to prevent deterioration from water infiltration and to maintain structural integrity.
- Rout and seal typical floor cracks and install cove sealants at cold joints to prevent ingress of water and other environmental contaminants.
- Inject chemical grout at the joint between the walls and slab to reduce the possibility of water infiltration through the joint.
- Work with adjoining property owner(s) to install a waterproofing membrane as a moisture barrier in the planter adjacent to concrete retaining walls.
- Replace de-stressed PT tendons that are uncovered during the partial or full-depth concrete repair work. Functional PT tendons that are uncovered during the partial or full-depth concrete repair work should be protected with new sheathing to mitigate deterioration.
- Clean staining on floor deck and walls to improve the aesthetics of the facility.
- Repaint traffic stall striping and markings.

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### PREVENTIVE ITEMS

We recommend the following preventative work items over the next ten years for the Lot 4 Parking Structure:

- Cut a drip edge into the ceiling on the western side of the structure. This will help to keep water from entering the lower level of the garage.
- Maintain sealants every five to seven years to prevent premature deterioration from water intrusion into the concrete. Once the sealants are installed in 2013 we recommend replacing the most critical areas in 2018 as they will be nearing the end of their useful service life.

### ENHANCEMENT OPTIONS

Painting the ceilings, columns and walls will brighten the appearance of the parking facility. This can be completed when your budget allows.

### OPINION OF PROBABLE COSTS

The Lot 4 Parking Structure CIPP anticipates a total budget of \$368,500 in 2013 dollars (\$395,000 in future value dollars) to perform repairs and capital improvements over the next ten years. Future value dollars were determined using an annual inflation rate of 3% and include estimated General Conditions and Contingencies.

The primary cost components of this budget are:

#### "Priority-1":

Concrete:

- Repairs of delamination and spalls in the upper level floor and curbs, ceilings, and columns in 2014: \$33,500.

Miscellaneous Repair:

- Installation of a new vehicular barrier system in 2014: \$42,500.

### OPINION OF PROBABLE COSTS

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- Post-Tension strand repair and protection in 2014: \$22,000.
- Addition of height restraint bar in 2014: \$8,000.
- Removing trip hazard in 2014: \$1,500.

### "Priority-2":

#### Waterproofing:

- Planter waterproofing in 2015: \$25,000.
- Routing/Sealing floor cracks in 2015: \$6,000.
- Cove and joint sealants: \$4,000.

### "Priority-3":

#### Waterproofing:

- Epoxy and chemical grout injection in 2016: \$62,000.

Please note that the "Contingency and General Conditions" in the CIPP table are strictly for budgeting purposes. Actual Contingency and General Conditions will be determined when contractor bids are received for the work performed by a qualified restoration contractor.

It is our experience that the repairs we have recommended on a structure of this age would extend its service life for another 10-20 years. As such, we suggest considering the option of demolishing the existing structure, while salvaging the columns and foundations, and constructing a new elevated parking slab of a similar design. The cost of this option, including demolition, would amount to approximately \$58.00-\$70.00/s.f., or about \$800,000-\$1,300,000 for the 13,800s.f. elevated slab. Pursuing this option would reduce the potential for continuous and costly maintenance repairs resulting from durability issues, which makes up the majority of this CIPP. Further information on this option can be discussed if the City so chooses.



## Parking Structure 4 10 Year Budget Forecast



**WALKER**  
RESTORATION CONSULTANTS

LEGEND	
Priority-1	
Priority-2	
Priority-3	

NO.	WORK DESCRIPTION	TOTAL COST	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
<b>1</b>	<b>Concrete</b>	\$ 50,000	\$ 33,500	\$ 13,000	\$ -	\$-	\$-	\$ 3,000	\$ 500	\$ -	\$ -	\$ -
1.1	Floor Repair - Partial Depth	\$ 11,500	\$ 10,500					\$ 1,000				
1.2	Floor Repair - Curbs	\$ 10,500	\$ 10,000					\$ 500				
1.3	Ceiling Repair - Partial Depth	\$ 13,500	\$ 12,500					\$ 1,000				
1.4	Wall Repair - Partial Depth	\$ 5,500		\$ 5,000					\$ 500			
1.5	Column Repair	\$ 1,000	\$ 500					\$ 500				
1.6	Concrete Drain Enclosure Reconstruction	\$ 8,000		\$ 8,000								
<b>2</b>	<b>Waterproofing</b>	\$ 106,500	\$ -	\$ 35,000	\$ 62,000	\$-	\$-	\$ -	\$ 5,500	\$ 4,000	\$ -	\$ -
2.1	Wall (Planter) Waterproofing	\$ 25,000		\$ 25,000								
2.2	Epoxy Injection - Ceiling	\$ 33,000			\$ 32,000					\$ 1,000		
2.3	Epoxy Injection - Floor	\$ 2,500			\$ 2,000					\$ 500		
2.4	Epoxy Injection - Walls	\$ 24,500			\$ 24,000					\$ 500		
2.5	Epoxy Injection - Beams	\$ 1,500			\$ 1,000					\$ 500		
2.6	Rout/Seal Floor Cracks	\$ 9,000		\$ 6,000					\$ 3,000			
2.7	Cove Sealant	\$ 5,500		\$ 3,500					\$ 2,000			
2.8	Tool/Seal Control Joints	\$ 1,000		\$ 500					\$ 500			
2.9	Chemical Grout Injection	\$ 4,500			\$ 3,000					\$ 1,500		
<b>4</b>	<b>Drainage/Lighting</b>	\$ 3,500	\$ -	\$ 2,000	\$ -	\$-	\$-	\$ -	\$ -	\$ -	\$ -	\$ -
4.1	Clean Existing Drain	\$ 2,000		\$ 1,000					\$ 1,000			
4.2	Electrical Allowance	\$ 1,000		\$ 500					\$ 500			
4.3	Replace LED Light Fixture Cover	\$ 500		\$ 500								
<b>5</b>	<b>Miscellaneous/Architectural Repairs</b>	\$ 79,500	\$ 74,000	\$ 1,500	\$ 2,500	\$-	\$-	\$ -	\$ 1,500	\$ -	\$ -	\$ -
5.1	New Vehicular Barrier System	\$ 42,000	\$ 42,000									
5.2	Post Tension Strand Repair	\$ 20,000	\$ 20,000									
5.3	Post Tension Protection	\$ 2,500	\$ 2,500									
5.4	Sandblast Walls	\$ 1,500		\$ 1,500								
5.5	Repaint Stall Striping	\$ 3,000			\$ 1,500				\$ 1,500			
5.6	Add Height Restriction Bar at Upper Level Vehicular Entry	\$ 8,000	\$ 8,000									
5.7	Remove Trip Hazard at Upper Level Pedestrian Entry	\$ 1,500	\$ 1,500									
5.8	Cut Drip Edge in Ceiling	\$ 1,000			\$ 1,000							
<b>6</b>	<b>Enhancements</b>	\$ 40,500	\$ -	\$ -	\$ 40,500	\$-	\$-	\$ -	\$ -	\$ -	\$ -	\$ -
6.1	Clean and Paint Ceilings	\$ 34,000			\$ 34,000							
6.2	Paint Columns and Walls	\$ 6,500			\$ 6,500							
<b>Sub Total</b>		\$ 278,500	\$ 107,500	\$ 51,500	\$ 105,000	\$ -	\$ -	\$ 3,000	\$ 7,500	\$ 4,000	\$ -	\$ -
Mobilization		\$ 30,000	\$ 11,000	\$ 6,000	\$ 11,000	\$ -	\$ -	\$ 500	\$ 1,000	\$ 500	\$ -	\$ -
Engineering and Construction Administration Allowance		\$ 30,000	\$ 11,000	\$ 6,000	\$ 11,000	\$ -	\$ -	\$ 500	\$ 1,000	\$ 500	\$ -	\$ -
Construction Contingency		\$ 30,000	\$ 11,000	\$ 6,000	\$ 11,000	\$ -	\$ -	\$ 500	\$ 1,000	\$ 500	\$ -	\$ -
<b>Opinion of Annual Budget (2013 Dollars)</b>		\$ 368,500	\$ 140,500	\$ 69,500	\$ 138,000	\$ -	\$ -	\$ 4,500	\$ 10,500	\$ 5,500	\$ -	\$ -
<b>Opinion of Annual Budget (Adjusted Future Value)</b>			\$ 144,800	\$ 73,800	\$ 150,800	\$ -	\$ -	\$ 5,400	\$ 13,000	\$ 7,000	\$ -	\$ -
<b>Opinion of Total 10-Year Budget (Adjusted Future Value)</b>		\$ 395,000		Note: Future value cost based on inflation; 3% annually								

Note 1: Contingency based on 10% of Sub Total rounded up to the nearest \$500.

Note 2: General Conditions based on 10% of Sub Total rounded up to the nearest \$500.

Note 3: Consulting & Engineering Fees based on 10% of Sub Total rounded up to the nearest \$500.

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The Walker team visited the structure on July 26, 2013 to review the existing conditions of the parking structure. Based on our condition appraisal, the parking structure was found to be in fair condition. It was noted that the existing vehicular barrier rails are non-compliant with the current building code requirements and could pose a potential liability risk to the City. Typical signs of deterioration in the structure consistent with its age were noted. Specifically, cracked and deteriorated concrete walls, floors, columns and ceilings were observed at select locations.

It has been our experience that owners who address durability and maintenance issues for their parking structures can expect to receive a maximized service life and less costly future repairs as compared to a structure that does not receive proper preventative maintenance.

## Vehicular Barriers

The vehicular barriers consist of metal rails supported on cast-in-place concrete curbs. The spacing between the horizontal members does not meet the current code. Current code limits this spacing to a maximum of 4" in order to prevent the possibility of small objects and children passing through. Existing spacing between the horizontal members was measured to be 10".

In addition, current code requires vehicular barriers to be designed to resist a bumper load of 6000 lbs. Although a detailed review of the capacity of the existing barrier system was not part of the current scope, it appears (by experience) that the existing barrier system will not be able to withstand much of a vehicular impact.

While the existing vehicular barriers in this structure have been in place since the original construction and may be grandfathered in under the current code, we recommend the City take a proactive approach by installing a new vehicular barrier system on the upper level. This would ensure that the vehicular barriers would meet current code requirements and minimize any potential hazards that exist with the current system.

In general, the existing barrier rail system is in poor condition. A number of the posts were noted to be bent from vehicular

## DISCUSSION



Photo 8: Vehicular Barriers on east side of the upper level



Photo 13: Cracking in concrete curb at rail mount location.

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impact and many of the anchoring embedments in the curbs were loose. We recommend the removal of the existing system in conjunction with the installation of a new barrier system.

## Concrete Structure

The structural system is composed of a one-way post-tensioned (PT) concrete slab supported on wide-shallow PT beams spanning on reinforced concrete columns. Extended PT drop panels run along each column line in the north-south direction. This structure has three concrete shear walls in the east-west direction and two concrete shear walls in the north-south direction.

Based on visual review and sounding observations on the floor deck along with selective material tests, the concrete in the structure is noted to be in fair condition.

## Elevated Slab

- Concrete spalls were visually observed and located by sounding at isolated locations on the floor and ceiling surfaces. **The active spalling in the ceilings presents a possible liability issue for the City because of the likelihood of striking a pedestrian or a vehicle.** In order to stop the ongoing spalling in these areas, it is recommended that the deteriorated concrete be removed, underlying reinforcement cleaned, and the areas re-patched with high quality repair mortar.
- Prior concrete patchwork was noted on the top surface of the supported slab. Many of the patches were noted to be failed and delaminated. In order to stop further deterioration to the concrete and the underlying PT, it is recommended that the delaminated patches be removed, underlying reinforcement and PT tendons cleaned and protected, and the areas re-patched with high quality repair mortar.
- Above average floor cracks were noted throughout the upper level. The cracks were most often aligned with the wide-shallow post-tensioned beams below. We recommend these cracks be routed and sealed



Photo 15: Typical spalling and exposed reinforcement seen in the ceiling



Photo 20: Large floor cracks running parallel to drop panels below.

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with a silicone sealant to prevent ingress of water and reduce deterioration of embedded PT tendons (see Waterproofing Systems section).

- Large cracks with signs of active leakage were noted on the ceiling. The leakage indicates infiltration of moisture through the full depth of the slab, which could be corroding the embedded steel reinforcement. In order to avoid further deterioration from moisture penetration and restore the structural integrity of the concrete, cracks in the ceiling should be repaired with epoxy injection. (see Waterproofing Systems section).

### *Walls/Drop Panels/Columns/Curbs/Drain Enclosure*

- Spalled areas were noted at select locations in the concrete retaining walls. We recommend these spalls be removed, underlying reinforcement cleaned, and area patched with a high quality repair mortar.
- Several large cracks were identified in the wide-shallow beams. These cracks should be injected with epoxy to restore the structural integrity and mitigate the infiltration of water and other contaminants, which could lead to the deterioration of the embedded PT tendons (see Waterproofing Systems section).
- Cracking and spalling was identified near the base of a number of columns, exposing the underlying reinforcement in some cases. The shortening of the slab and beams in one direction due to post-tensioning cause these cracks in the columns. This phenomenon is common in structures of this type. We recommend the spalled concrete in the columns be removed, underlying reinforcement cleaned, and area patched with a high quality repair mortar. The cracks in the columns should be repaired with epoxy injection.
- Significant cracking and spalling was noted in the concrete curb adjacent to the upper level planter on the east side of the structure. This provides avenues for water and other contaminants to get into the



Photo 21: Large crack seen extending from the control joint.



Photo 24: Large crack seen in a drop panel.



Photo 25: Spall and cracking in a column.



Photo 28: Cracked curb on the upper level

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retaining wall below, which can lead to deterioration of the embedded reinforcing steel. We recommend all damaged curbs be removed and repaired with a high quality mortar to eliminate avenues of water infiltration into the structure.

- Extensive cracking and signs of active leakage were identified on the concrete drain enclosure located on the north side of the lower level. The leaking material has the potential to infiltrate the surrounding cracks in the adjacent concrete walls and deteriorate the embedded steel reinforcement. We believe the drain enclosure does not serve its purpose and recommend it be reconstructed to stop further deterioration to the adjacent concrete retaining wall.



Photo 32: Concrete drain enclosure exhibiting signs of active leakage.

## Waterproofing Systems

Sealants were generally absent in this garage. In this type of structure, sealants are typically placed along perimeter wall or curb cove joints to prevent the ingress of moisture into the structure through cold joints in the concrete. Corrosion of steel reinforcement due to moisture infiltration is a primary reason for concrete deterioration leading to potential structural issues. Sealants should be installed at these locations and replaced upon reaching the end of their useful service life, about every five years. This plan is part of the ongoing maintenance strategy to increase the longevity of the structure.

We recommend the following waterproofing repairs be implemented to stop further deterioration of the concrete and embedded steel reinforcement:

- Above average floor cracks were identified on the upper level. These cracks provide avenues of moisture infiltration and should be routed and sealed in order to reduce the potential for deterioration to the PT elements below.
- The concrete retaining walls adjacent to a planter located on the east side of the structure were exhibiting high amounts of efflorescence. This is likely a result of moisture penetrating the wall due to a

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possible lack of waterproofing between the soil and the walls.

We recommend the city look into working with the neighboring property owner(s) to temporarily remove the soil to install a vertical waterproofing and drainage membrane on the retaining walls adjacent to the planter.

- Large cracks showing signs of active leakage were noted in the ceiling. This indicates infiltration of moisture through the full depth of the slab. **The moisture infiltration has led to corrosion of the steel reinforcement in many areas, which has caused concrete to spall off and present a possible liability issue should one of these falling pieces hit a pedestrian or a vehicle.** In order to avoid further deterioration from moisture penetration and maintain the structural integrity of the slab, cracks in the ceiling should be repaired with epoxy injection
- Cracks were noted extending from the concrete drain enclosure in the north wall. Moisture from the nearby drain has the potential to infiltrate these cracks and accelerate deterioration of the concrete and embedded steel reinforcement. In order to restore their structural integrity and increase the resistance to moisture penetration, we recommend repairing all cracks in the concrete walls with epoxy injection.
- Several full depth cracks were identified in the wide-shallow beams. These cracks should be injected with epoxy to stop the infiltration of water and other contaminants, which could lead to the deterioration of the embedded PT tendons.
- Cove sealant was absent at the cold joints between the horizontal and vertical surfaces in this structure. We recommend applying cove sealant at these locations to prevent water and other contaminants from seeping into the joint, causing corrosion of the embedded steel reinforcement and deterioration of the surrounding concrete.



Photo 38: High amounts of efflorescence seen on the wall adjacent to the planter.



Photo 43: Signs of active leakage through a crack in the ceiling.

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- One construction joint was noted in this structure and was observed to be unsealed. The unsealed joint provides an avenue for water to leak to the level below during rain events as well as deck wash downs and nearby sprinkler usage. We recommend the construction joint be tooled and sealed to prevent premature deterioration of the embedded steel reinforcement and PT tendons and to prevent water from dripping on vehicles and pedestrians below.

### Drainage/Lighting

One floor drain was noted on the upper level on the north side of the structure. We observed water from a surrounding sprinkler system flow towards the drain with little standing water collecting. This indicates adequate slope towards the drain on the upper level. Once in the drain, however, the water was observed to leak out of the concrete drain enclosure on the lower level. We recommend the drain basin be reconstructed (see Concrete Structure section). As part of the ongoing maintenance program, we recommend routine cleaning of the drain to maintain its maximized use.

Light level measurements were not part of the scope of this project; however the lower level was noted to be well-lit by LED fixtures. The fixtures on the perimeter of the lower level appeared to be operated by timers and are off during the day to maintain energy efficiency. Two LED fixtures were noted to be missing acrylic covers that need replacement.

### Miscellaneous/Architectural

During our field review we observed a number of potential repairs that do not classify as concrete or waterproofing related. Although a detailed review of the capacity of the existing barrier system was not a part of the current scope, it appears based on our experience that the existing barrier system will not be able to withstand a vehicular impact. As such, we recommend the installation of a new barrier system (see Vehicular Barriers section).

Other observations and recommendations include:

- Water running down the exposed face on the west side of the structure causes localized staining at the



Photo 44: Active leakage below the location of the construction joint.



Photo 45: Upper level drain.

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perimeter of the ceiling. A drip edge was not provided during construction which would stop the water from running along the ceiling. When water makes contact with the drip edge it no longer travels along the ceiling, rather it falls on the floor surface where it can be removed during deck wash downs. A drip edge can be cut into the ceiling along the west side of the structure to prevent water from continuing to stain the ceiling. The existing staining can be removed by power washing the ceilings.

- In order to enhance the appearance of the structure, we recommend the sandblasting of all wall surfaces to remove the staining due to efflorescence and other environmental effects.
- Parking stall striping in this structure has faded and reached the end of its useful service life. We recommend that all markings be removed and restriped, and done so routinely every five years, or as needed.
- Currently there are no height or weight restrictions placed on vehicles that can park on the upper level. This exposes the upper level to potential heavy loads from oversized vehicles that can access the structure. In order to prevent large vehicles from accessing the upper level, we recommend installing a height restriction bar at the upper level entry ramp from 38<sup>th</sup> Street.
- An uneven transition between the sidewalk and the elevated slab was noted at the pedestrian entry onto the upper level from Rosecrans Ave. This is considered a trip hazard and a potential liability risk to the City. We recommended this transition be flattened out to prevent a risk to pedestrians.

## Enhancements

The painted portions of the columns were noted to be damaged from tire marks and impact from vehicles passing by. As an enhancement, we recommend the full-height of all columns be repainted.



Photo 49: Staining around the perimeter of the ceiling.



Photo 39: Damaged wall.



Photo 59: Trip hazard at pedestrian entry.

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The ceilings and walls are not painted in this structure. Painting the ceilings and walls will provide better light reflectance and enhance passive security and user comfort.

## TIER-1 SEISMIC REVIEW

The overall purpose of the seismic evaluation is to investigate and identify inherent weaknesses and quickly identify potential deficiencies in the design of the structure. The evaluation was completed per the guidelines of the ASCE 31-03 Seismic Evaluation of Existing Buildings (ASCE 31) Tier 1 Screening Phase in order to determine if the building's elements, including its lateral force resisting system, meets the Life Safety (LS) Seismic Performance Level.

The Tier 1 screening phase consists of three sets of checklists that allow rapid evaluation of the structural, nonstructural, and foundation/geologic hazard elements of the building and site conditions. In some cases, "Quick Checks" may be required during a Tier-1 Evaluation; however, the level of analysis necessary is minimal.

The documents used to conduct the Tier 1 screening include original structural drawings prepared by South Bay Engineering Corporation in 1979. In general, these drawings together with our site visit formed the basis of our Tier 1 evaluation.

The lateral force resisting system in this structure consists of cast-in-place concrete shear walls in both directions. This structure is located in what is considered a high level of seismicity, as defined by Table 2-1 of ASCE 31-03. Therefore, we have reviewed the Building Type C2 (Concrete Shear Walls with Stiff Diaphragms) Tier 1 basic and supplemental checklists for this structure.

One issue was identified from the checklists as non-compliant (NC). For reference, the structural checklists are included in Appendix B4 of this report. Supporting structural calculations required for certain Tier 1 "quick checks" are also included in Appendix B4.

The Tier 1 screening phase identified the following structural items below as "non-compliant", thus requiring further investigation and/or more rigorous calculations (which are

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beyond the scope of this report) in order to determine if the structure as a whole is compliant:

- **Torsion:** ASCE 31 requires the distance between the story center of mass and the story center of rigidity to be less than 20% of the building width in either direction. The estimated distance between the center of mass and the center of rigidity of this structure is 53' in the east-west direction. This is greater than 20% of the width of the building in the east-west direction (20% of 99' = 20').

Whenever deficiencies are identified in the Tier 1 screening phase, the design professional may choose to perform a Deficiency-Only Tier 2 Evaluation that addresses only the deficiencies identified in Tier 1. For Tier 2, a complete analysis of the building that addresses the deficiencies identified in Tier 1 must be performed.

Torsion was identified as a potential deficiency because the center of gravity of this structure is near the center of the diaphragm (elevated slab), while the center of rigidity is close to the east wall. Under longitudinal loading, the eccentricity between the center of gravity and the center of rigidity would cause a torsional moment. The entire earthquake force would be resisted directly by the east wall and the torsional moment would be resisted by a couple consisting of equal and opposite forces in the north and south walls. The north and south walls would have displacements in opposite directions, causing the diaphragm to want to rotate. In a rigid diaphragm structure such as this one, the torsional forces would be transmitted back to the walls.

As a part of the Tier 1 "quick checks", the average shear stress was calculated for each wall. This provides a quick assessment of the overall level of demand on the structure. Results revealed that the average shear stresses in the walls in this structure comply with the shear stress limits set forth by the ASCE 31-03. This can largely be attributed to the widths of the walls, particularly the walls that run in the north-south direction. Further, we found no non-compliant items on the geologic and non-structural checklists. Thus, the level of demand on the walls based on calculated seismic forces is acceptable and the current configuration of the lateral-

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force-resisting system is adequate. As such, we do not feel that the potential deficiencies identified in the Tier 1 screening phase warrant a Tier 2 analysis.

## CONCRETE TESTING

Concrete cores were extracted from two locations on the supported slab of the parking area and sent to a Universal Construction Testing (UCT) laboratory to establish a base-line for chloride ion content and determine the compressive strength of the concrete.

## CHLORIDE-ION CONTENT

Since concrete is a naturally porous material, chloride ions penetrate into concrete, and subsequent accumulation, occurs readily on surfaces exposed to marine salts, wetting and drying. Research indicates that corrosion begins when chloride accumulation exceeds 280 to 410 parts per million (ppm) in the concrete at the depth of reinforcing steel. Once the reinforcing bars corrode they will typically begin to cause delaminations and spalls in the concrete slabs.

Tracking the rate of chloride ion intrusion helps in establishing the potential for corrosion of the reinforcing steel in the concrete; thus, potentially leading to the accelerated deterioration of the concrete both structurally and aesthetically. The highest chloride ion content in the slab was determined to be 170 parts per million (ppm) located in the first inch of the top surface. Since the chloride levels in the concrete are below the corrosion threshold, chloride induced corrosion of the steel is not likely.

## COMPRESSIVE STRENGTH

Compressive strength was also tested in both of the cores extracted from the concrete floor slab. The average compressive strength of the cores extracted was measured to be 5,430 pounds per square inch (psi). This is an adequate compressive strength for the concrete in this construction application.

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**WALKER**  
RESTORATION CONSULTANTS

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## CARBONATION

Carbonation of concrete occurs when the carbon dioxide in the atmosphere reacts with hydrated cement minerals to produce calcium carbonate. Carbonation can be detrimental because it neutralizes the alkalinity present in the concrete. If it travels deep enough, carbonation can make the embedded reinforcement more susceptible to corrosion.

We measured the extent of carbonation in this structure by spraying a freshly exposed surface of the concrete (where the cores were extracted) with a phenolphthalein solution. The calcium hydroxide is colored pink while the carbonated portion is uncolored. In one of the two locations we tested, we found carbonation to have penetrated upwards approximately 3/4" from the bottom surface of the slab and found no evidence of carbonation at the top surface of the slab. In the second location, we found no evidence of carbonation in either the top or bottom surfaces. This indicates that the level of carbonation in this slab is minimal, thus a petrographic examination was not pursued.

## CONCRETE COVER

Using appropriate concrete cover is a key factor in corrosion protection. Adequate cover together with good concrete quality can delay chloride ion penetration thereby prolonging any substantial deterioration to the embedded steel reinforcement. The minimum concrete cover for this type of structure specified by the ACI Building Code is 1".

We initiated our investigation of the concrete cover with a 2'x2' exploratory excavation of the elevated slab. In general, the location of the excavation in this type of structure is selected such that the PT tendon profile is at or near its peak, near the top surface of the slab. We expected to expose underlying PT tendons at a depth of 1" from the top of the slab. However, no tendons were exposed despite excavating to a depth of 2.5". This prompted us to halt the excavation and instead move forward with a Ground Penetrating Radar (GPR) exploration to determine the precise concrete cover.

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An independent GPR contractor was utilized to assist us in determining the concrete cover of the embedded reinforcement and PT tendons. Any notable discrepancy between the as-built tendon profiles and the engineered design could lead to a loss of strength and integrity of the slab. The structural drawings indicated a 1" cover at the highest point of the tendon profile. The results of the GPR showed the actual cover at the highest point of the tendon profile to be 3-3/8" from the top surface. The larger concrete cover meant the distance between the highest and lowest points of the parabolic tendon profile running in the banded (north-south) direction was likely smaller than the design value. This distance is a key component that factors into the load capacity of a PT member. If all other variables are equal, the smaller this distance is the less transverse load the member can carry.

While the design called for the distance between the highest and lowest points on the tendon profile to be 10", GPR showed this distance to average approximately 7-3/8" along the full length of a typical drop panel. Despite this condition, the 270-kip prestressing force that this structure was designed with provides enough strength to resist parking loads. As a precaution, we suggest limiting the size (and thereby the weight) of vehicles that can park the upper level through the use of a height restriction bar (see Miscellaneous/Architectural section in our Discussion).

Please refer to Appendix C for more information related to materials testing performed by UCT.



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APPENDIX A2

PHOTO LOG: LOT 2  
PARKING STRUCTURE

# MANHATTAN BEACH LOT 2 PARKING STRUCTURE

## APPENDIX A2 -PHOTO LOG



PROJECT #37-8377.00



View of Northwest corner from 12<sup>th</sup> Street.

Photo 1



View of southeast corner from Center Place alleyway.

Photo 2

# MANHATTAN BEACH LOT 2 PARKING STRUCTURE

## APPENDIX A2 -PHOTO LOG



PROJECT #37-8377.00



South side of structure facing Center Place alleyway.

Photo 3



Faded signage and surrounding cracks in stucco outside of lower level entry.

Photo 4

# MANHATTAN BEACH LOT 2 PARKING STRUCTURE

## APPENDIX A2 -PHOTO LOG

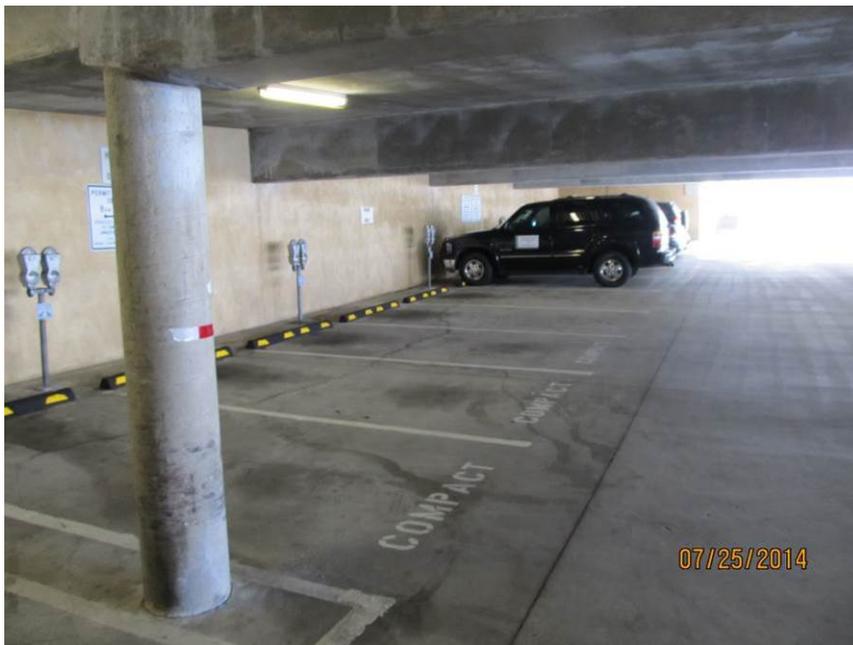


PROJECT #37-8377.00



Access into lower level from Center Place alleyway.

Photo 5



Interior view of lower level facing southeast.

Photo 6

# MANHATTAN BEACH LOT 2 PARKING STRUCTURE

## APPENDIX A2 -PHOTO LOG

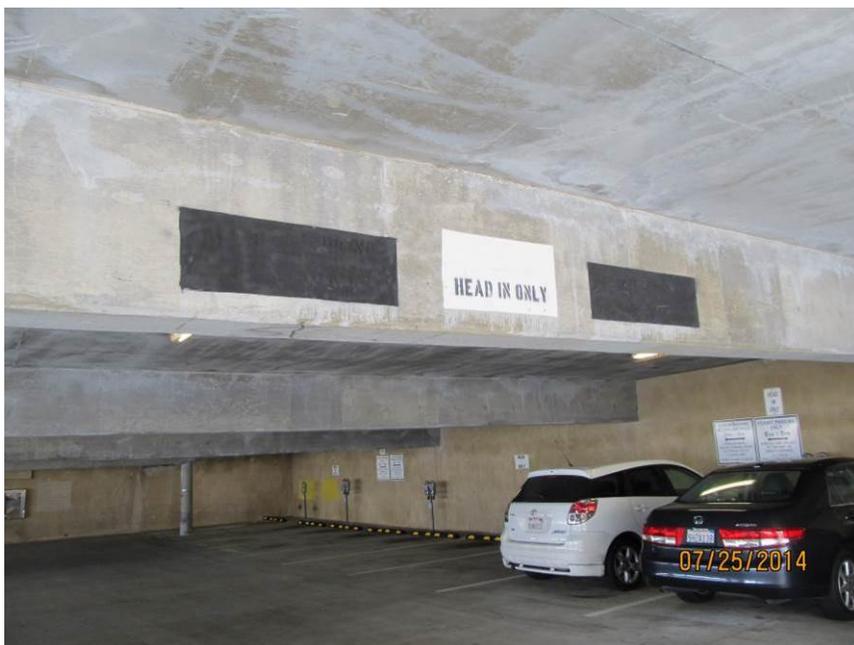


PROJECT #37-8377.00



Interior view of lower level facing southwest.

Photo 7



Interior view of lower level facing northeast.

Photo 8

# MANHATTAN BEACH LOT 2 PARKING STRUCTURE

## APPENDIX A2 -PHOTO LOG



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Typical lower level parking coin-only parking meter.

Photo 9



Extensive efflorescence seen in the ceiling.

Photo 10

# MANHATTAN BEACH LOT 2 PARKING STRUCTURE

## APPENDIX A2 -PHOTO LOG



PROJECT #37-8377.00



Photo 11

Cracking and efflorescence in the ceiling and beam.



Photo 12

Cracking and previous patchwork seen in the ceiling.

PROJECT #37-8377.00



Photo 13

Cracking in the stucco skim coat extending from the beam-to-wall connection.

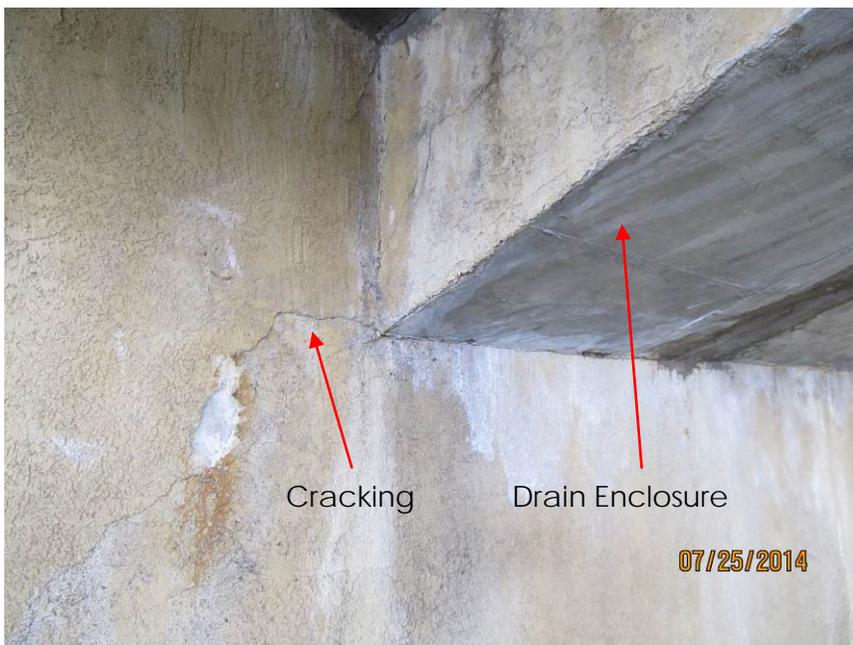


Photo 14

Cracking seen extending from concrete drain enclosure. Signs of active leakage can also be seen.

PROJECT #37-8377.00



Photo 15

Cracking in the skim coat above the south entry into the lower level.



Photo 16

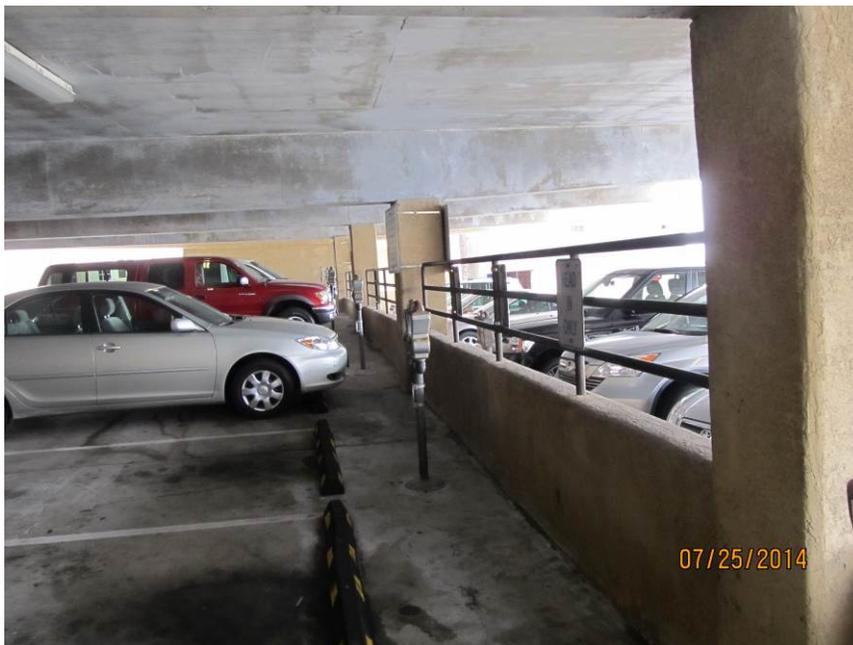
Cracking seen in the skim coat near a cold joint.

PROJECT #37-8377.00



Exposed junction box in the ceiling.

Photo 17



Vehicular barrier in the lower level.

Photo 18

PROJECT #37-8377.00



Photo 19

Unused meter mount in the lower level.



Photo 20

Efflorescence seen on a beam.

# MANHATTAN BEACH LOT 2 PARKING STRUCTURE

## APPENDIX A2 -PHOTO LOG



PROJECT #37-8377.00



Active leakage seen at the joint between the walls and ceiling.

Photo 21



Typical drive aisle on the upper level. Cracking can be seen in the floor.

Photo 22

# MANHATTAN BEACH LOT 2 PARKING STRUCTURE

## APPENDIX A2 -PHOTO LOG



PROJECT #37-8377.00



Cracking on the upper level.

Photo 23



Large cracks seen in the elevated deck.

Photo 24

# MANHATTAN BEACH LOT 2 PARKING STRUCTURE

## APPENDIX A2 -PHOTO LOG



PROJECT #37-8377.00



Photo 25

Typical pattern of prior spall patches over once exposed PT tendons.



Photo 26

Large crack and patches likely from previous seismic retrofit work in upper level.

PROJECT #37-8377.00



Photo 27

Large cracks seen in the elevated deck.



Photo 28

Unsealed cove joint.

PROJECT #37-8377.00



Photo 29

Exposed PT strand seen through a previously patched area.



Photo 30

Close-up of exposed PT strand showing signs of corrosion.

PROJECT #37-8377.00



Photo 31

An exposed and deteriorated PT strand in the elevated deck.



Photo 32

The "screwdriver method" was utilized to determine that the PT tendon has been de-stressed.

PROJECT #37-8377.00



Photo 33

Signs of active leakage through the joint between wall and ceiling.

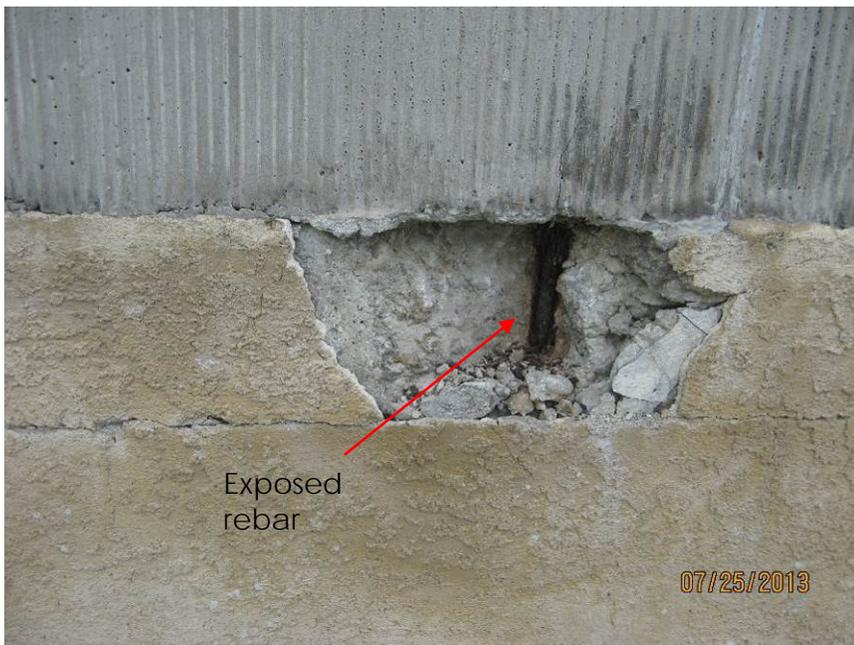


Photo 34

Concrete spall on an exterior wall, exposing underlying reinforcement.

PROJECT #37-8377.00

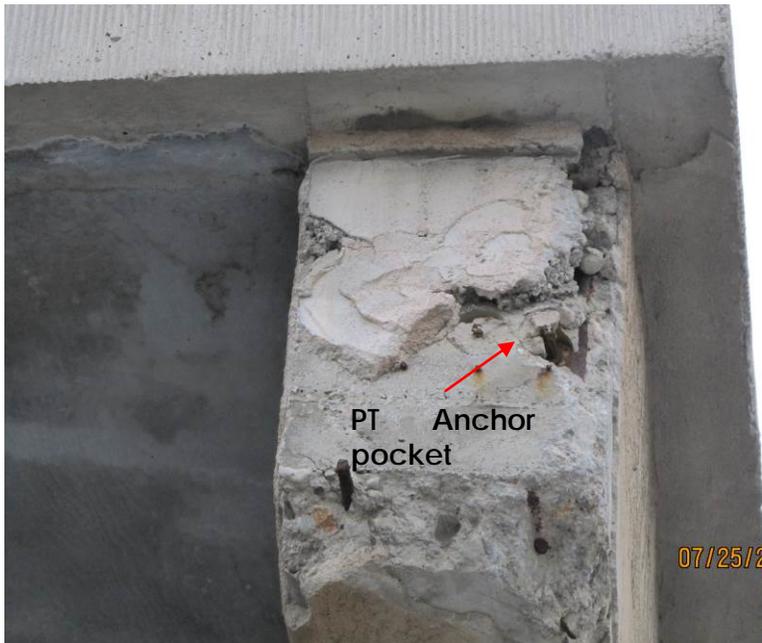


Photo 35

Closeup of the end of a beam which shows typical spalling that has exposed the PT anchor pockets.



Photo 36

Cracking seen in a wall around a beam.

# MANHATTAN BEACH LOT 2 PARKING STRUCTURE

## APPENDIX A2 -PHOTO LOG



PROJECT #37-8377.00



Previously repaired beam crack using epoxy injection.

Photo 37



Typical barrier rail on the perimeter of the upper level.

Photo 38

# MANHATTAN BEACH LOT 2 PARKING STRUCTURE

## APPENDIX A2 -PHOTO LOG



PROJECT #37-8377.00



Photo 39

Spacing between the horizontal members was noted at 9" ..



Photo 40

Total height of the existing barrier rail measured to be 41" .

# MANHATTAN BEACH LOT 2 PARKING STRUCTURE

## APPENDIX A2 -PHOTO LOG



PROJECT #37-8377.00



Photo 41

Previous repair work on barrier railing showing signs of deterioration.



Photo 42

Previous repair work on barrier railing showing signs of deterioration.

PROJECT #37-8377.00



Photo 43

Previous repair work on barrier railing showing signs of deterioration.



Photo 44

Deteriorated anchor plate at the base of barrier rail.

PROJECT #37-8377.00



Spalled concrete at top tread of cast-in-place stairs.

Photo 45



Damaged skim coat, perhaps due to vehicle impact.

Photo 46

PROJECT #37-8377.00



Photo 47

Previous repair work on barrier railing showing signs of deterioration.



Photo 48

Damaged fire hose cabinet with missing fire hose and non-functioning standpipe.

PROJECT #37-8377.00



Photo 49

Electrical panels on lower level.



Photo 50

Floor drain located on upper level.

# MANHATTAN BEACH LOT 2 PARKING STRUCTURE

## APPENDIX A2 -PHOTO LOG



PROJECT #37-8377.00



Large area of debonded stucco on exterior of building.

Photo 51



West elevation of the structure showing proposed area for new drip edge.

Photo 52

# MANHATTAN BEACH LOT 2 PARKING STRUCTURE

## APPENDIX A2 -PHOTO LOG



PROJECT #37-8377.00

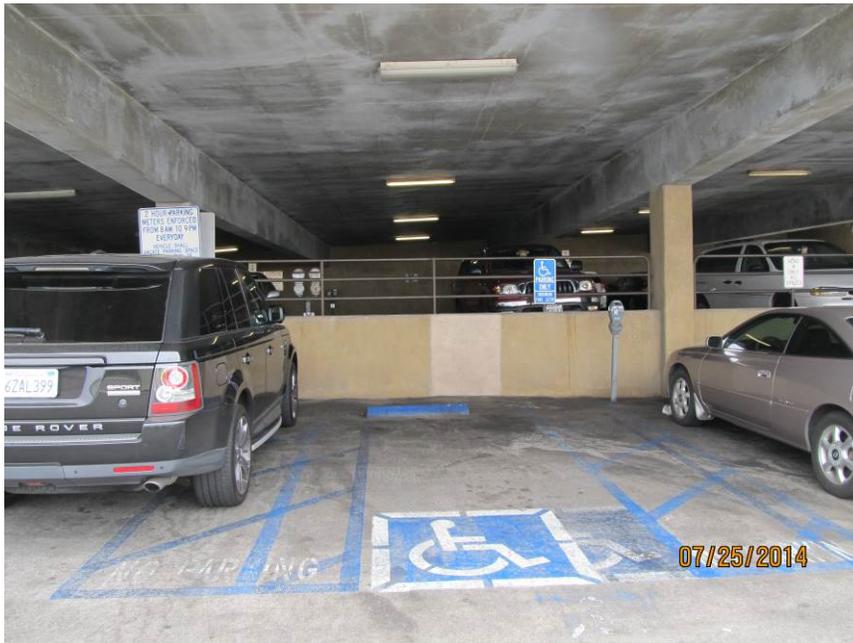


Photo 53

Conflicting striping at lower level.



Photo 54

Non-functioning light fixtures on the lower level.

# MANHATTAN BEACH LOT 2 PARKING STRUCTURE

## APPENDIX A2 -PHOTO LOG



PROJECT #37-8377.00



A typical T5 florescent light fixture with a metal cage cover; many fixtures such as this one were showing signs of corrosion.

Photo 54



A typical florescent light fixture with an acrylic lens; many fixtures such as this one were showing signs of corrosion.

Photo 55

PROJECT #37-8377.00



Photo 56

Bracing installed as a part of a previous seismic retrofit.

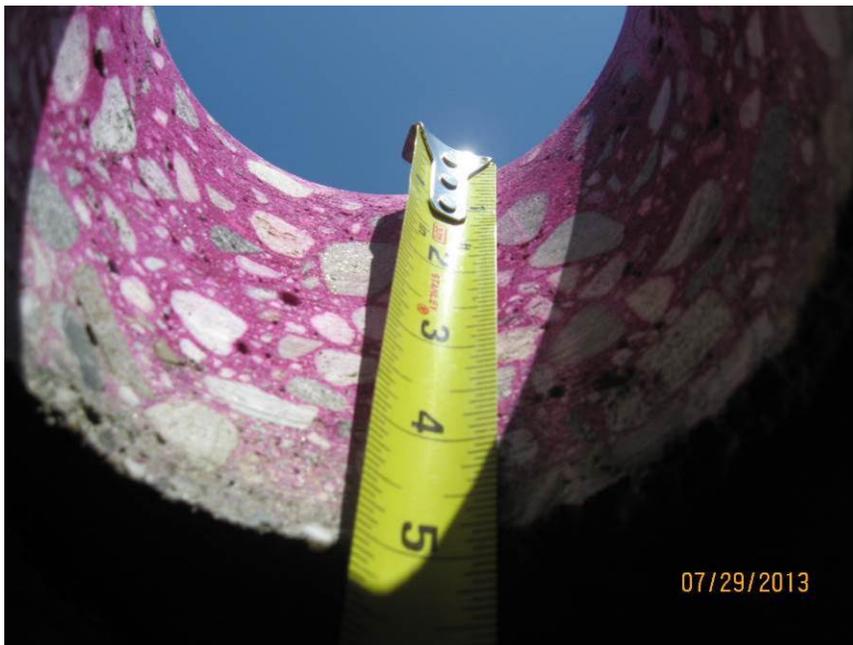


Photo 57

Carbonation testing using a phenolphthalein solution. The pink region indicates no carbonation at the top of the slab. The colorless region indicates 1-3/8" of carbonation at the bottom of the slab.



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APPENDIX A3

PHOTO LOG: LOT 3  
PARKING STRUCTURE

# MANHATTAN BEACH LOT 3 PARKING STRUCTURE

## APPENDIX A3 -PHOTO LOG



PROJECT #37-8377.00



Exterior view from corner of Morningside Drive and 12th Street.

Photo 1



Exterior view from Center Place alleyway.

Photo 2

# MANHATTAN BEACH LOT 3 PARKING STRUCTURE

## APPENDIX A3 -PHOTO LOG



PROJECT #37-8377.00



Designated trash area located at the southwest corner of the ground level.

Photo 2



Recently upgraded LED lighting fixtures on first level.

Photo 3

# MANHATTAN BEACH LOT 3 PARKING STRUCTURE

## APPENDIX A3 -PHOTO LOG



PROJECT #37-8377.00



Masonry shear wall seen adjacent to the east exit ramp.

Photo 5



Exit ramp on east side of structure.

Photo 6

# MANHATTAN BEACH LOT 3 PARKING STRUCTURE

## APPENDIX A3 -PHOTO LOG



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Three interior steel braced frames on the second level.

Photo 7



Drive aisle facing west on the upper level.

Photo 8

# MANHATTAN BEACH LOT 3 PARKING STRUCTURE

## APPENDIX A3 -PHOTO LOG



PROJECT #37-8377.00



Entry to the ground level from 12st street at west side of structure. The ramp to the right takes vehicles up to the second floor.

Photo 9



Electrical panels on first level.

Photo 10

# MANHATTAN BEACH LOT 3 PARKING STRUCTURE

## APPENDIX A3 -PHOTO LOG



PROJECT #37-8377.00



Mechanical equipment on second level.

Photo 11



Typical meters seen on the second level. Upgraded meters were noted on the roof level.

Photo 12

# MANHATTAN BEACH LOT 3 PARKING STRUCTURE

## APPENDIX A3 -PHOTO LOG



PROJECT #37-8377.00



Vehicular barriers on the second level.

Photo 13



Spacing between the horizontal members was measured to be 6". Current code restricts this spacing to 4".

Photo 14

# MANHATTAN BEACH LOT 3 PARKING STRUCTURE

## APPENDIX A3 -PHOTO LOG



PROJECT #37-8377.00



Photo 15

Typical spalled concrete at the anchor of a barrier rail.



Photo 16

Typical spalled concrete at the anchor of a barrier rail.

PROJECT #37-8377.00



Photo 17

Typical spalled concrete at the anchor of a barrier rail, like a result of a failed sealant at the anchoring point.



Photo 18

Typical spalled concrete at the anchor of a barrier rail.

PROJECT #37-8377.00



Photo 19

Typical spalling with exposed reinforcement seen in the ceiling. A corroded light fixture can also be seen.



Photo 20

Typical spalling with exposed reinforcement seen in the ceiling.

PROJECT #37-8377.00



Photo 21

Typical spalling with exposed reinforcement seen in the ceiling.



Photo 22

Typical spalling with exposed reinforcement seen in the ceiling.

PROJECT #37-8377.00



Photo 23

Typical spalling with exposed reinforcement seen in the ceiling. High amounts of efflorescence can also be seen. This is an indication of active leakage through the slab.



Photo 24

Delaminated and spalled concrete seen initiating from the interface between the slab and the top of beam.

PROJECT #37-8377.00



Photo 25

Delaminated and spalled concrete seen initiating from the interface between the slab and the top of beam, particularly at the location of shear studs.

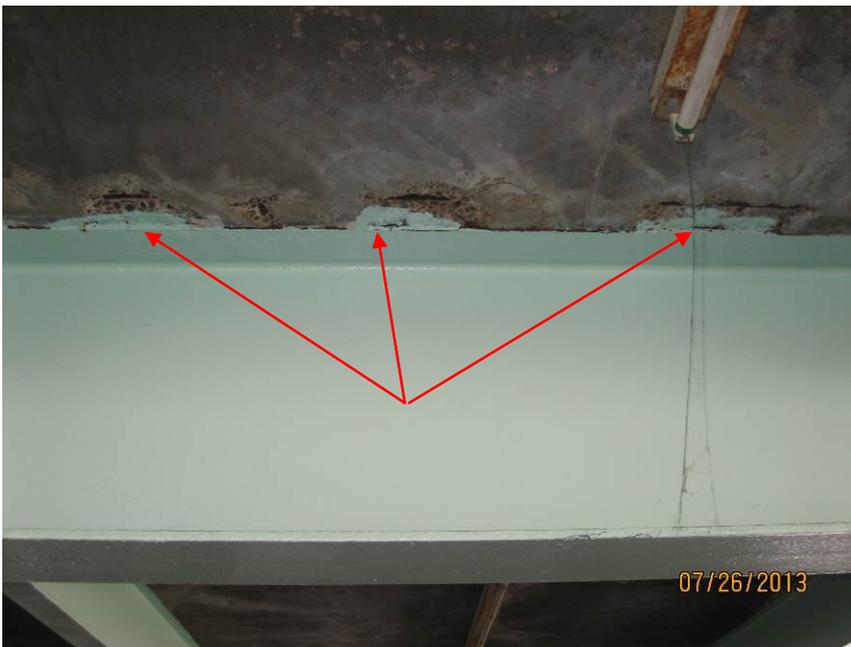


Photo 26

Delaminated and spalled concrete seen initiating from the interface between the slab and the top of beam, particularly at the location of shear studs.

PROJECT #37-8377.00



Photo 27

Delaminated and spalled concrete seen initiating from the interface between the slab and the top of beam.



Photo 28

Typical spalling and delaminated concrete in the ceiling. A missing bulb in a nearby light fixture can also be seen.

PROJECT #37-8377.00



Photo 29

Typical floor cracks on second level.



Photo 30

Typical floor crack on second level.

PROJECT #37-8377.00



Photo 31

Exterior beam to wall connection.



Photo 32

Large crack in a masonry shear wall on the west side of the structure.

# MANHATTAN BEACH LOT 3 PARKING STRUCTURE

## APPENDIX A3 -PHOTO LOG



PROJECT #37-8377.00



Damaged masonry wall on the west side of the structure.

Photo 33



Large crack in a masonry shear wall on the west side of the structure.

Photo 34

PROJECT #37-8377.00



Large crack in a masonry wall.

Photo 35



Previous curb patchwork at barrier rail connection.

Photo 36

# MANHATTAN BEACH LOT 3 PARKING STRUCTURE

## APPENDIX A3 -PHOTO LOG



PROJECT #37-8377.00



Photo 37

Previous patchwork and spalls seen in curb.



Photo 38

Spall in curb at shear stud location. Corrosion can also be seen in the supporting steel beam.

# MANHATTAN BEACH LOT 3 PARKING STRUCTURE

## APPENDIX A3 -PHOTO LOG



PROJECT #37-8377.00



Spalls in curb at shear stud locations.

Photo 39



Spalls in curb at shear stud locations.

Photo 40

PROJECT #37-8377.00



Photo 41

Spalls in curb at shear stud locations.

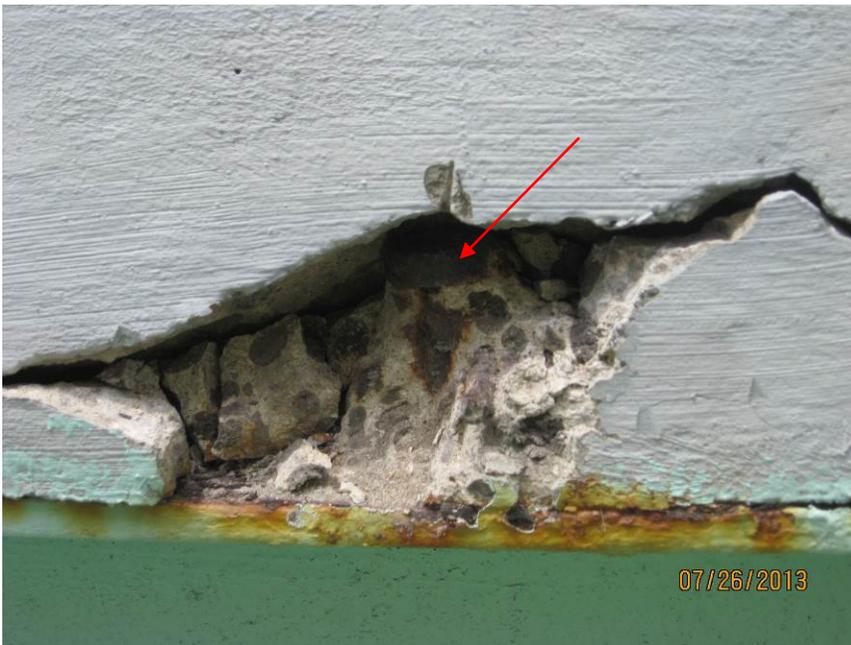


Photo 42

Closeup of a spall at a shear stud location. The shear stud itself is exposed in this photograph.

PROJECT #37-8377.00



Photo 43

Spalling in the curb at the anchoring point of a roof level light post.

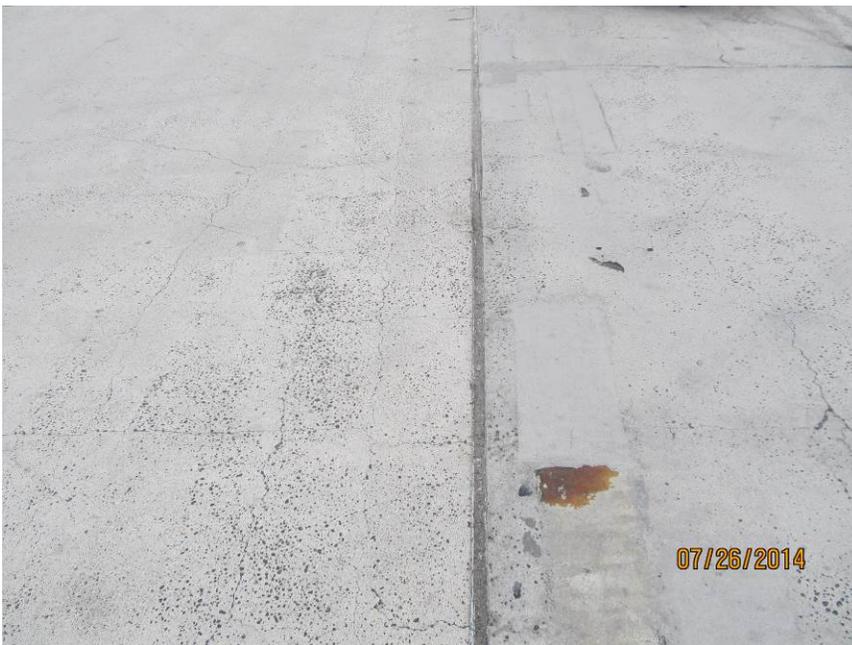


Photo 44

Typical control joint seen on the roof level.

PROJECT #37-8377.00



Typical control joints on the second level.

Photo 45



Close up of the deteriorated control joint sealant.

Photo 46

PROJECT #37-8377.00



Photo 47

Efflorescence in the second level ceiling, a sign of active leakage through the slab.



Photo 48

Efflorescence in the second level ceiling, a sign of active leakage through the slab.

PROJECT #37-8377.00



Photo 49

Efflorescence in the second level ceiling, a sign of active leakage through the slab.



Photo 50

Efflorescence in the second level ceiling, a sign of active leakage through the slab.

PROJECT #37-8377.00



Photo 51

Efflorescence in the second level ceiling, a sign of active leakage through the slab.



Photo 52

East stairs.

PROJECT #37-8377.00



Photo 53

East stairs.



Photo 54

Steel connectors at the underside of the metal tread stairs showing signs of corrosion.

PROJECT #37-8377.00



Photo 55

Steel connectors at the underside of the metal tread stairs showing signs of deterioration.



Photo 56

Damaged concrete at to stair connection to roof level slab.

PROJECT #37-8377.00



Photo 57

Deteriorated expansion joint at second level entry to west stairs.



Photo 58

Deteriorating steel stair connection plate.

# MANHATTAN BEACH LOT 3 PARKING STRUCTURE

## APPENDIX A3 -PHOTO LOG



PROJECT #37-8377.00



Deteriorating base plates (at posts supporting west stairs).

Photo 59



Corroded lighting fixture.

Photo 60

PROJECT #37-8377.00



Photo 61

Corroded lighting fixture missing bulb.



Photo 62

Typical roof level lighting fixture.

PROJECT #37-8377.00



Photo 63

Standpipe adjacent to the east stairs.



Photo 64

Drain located on southwest corner of roof level.

PROJECT #37-8377.00



Photo 65

Down spout from third level drain feeding into second level drain.



Photo 66

Termination of downspout at ground level.

# MANHATTAN BEACH LOT 3 PARKING STRUCTURE

## APPENDIX A3 -PHOTO LOG



PROJECT #37-8377.00



Photo 67

Corroded anchor plate at base of railing.



Photo 68

Corroded anchor plate at base of railing.

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Photo 69

Corroded base of a perimeter steel pipe column showing early signs section loss.



Photo 70

Steel jacket previously installed at base of steel pipe column.

# MANHATTAN BEACH LOT 3 PARKING STRUCTURE

## APPENDIX A3 -PHOTO LOG



PROJECT #37-8377.00



Photo 71

Typical steel column concrete enclosure that requires new paint.



Photo 72

Opening on second level to adjacent lot (not owned by city).

PROJECT #37-8377.00



Photo 73

Deteriorated expansion joint at opening to adjacent property.



Photo 74

Deteriorated expansion joint at opening to adjacent property.

PROJECT #37-8377.00



Photo 75

View of expansion joint and gate from adjacent property.

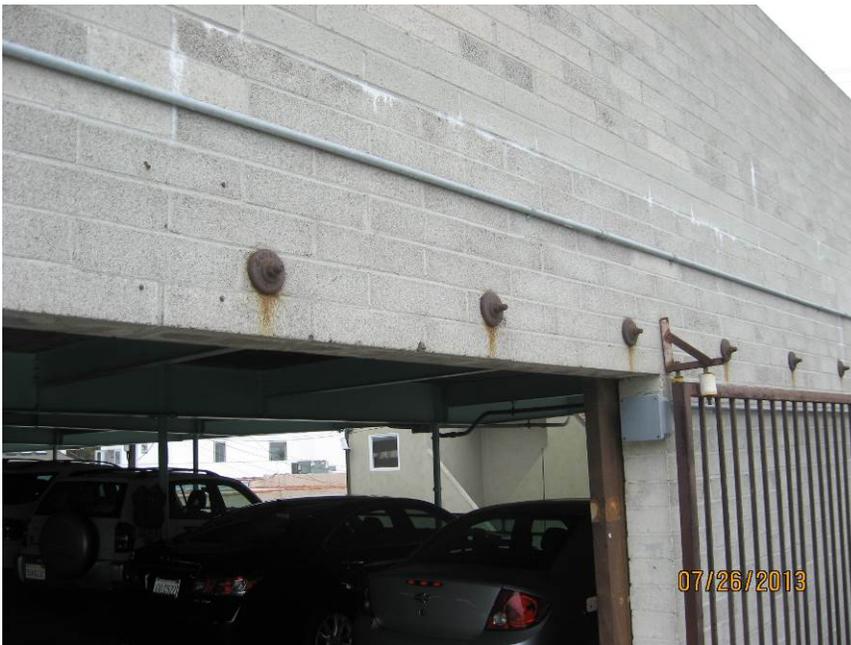


Photo 76

Gate anchors showing signs of corrosion.

PROJECT #37-8377.00



Photo 77

Makeshift signage above opening to adjacent property.



Photo 78

Mechanical/Plumbing lines running along second level ceiling.

# MANHATTAN BEACH LOT 3 PARKING STRUCTURE

## APPENDIX A3 -PHOTO LOG



PROJECT #37-8377.00



Pedestrian handrail  
damaged from vehicle  
impact.

Photo 79



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APPENDIX A4

PHOTO LOG: LOT 4  
PARKING STRUCTURE

# MANHATTAN BEACH LOT 4 PARKING STRUCTURE

## APPENDIX B4 -PHOTO LOG



PROJECT #37-8377.00



Street view from corner of Rosecranes Ave. and Highland Ave.

Photo 1



Street view from corner of 38<sup>th</sup> Pl. and Highland Ave.

Photo 2

# MANHATTAN BEACH LOT 4 PARKING STRUCTURE

## APPENDIX B4 -PHOTO LOG



PROJECT #37-8377.00



Lower level facing northeast.

Photo 3



Upper level facing north.

Photo 4

# MANHATTAN BEACH LOT 4 PARKING STRUCTURE

## APPENDIX B4 -PHOTO LOG



PROJECT #37-8377.00



Gated area on first level.

Photo 5



Typical credit card parking meter on upper level.

Photo 6

# MANHATTAN BEACH LOT 4 PARKING STRUCTURE

## APPENDIX B4 -PHOTO LOG



PROJECT #37-8377.00



Photo 7

Typical wall mounted coin-only parking meter on lower level.

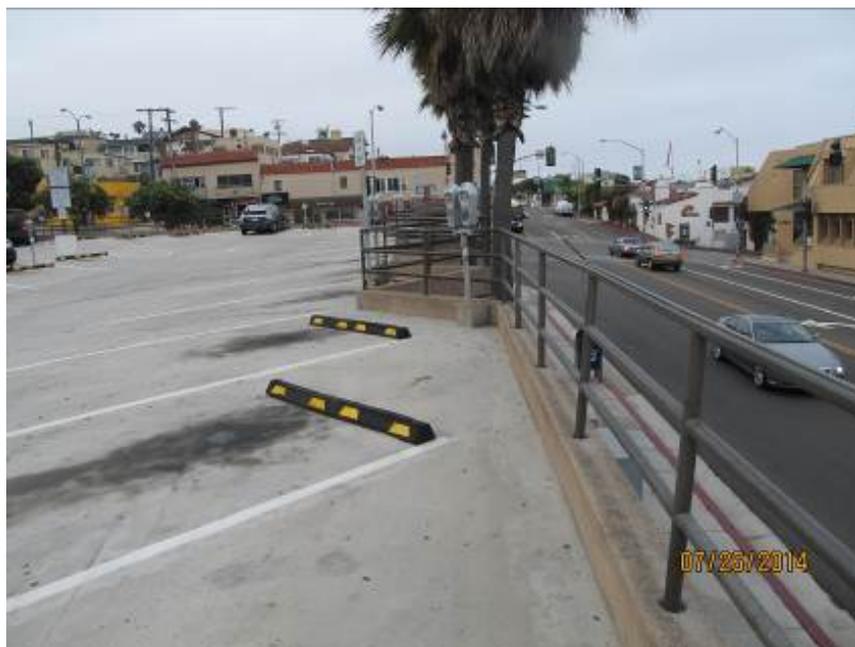


Photo 8

Vehicular Barriers on the east side of the upper level.

# MANHATTAN BEACH LOT 4 PARKING STRUCTURE

## APPENDIX B4 -PHOTO LOG



PROJECT #37-8377.00



Photo 9

The spacing between horizontal members of barrier rails was measured to be 10". Current code limits this spacing to 4".



Photo 10

Vehicular barriers on the north side of the upper level.

# MANHATTAN BEACH LOT 4 PARKING STRUCTURE

## APPENDIX B4 -PHOTO LOG



PROJECT #37-8377.00



"Zig-zag" pattern of barrier rails on upper level.

Photo 11



Cracking in concrete curb at rail mount location.

Photo 12

PROJECT #37-8377.00



Photo 13

Cracking in concrete curb at rail mount location.



Photo 14

Cracking in perimeter concrete curb seen at various locations. The curb can also be seen unsealed and separating from the elevated slab.

PROJECT #37-8377.00



Photo 15

Spalled concrete in ceiling, which has exposed embedded reinforcement.



Photo 16

Spalled concrete in ceiling, which has exposed embedded reinforcement.

PROJECT #37-8377.00



Photo 17

Spalled concrete and cracking in the ceiling.



Photo 18

Exposed and deteriorated conduit due to spalled concrete in the ceiling.

# MANHATTAN BEACH LOT 4 PARKING STRUCTURE

## APPENDIX B4 -PHOTO LOG



PROJECT #37-8377.00



Spalled concrete and extensive efflorescence in the ceiling.

Photo 19



Large floor cracks running parallel to beams below.

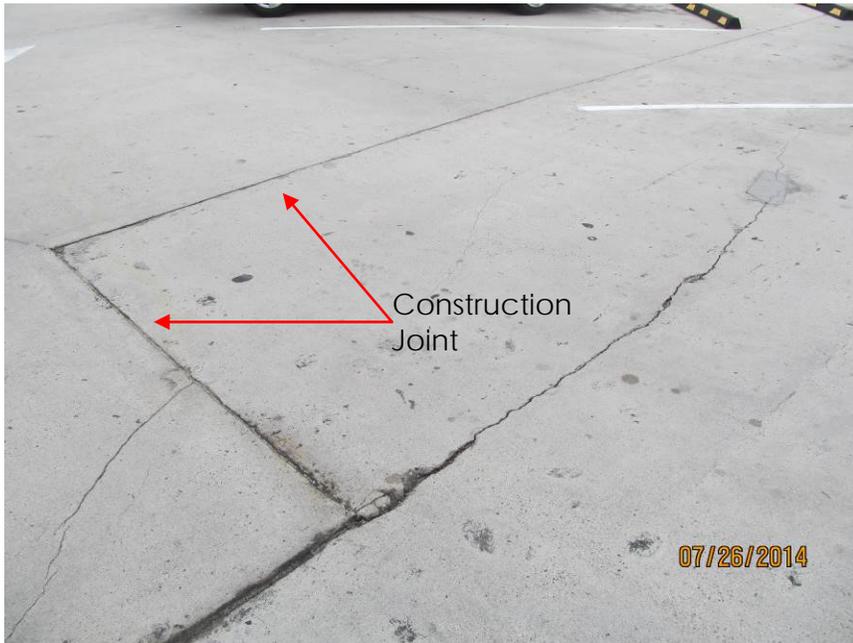
Photo 20

# MANHATTAN BEACH LOT 4 PARKING STRUCTURE

## APPENDIX B4 -PHOTO LOG



PROJECT #37-8377.00



Large crack seen extending from the construction joint.

Photo 21



Typical floor cracks on the upper level.

Photo 22

PROJECT #37-8377.00



Photo 23

Typical floor cracks on the upper level.



Photo 24

Large crack seen in a drop panel.

PROJECT #37-8377.00



Photo 25

Spalling and cracking at the base of a column.

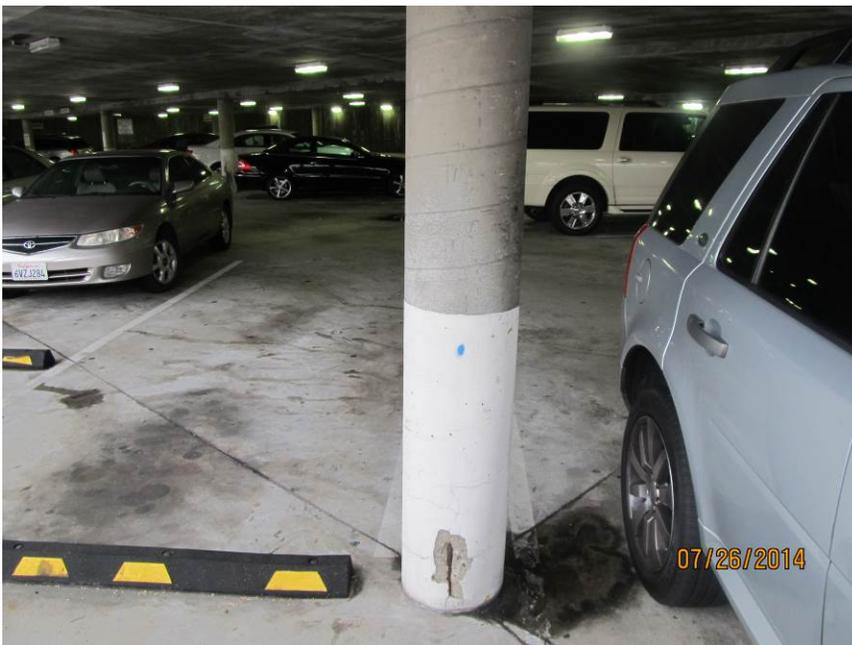
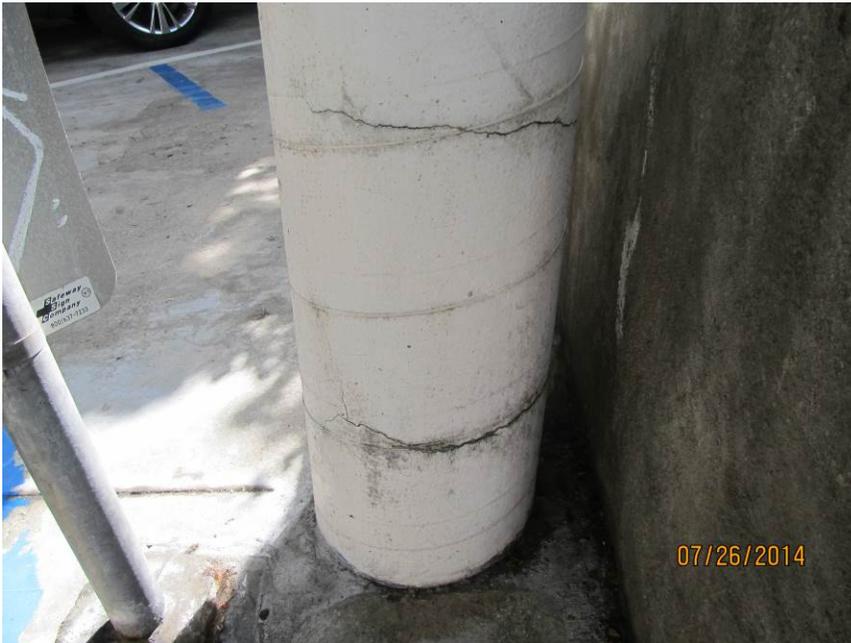


Photo 26

Spalling at the base of a column.

PROJECT #37-8377.00



Cracking in a perimeter column.

Photo 27



Extensive cracking in the curb adjacent to a planter.

Photo 28

PROJECT #37-8377.00



Photo 29

Extensive cracking in the curb adjacent to a planter.



Photo 30

Damage in concrete curb adjacent to a planter.

PROJECT #37-8377.00



Photo 31

Signs of active leakage surrounding concrete drain enclosure (yellow).

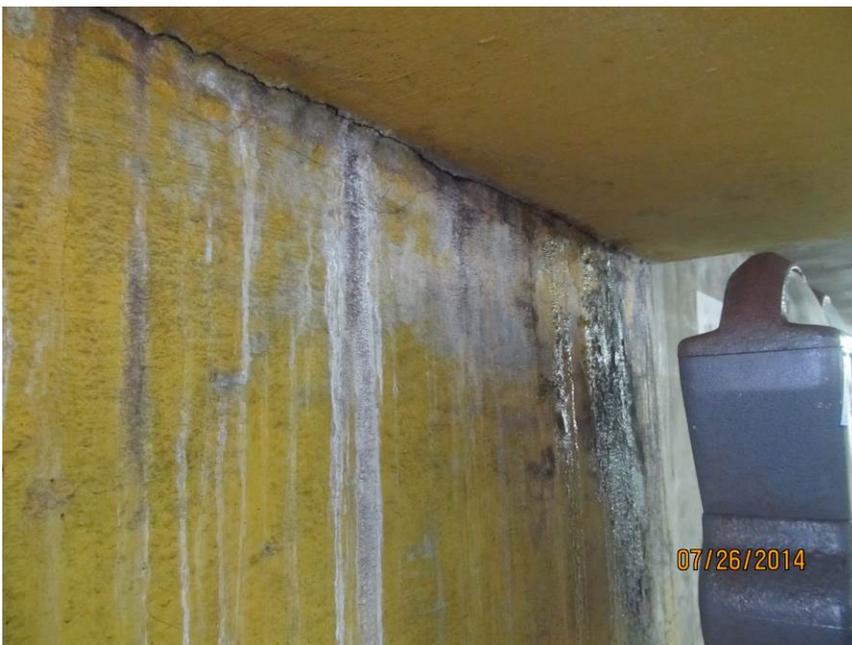


Photo 32

Concrete drain enclosure exhibiting signs of active leakage.

PROJECT #37-8377.00



Photo 33

Extensive cracking in the concrete drain enclosure.



Photo 34

Extensive cracking and active leakage in the concrete drain enclosure.

PROJECT #37-8377.00



Photo 35

Extensive cracking and active leakage in the concrete drain enclosure.



Photo 36

Cracking in the concrete wall near the drain enclosure.

PROJECT #37-8377.00



Photo 37

Staining showing active water infiltration through a concrete retaining wall.



Photo 38

Staining showing active water infiltration through a concrete retaining wall.

PROJECT #37-8377.00



Photo 39

Damaged concrete due to moisture infiltration through the retaining wall.



Photo 40

Damaged concrete due to moisture infiltration through the retaining wall.

PROJECT #37-8377.00

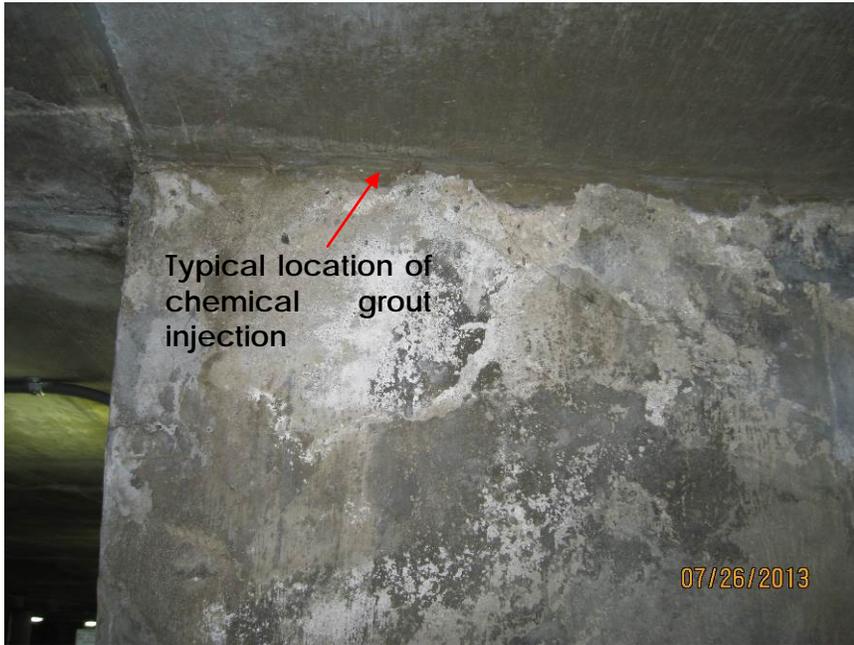


Photo 41

Damaged skim coat due to moisture infiltration through the retaining wall.

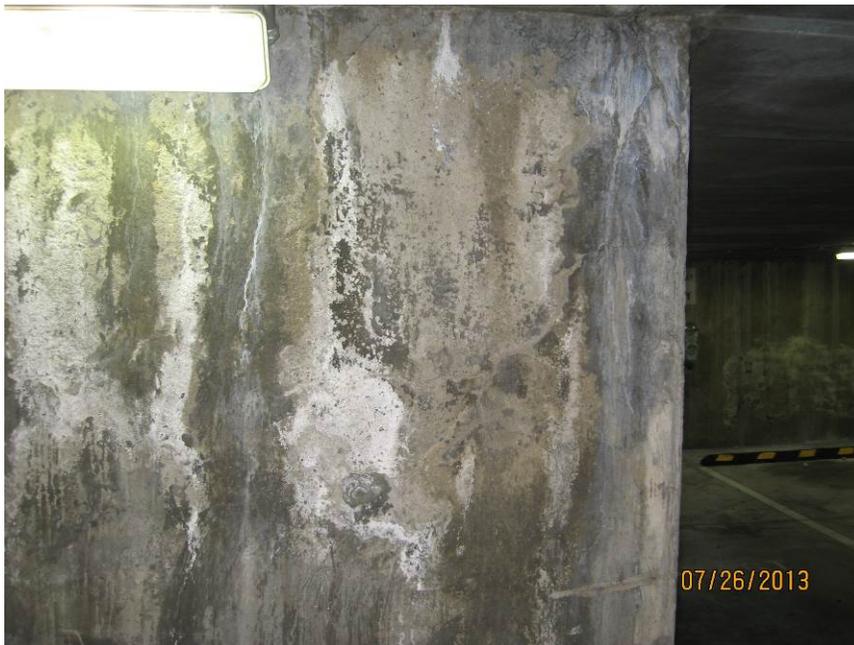


Photo 42

Damaged skim coat due to moisture infiltration through the retaining wall.

PROJECT #37-8377.00



Photo 43

Signs of active leakage through a crack in the ceiling.



Photo 44

Active leakage below the location of the construction joint.

PROJECT #37-8377.00



Photo 45

Upper level drain.



Photo 46

Water from nearby sprinklers observed to be properly sloping towards the drain.

# MANHATTAN BEACH LOT 4 PARKING STRUCTURE

## APPENDIX B4 -PHOTO LOG



PROJECT #37-8377.00



Photo 47

Water from sprinklers collecting near the unsealed joint between the curb and the slab.



Photo 48

Deteriorated sealant at cold joint between curb and floor slab.

PROJECT #37-8377.00



Photo 49

Staining around the perimeter of the ceiling.



Photo 50

Cracking seen in perimeter curb/façade.

# MANHATTAN BEACH LOT 4 PARKING STRUCTURE

## APPENDIX B4 -PHOTO LOG



PROJECT #37-8377.00



Photo 51

Cracking seen in perimeter curb/façade.



Photo 52

Cracking seen in perimeter curb/façade.

# MANHATTAN BEACH LOT 4 PARKING STRUCTURE

## APPENDIX B4 -PHOTO LOG



PROJECT #37-8377.00



Cracking seen in perimeter curb/façade.

Photo 53



Delaminated concrete at base of upper level parking meter.

Photo 54

# MANHATTAN BEACH LOT 4 PARKING STRUCTURE

## APPENDIX B4 -PHOTO LOG



PROJECT #37-8377.00



Typical upper level perimeter parking meter anchoring method.

Photo 55



Vehicular entry to lower level with height restriction signage.

Photo 56

PROJECT #37-8377.00



Photo 57

Electrical panels on lower level.



Photo 58

LED Light fixture with missing cover.

# MANHATTAN BEACH LOT 4 PARKING STRUCTURE

## APPENDIX B4 -PHOTO LOG



PROJECT #37-8377.00



Photo 59

Trip hazard at pedestrian entry to upper level from Rosecrans Ave.



Photo 60

Trip hazard at pedestrian entry to upper level from Rosecrans Ave.

PROJECT #37-8377.00



Photo 61

Typical tire marks and streaks from vehicles coming in contact with columns.



Photo 62

Carbonation testing showing no signs of carbonation throughout the full depth of the slab (pink color indicates no carbonation).

MANHATTAN BEACH LOT 4 PARKING STRUCTURE

APPENDIX B4 -PHOTO LOG



PROJECT #37-8377.00

Photo 63

Unsealed cove joints and corrosion on steel embed plate.

Photo 64

Unsealed control joint.

MANHATTAN BEACH LOT 4 PARKING STRUCTURE

APPENDIX B4 -PHOTO LOG



PROJECT #37-8377.00

Photo 65

Unsealed saw-cut joint.

Photo 66

Prep work for chloride content and carbonation testing.



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APPENDIX B2

TIER 1 SEISMIC  
CHECKLISTS AND  
HAND  
CALCULATIONS:  
LOT 2 PARKING  
STRUCTURE

**3.7.9 Basic Structural Checklist for Building Type C2: Concrete Shear Walls with Stiff Diaphragms**

This Basic Structural Checklist shall be completed where required by Table 3-2.

Each of the evaluation statements on this checklist shall be marked **Compliant (C)**, **Non-compliant (NC)**, or **Not Applicable (N/A)** for a Tier 1 Evaluation. **Compliant statements identify issues that are acceptable according to the criteria of this standard, while non-compliant statements identify issues that require further investigation. Certain statements may not apply to the buildings being evaluated. For non-compliant evaluation statements, the design professional may choose to conduct further investigation using the corresponding Tier 2 Evaluation procedure; corresponding section numbers are in parentheses following each evaluation statement.**

**C3.7.9 Basic Structural Checklist for Building Type C2**

These buildings have floor and roof framing that consists of cast-in-place concrete slabs, concrete beams, one-way joists, two-way waffle joists, or flat slabs. Floors are supported on concrete columns or bearing walls. Lateral forces are resisted by cast-in-place concrete shear walls. In older construction, shear walls are lightly reinforced but often extend throughout the building. In more recent construction, shear walls occur in isolated locations and are more heavily reinforced with boundary elements and closely spaced ties to provide ductile performance. The diaphragms consist of concrete slabs and are stiff relative to the walls. Foundations consist of concrete spread footings, mat foundations, or deep foundations.

**Building System**

- C NC N/A LOAD PATH: The structure shall contain a minimum of one complete load path for Life Safety and Immediate Occupancy for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation. (Tier 2: Sec. 4.3.1.1)
- C NC N/A MEZZANINES: Interior mezzanine levels shall be braced independently from the main structure, or shall be anchored to the lateral-force-resisting elements of the main structure. (Tier 2: Sec. 4.3.1.3)
- C NC N/A WEAK STORY: The strength of the lateral-force-resisting system in any story shall not be less than 80 percent of the strength in an adjacent story, above or below, for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.1)
- C NC N/A SOFT STORY: The stiffness of the lateral-force-resisting system in any story shall not be less than 70 percent of the lateral-force-resisting system stiffness in an adjacent story above or below, or less than 80 percent of the average lateral-force-resisting system stiffness of the three stories above or below for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.2)
- C NC N/A GEOMETRY: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30 percent in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines. (Tier 2: Sec. 4.3.2.3)
- C NC N/A VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. (Tier 2: Sec. 4.3.2.4)
- C NC N/A MASS: There shall be no change in effective mass more than 50 percent from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses, and mezzanines need not be considered. (Tier 2: Sec. 4.3.2.5)

## Screening Phase (Tier 1)

- (C) (NC) N/A TORSION: The estimated distance between the story center of mass and the story center of rigidity shall be less than 20 percent of the building width in either plan dimension for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.6)
- (C) (NC) N/A DETERIORATION OF CONCRETE: There shall be no visible deterioration of concrete or reinforcing steel in any of the vertical- or lateral-force-resisting elements. (Tier 2: Sec. 4.3.3.4)
- (C) (NC) N/A POST-TENSIONING ANCHORS: There shall be no evidence of corrosion or spalling in the vicinity of post-tensioning or end fittings. Coil anchors shall not have been used. (Tier 2: Sec. 4.3.3.5)
- (C) (NC) N/A CONCRETE WALL CRACKS: All existing diagonal cracks in wall elements shall be less than 1/8 inch for Life Safety and 1/16 inch for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern. (Tier 2: Sec. 4.3.3.9)

### Lateral-Force-Resisting System

- (C) (NC) (N/A) COMPLETE FRAMES: Steel or concrete frames classified as secondary components shall form a complete vertical-load-carrying system. (Tier 2: Sec. 4.4.1.6.1)
- (C) (NC) N/A REDUNDANCY: The number of lines of shear walls in each principal direction shall be greater than or equal to 2 for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.1.1)
- (C) (NC) N/A SHEAR STRESS CHECK: The shear stress in the concrete shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than the greater of 100 psi or  $2\sqrt{f'_c}$  for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.2.1)
- (C) (NC) N/A REINFORCING STEEL: The ratio of reinforcing steel area to gross concrete area shall be not less than 0.0015 in the vertical direction and 0.0025 in the horizontal direction for Life Safety and Immediate Occupancy. The spacing of reinforcing steel shall be equal to or less than 16 inches for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.2.2)

### Connections

- (C) (NC) N/A TRANSFER TO SHEAR WALLS: Diaphragms shall be connected for transfer of loads to the shear walls for Life Safety and the connections shall be able to develop the lesser of the shear strength of the walls or diaphragms for Immediate Occupancy. (Tier 2: Sec. 4.6.2.1)
- (C) (NC) N/A FOUNDATION DOWELS: Wall reinforcement shall be doweled into the foundation for Life Safety, and the dowels shall be able to develop the lesser of the strength of the walls or the uplift capacity of the foundation for Immediate Occupancy. (Tier 2: Sec. 4.6.3.5)

### 3.7.9S Supplemental Structural Checklist for Building Type C2: Concrete Shear Walls with Stiff Diaphragms

This Supplemental Structural Checklist shall be completed where required by Table 3-2. The Basic Structural Checklist shall be completed prior to completing this Supplemental Structural Checklist.

#### Lateral-Force-Resisting System

- C NC (N/A) DEFLECTION COMPATIBILITY: Secondary components shall have the shear capacity to develop the flexural strength of the components for Life Safety and shall meet the requirements of Sections 4.4.1.4.9, 4.4.1.4.10, 4.4.1.4.11, 4.4.1.4.12 and 4.4.1.4.15 for Immediate Occupancy. (Tier 2: Sec. 4.4.1.6.2)
- C NC (N/A) FLAT SLABS: Flat slabs/plates not part of lateral-force-resisting system shall have continuous bottom steel through the column joints for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.1.6.3)
- C NC (N/A) COUPLING BEAMS: The stirrups in coupling beams over means of egress shall be spaced at or less than  $d/2$  and shall be anchored into the confined core of the beam with hooks of  $135^\circ$  or more for Life Safety. All coupling beams shall comply with the requirements above and shall have the capacity in shear to develop the uplift capacity of the adjacent wall for Immediate Occupancy. (Tier 2: Sec. 4.4.2.2.3)
- C NC (N/A) OVERTURNING: All shear walls shall have aspect ratios less than 4-to-1. Wall piers need not be considered. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.2.4)
- C NC (N/A) CONFINEMENT REINFORCING: For shear walls with aspect ratios greater than 2-to-1, the boundary elements shall be confined with spirals or ties with spacing less than  $8d_b$ . This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.2.5)
- C NC (N/A) REINFORCING AT OPENINGS: There shall be added trim reinforcement around all wall openings with a dimension greater than three times the thickness of the wall. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.2.6)
- C NC (N/A) WALL THICKNESS: Thickness of bearing walls shall not be less than  $1/25$  the unsupported height or length, whichever is shorter, nor less than 4 inches. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.2.7)

#### Diaphragms

- (C) NC (N/A) DIAPHRAGM CONTINUITY: The diaphragms shall not be composed of split-level floors and shall not have expansion joints. (Tier 2: Sec. 4.5.1.1)
- C NC (N/A) OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls shall be less than 25 percent of the wall length for Life Safety and 15 percent of the wall length for Immediate Occupancy. (Tier 2: Sec. 4.5.1.4)
- C NC (N/A) PLAN IRREGULARITIES: There shall be tensile capacity to develop the strength of the diaphragm at re-entrant corners or other locations of plan irregularities. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.7)
- C NC (N/A) DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragm openings larger than 50 percent of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.8)

Connections

C NC

N/A

UPLIFT AT PILE CAPS: Pile caps shall have top reinforcement and piles shall be anchored to the pile caps for Life Safety, and the pile cap reinforcement and pile anchorage shall be able to develop the tensile capacity of the piles for Immediate Occupancy. (Tier 2: Sec. 4.6.3.10)

### 3.8 Geologic Site Hazards and Foundations Checklist

This Geologic Site Hazards and Foundations Checklist shall be completed where required by Table 3-2.

Each of the evaluation statements on this checklist shall be marked Compliant (C), Non-compliant (NC), or Not Applicable (N/A) for a Tier 1 Evaluation. Compliant statements identify issues that are acceptable according to the criteria of this standard, while non-compliant statements identify issues that require further investigation. Certain statements may not apply to the buildings being evaluated. For non-compliant evaluation statements, the design professional may choose to conduct further investigation using the corresponding Tier 2 Evaluation procedure; corresponding section numbers are in parentheses following each evaluation statement.

#### Geologic Site Hazards

The following statements shall be completed for buildings in levels of high or moderate seismicity.

- C  NC  N/A LIQUEFACTION: Liquefaction-susceptible, saturated, loose granular soils that could jeopardize the building's seismic performance shall not exist in the foundation soils at depths within 50 feet under the building for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.7.1.1)
- C  NC  N/A SLOPE FAILURE: The building site shall be sufficiently remote from potential earthquake-induced slope failures or rockfalls to be unaffected by such failures or shall be capable of accommodating any predicted movements without failure. (Tier 2: Sec. 4.7.1.2)
- C  NC  N/A SURFACE FAULT RUPTURE: Surface fault rupture and surface displacement at the building site is not anticipated. (Tier 2: Sec. 4.7.1.3)

#### Condition of Foundations

The following statement shall be completed for all Tier 1 building evaluations.

- C  NC  N/A FOUNDATION PERFORMANCE: There shall be no evidence of excessive foundation movement such as settlement or heave that would affect the integrity or strength of the structure. (Tier 2: Sec. 4.7.2.1)

The following statement shall be completed for buildings in levels of high or moderate seismicity being evaluated to the Immediate Occupancy Performance Level.

- C  NC  N/A DETERIORATION: There shall not be evidence that foundation elements have deteriorated due to corrosion, sulfate attack, material breakdown, or other reasons in a manner that would affect the integrity or strength of the structure. (Tier 2: Sec. 4.7.2.2)

#### Capacity of Foundations

The following statement shall be completed for all Tier 1 building evaluations.

- C  NC  N/A POLE FOUNDATIONS: Pole foundations shall have a minimum embedment depth of 4 feet for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.7.3.1)

The following statements shall be completed for buildings in levels of moderate seismicity being evaluated to the Immediate Occupancy Performance Level and for buildings in levels of high seismicity.

- C  NC  N/A OVERTURNING: The ratio of the horizontal dimension of the lateral-force-resisting system at the foundation level to the building height (base/height) shall be greater than  $0.6S_w$ . (Tier 2: Sec. 4.7.3.2)

$b/h = 96' / 10' = 9.6$

$0.6 S_w = 0.6(1.184) = 0.7 \text{ OK } \checkmark$

Screening Phase (Tier 1)

- |          |    |     |  |
|----------|----|-----|--|
| <b>C</b> | NC | N/A | TIES BETWEEN FOUNDATION ELEMENTS: The foundation shall have ties adequate to resist seismic forces where footings, piles, and piers are not restrained by beams, slabs, or soils classified as Class A, B, or C. (Section 3.5.2.3.1, Tier 2; Sec. 4.7.3.3) |
| C        | NC | N/A | DEEP FOUNDATIONS: Piles and piers shall be capable of transferring the lateral forces between the structure and the soil. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2; Sec. 4.7.3.4)                             |
| C        | NC | N/A | SLOPING SITES: The difference in foundation embedment depth from one side of the building to another shall not exceed one story in height. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2; Sec. 4.7.3.5)            |

### 3.9.1 Basic Nonstructural Component Checklist

This Basic Nonstructural Component Checklist shall be completed where required by Table 3-2.

Each of the evaluation statements on this checklist shall be marked **Compliant (C)**, **Non-compliant (NC)**, or **Not Applicable (N/A)** for a Tier 1 Evaluation. **Compliant statements** identify issues that are acceptable according to the criteria of this standard, while **non-compliant statements** identify issues that require further investigation. Certain statements may not apply to the buildings being evaluated. For non-compliant evaluation statements, the design professional may choose to conduct further investigation using the corresponding Tier 2 Evaluation procedure; corresponding section numbers are in parentheses following each evaluation statement.

#### Partitions

- C NC **(N/A)** **UNREINFORCED MASONRY:** Unreinforced masonry or hollow clay tile partitions shall be braced at a spacing equal to or less than 10 feet in levels of low or moderate seismicity and 6 feet in levels of high seismicity. (Tier 2: Sec. 4.8.1.1)

#### Ceiling Systems

- C NC **(N/A)** **SUPPORT:** The integrated suspended ceiling system shall not be used to laterally support the tops of gypsum board, masonry, or hollow clay tile partitions. Gypsum board partitions need not be evaluated where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.2.1)

#### Light Fixtures

- C NC **(N/A)** **EMERGENCY LIGHTING:** Emergency lighting shall be anchored or braced to prevent falling during an earthquake. (Tier 2: Sec. 4.8.3.1)

#### Cladding and Glazing

- C NC **(N/A)** **CLADDING ANCHORS:** Cladding components weighing more than 10 psf shall be mechanically anchored to the exterior wall framing at a spacing equal to or less than 4 feet. A spacing of up to 6 feet is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.4.1)
- C NC **(N/A)** **DETERIORATION:** There shall be no evidence of deterioration, damage or corrosion in any of the connection elements. (Tier 2: Sec. 4.8.4.2)
- C NC **(N/A)** **CLADDING ISOLATION:** For moment frame buildings of steel or concrete, panel connections shall be detailed to accommodate a story drift ratio of 0.02. Panel connection detailing for a story drift ratio of 0.01 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.4.3)
- C NC **(N/A)** **MULTI-STORY PANELS:** For multi-story panels attached at each floor level, panel connections shall be detailed to accommodate a story drift ratio of 0.02. Panel connection detailing for a story drift ratio of 0.01 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.4.4)
- C NC **(N/A)** **BEARING CONNECTIONS:** Where bearing connections are required, there shall be a minimum of two bearing connections for each wall panel. (Tier 2: Sec. 4.8.4.5)

## Screening Phase (Tier 1)

- C NC (N/A) INSERTS: Where inserts are used in concrete connections, the inserts shall be anchored to reinforcing steel or other positive anchorage. (Tier 2: Sec. 4.8.4.6)
- C NC (N/A) PANEL CONNECTIONS: Exterior cladding panels shall be anchored out-of-plane with a minimum of 4 connections for each wall panel. Two connections per wall panel are permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.4.7)

### Masonry Veneer

- C NC (N/A) SHELF ANGLES: Masonry veneer shall be supported by shelf angles or other elements at each floor 30 feet or more above ground for Life Safety and at each floor above the first floor for Immediate Occupancy. (Tier 2: Sec. 4.8.5.1)
- C NC (N/A) TIES: Masonry veneer shall be connected to the back-up with corrosion-resistant ties. The ties shall have a spacing equal to or less than 24 inches with a minimum of one tie for every 2-2/3 square feet. A spacing of up to 36 inches is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.5.2)
- C NC (N/A) WEAKENED PLANES: Masonry veneer shall be anchored to the back-up adjacent to weakened planes, such as at the locations of flashing. (Tier 2: Sec. 4.8.5.3)
- C NC (N/A) DETERIORATION: There shall be no evidence of deterioration, damage, or corrosion in any of the connection elements. (Tier 2: Sec. 4.8.5.4)

### Parapets, Cornices, Ornamentation, and Appendages

- C NC (N/A) URM PARAPETS: There shall be no laterally unsupported unreinforced masonry parapets or cornices with height-to-thickness ratios greater than 1.5. A height-to-thickness ratio of up to 2.5 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.8.1)
- C NC (N/A) CANOPIES: Canopies located at building exits shall be anchored to the structural framing at a spacing of 6 feet or less. An anchorage spacing of up to 10 feet is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.8.2)

### Masonry Chimneys

- C NC (N/A) URM CHIMNEYS: No unreinforced masonry chimney shall extend above the roof surface more than twice the least dimension of the chimney. A height above the roof surface of up to three times the least dimension of the chimney is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.9.1)

### Stairs

- C NC (N/A) URM WALLS: Walls around stair enclosures shall not consist of unbraced hollow clay tile or unreinforced masonry with a height-to-thickness ratio greater than 12-to-1. A height-to-thickness ratio of up to 15-to-1 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.10.1)
- C NC (N/A) STAIR DETAILS: In moment frame structures, the connection between the stairs and the structure shall not rely on shallow anchors in concrete. Alternatively, the stair details shall be capable of accommodating the drift calculated using the Quick Check procedure of Section 3.5.3.1 without including tension in the anchors. (Tier 2: Sec. 4.8.10.2)

**Building Contents and Furnishing**

- C NC (N/A) TALL NARROW CONTENTS: Contents over 4 feet in height with a height-to-depth or height-to-width ratio greater than 3-to-1 shall be anchored to the floor slab or adjacent structural walls. A height-to-depth or height-to-width ratio of up to 4-to-1 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.11.1)

**Mechanical and Electrical Equipment**

- C NC (N/A) EMERGENCY POWER: Equipment used as part of an emergency power system shall be mounted to maintain continued operation after an earthquake. (Tier 2: Sec. 4.8.12.1)
- C NC (N/A) HAZARDOUS MATERIAL EQUIPMENT: HVAC or other equipment containing hazardous material shall not have damaged supply lines or unbraced isolation supports. (Tier 2: Sec. 4.8.12.2)
- C NC (N/A) DETERIORATION: There shall be no evidence of deterioration, damage, or corrosion in any of the anchorage or supports of mechanical or electrical equipment. (Tier 2: Sec. 4.8.12.3)
- C NC (N/A) ATTACHED EQUIPMENT: Equipment weighing over 20 lb that is attached to ceilings, walls, or other supports 4 feet above the floor level shall be braced. (Tier 2: Sec. 4.8.12.4)

**Piping**

- C NC (N/A) FIRE SUPPRESSION PIPING: Fire suppression piping shall be anchored and braced in accordance with NFPA-13 (NFPA, 1996). (Tier 2: Sec. 4.8.13.1)
- C NC (N/A) FLEXIBLE COUPLINGS: Fluid, gas, and fire suppression piping shall have flexible couplings. (Tier 2: Sec. 4.8.13.2)

**Hazardous Materials Storage and Distribution**

- C NC (N/A) TOXIC SUBSTANCES: Toxic and hazardous substances stored in breakable containers shall be restrained from falling by latched doors, shelf lips, wires, or other methods. (Tier 2: Sec. 4.8.15.1)

### 3.9.2 Intermediate Nonstructural Component Checklist

This Intermediate Nonstructural Component Checklist shall be completed where required by Table 3-2. The Basic Nonstructural Component Checklist shall be completed prior to completing this Intermediate Nonstructural Component Checklist.

#### Ceiling Systems

- C NC **N/A** LAY-IN TILES: Lay-in tiles used in ceiling panels located at exits and corridors shall be secured with clips. (Tier 2: Sec. 4.8.2.2)
- C NC **N/A** INTEGRATED CEILINGS: Integrated suspended ceilings at exits and corridors or weighing more than 2 pounds per square foot shall be laterally restrained with a minimum of four diagonal wires or rigid members attached to the structure above at a spacing equal to or less than 12 feet. (Tier 2: Sec. 4.8.2.3)
- C NC **N/A** SUSPENDED LATH AND PLASTER: Ceilings consisting of suspended lath and plaster or gypsum board shall be attached to resist seismic forces for every 12 square feet of area. (Tier 2: Sec. 4.8.2.4)

#### Light Fixtures

- C NC **N/A** INDEPENDENT SUPPORT: Light fixtures in suspended grid ceilings shall be supported independently of the ceiling suspension system by a minimum of two wires at diagonally opposite corners of the fixtures. (Tier 2: Sec. 4.8.3.2)

#### Cladding and Glazing

- C NC **N/A** GLAZING: Glazing in curtain walls and individual panes over 16 square feet in area, located up to a height of 10 feet above an exterior walking surface, shall have safety glazing. Such glazing located over 10 feet above an exterior walking surface shall be laminated annealed or laminated heat-strengthened safety glass or other glazing system that will remain in the frame when glass is cracked. (Tier 2: Sec. 4.8.4.8)

#### Parapets, Cornices, Ornamentation, and Appendages

- C NC **N/A** CONCRETE PARAPETS: Concrete parapets with height-to-thickness ratios greater than 2.5 shall have vertical reinforcement. (Tier 2: Sec. 4.8.8.3)
- C NC **N/A** APPENDAGES: Cornices, parapets, signs, and other appendages that extend above the highest point of anchorage to the structure or cantilever from exterior wall faces and other exterior wall ornamentation shall be reinforced and anchored to the structural system at a spacing equal to or less than 10 feet for Life Safety and 6 feet for Immediate Occupancy. This requirement need not apply to parapets or cornices compliant with Section 4.8.8.1 or 4.8.8.3. (Tier 2: Sec. 4.8.8.4)

#### Masonry Chimneys

- C NC **N/A** ANCHORAGE: Masonry chimneys shall be anchored at each floor level and the roof. (Tier 2: Sec. 4.8.9.2)

**Mechanical and Electrical Equipment**

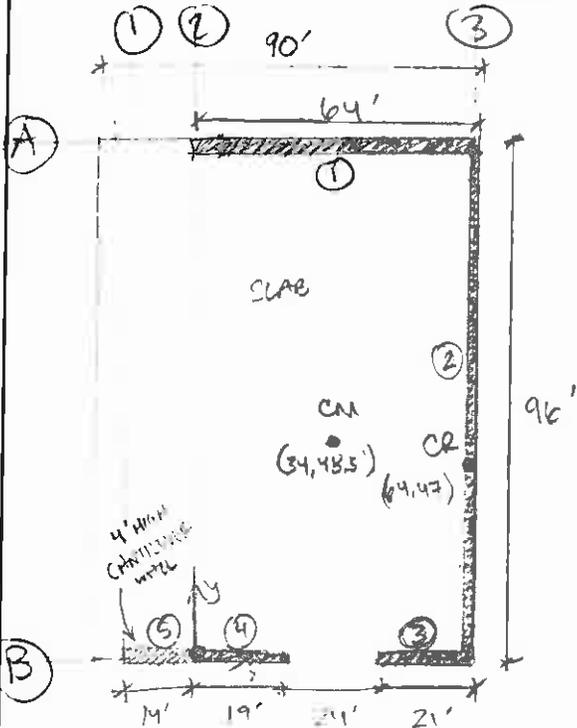
- C NC **N/A** VIBRATION ISOLATORS: Equipment mounted on vibration isolators shall be equipped with restraints or snubbers. (Tier 2: Sec. 4.R.12.5)

**Ducts**

- C NC **N/A** STAIR AND SMOKE DUCTS: Stair pressurization and smoke control ducts shall be braced and shall have flexible connections at seismic joints. (Tier 2: Sec. 4.8.14.1)



PARKING STRUCTURE #2 - TORSION CHECK.



DENSITY OF CONCRETE: 150 lb/ft<sup>3</sup>  
THICKNESS OF SLAB: 5"  
THICKNESS OF WALLS: 8"  
HEIGHT OF WALLS: 9' (EXCEPT FOR  
CANTILEVER)

MASS	RIGIDITY
$M_1 = 576$ kips	$R_1 = 24$
$M_2 = 86.4$	$R_2 = 35$
$M_3 = 18.9$	$R_3 = 7$
$M_4 = 17.1$	$R_4 = 7$
$M_5 = 5.6$	$R_5 = 11$
$M_{SLAB} = 1296$	

$$Y_{CM} = \frac{86.4 \times 64 + 1296 \times 52}{86.4 + 1296} = 34$$

$$Y_{CR} = \frac{57.6 \times 96 + 18.9 + 17.1 + 5.6 + 0 + 1296 \times 48}{57.6 + 18.9 + 17.1 + 5.6 + 1296} = 48.5'$$

$$X_{CR} = \frac{35 \times 64}{35} = 64'$$

$$Y_{CR} = \frac{24 \times 96 + (7+7+11) \times 0}{24+7+7+11} = 47'$$

EST. DISTANCE BETWEEN CM + CR > 0.2 x 9  
(= 30') > (18')

∴ NOT COMPLIANT FOR TORSION

→ LEVEL 2 SLIGHT CHECK RECOMMENDED.



### PARKING STRUCTURE #2

• PSEUDO-LATERAL FORCE (SEC. 3.5.2.1 ASCE 31-03)

$$V = C S_a W$$

$$C = 1.4 \text{ PER TABLE 3-4 (1 STORY)}$$

$$S_a = S_{D1} / T \text{ BUT NOT } > S_{D5}$$

$$S_{D5} = 1.184$$

$$S_{D1} = 0.726$$

$$T = C_t h_n \beta$$

$$C_t = 0.020, \beta = 0.75, h = 10'$$

$$T = 0.02(10)(0.75) = 0.15 \text{ SEC}$$

$$S_a = S_{D1} / T = 0.726 / 0.15 = 4.84 > S_{D5} = 1.184$$

$$\therefore S_a = 1.184$$

$$V = C S_a W = 1.4(1.184)W$$

$$V = \underline{\underline{2.576W}}$$



PARKING STRUCTURE 2 - SHEAR STRESS CHECK

PER SEC. 3.5.3.2, SHALL BE LESS THAN

GREATER OF 100 psi OR  $2\sqrt{f'_c} = 109.5$  psi  
(ASSUME  $f'_c = 3000$  psi)  $\therefore$  100 psi is limit.

$$v_j^{avg} = \frac{1}{n} \left( \frac{V_j}{A_w} \right) \quad (\text{EQ 3-12}) \quad m = 4.0 \text{ (TABLE 3-7)}$$

$V_j$  = STORY SHEAR PER 3.5.2.2

$$\hookrightarrow F_x = \frac{w_x h_x^k}{\sum w_i h_i^k} V$$

BUILDING WEIGHT =  $W = 1476$  kips (SLAB + WALLS)

$$V = C_S W = 1.658 (1476) = 2446 \text{ kips}$$

$$F_x = V = 2446 \text{ kips (one story structure)}$$

WALL AREAS

E-W DIRECTION	①	$A_1 = 8' \times 64' = 514 \text{ in}^2$	(E-W) $\rightarrow$ 6.5%
	②	$A_2 = 8' \times 21' = 168 \text{ in}^2$	(E-W) $\rightarrow$ 2.0%
	③	$A_3 = 8' \times 19' = 152 \text{ in}^2$	(E-W) $\rightarrow$ 1.8%
		<u>9984 in<sup>2</sup></u>	

N-S DIRECTION ④  $A_4 = 8' \times 96' = 768 \text{ in}^2$  (N-S)  $\rightarrow$  100%

E-W  $v_1^{avg} = 61.3$  psi  $<$  100 psi

E-W  $v_2^{avg} = 61.2$  psi  $<$  100 psi

E-W  $v_3^{avg} = 61.3$  psi  $<$  100 psi

N-S  $v_4^{avg} = 66.4$  psi  $<$  100 psi

• COMPLIANT FOR  
• SHEAR STRESS.



PARKING STRUCTURE #2 - REINFORCING STEEL CHECK

LIMITS:  $A_s/A_c \geq 0.0015$  IN VERTICAL

$A_c/A_c \geq 0.0025$  IN HORIZONTAL

WALL (1):  $A_{c1} = 6144 \text{ in}^2$  (HORIZ.),  $864 \text{ in}^2$  (VERT.)  
(64')

#4 @ 10" O.C. HORIZ.  $\cdot 0.2 \times 11 = 2.16 \text{ in}^2$

#5 @ 18" O.C. VERT.  $\cdot 0.31 \times 43 = 13.3 \text{ in}^2$

$$\frac{A_s}{A_c} = 0.0025 = 0.0025 \text{ IN HORIZ. OK}$$

$$= 0.0022 > 0.0015 \text{ IN VERT. OK}$$

WALL (3):  $A_{c1} = 2016 \text{ in}^2$  (HORIZ.),  $864 \text{ in}^2$  (VERT.)  
(21')

SAME REINFORCEMENT CRITERIA

#4 @ 10" O.C. HORIZ.  $\cdot 0.2 \times 11 = 2.16 \text{ in}^2$

#5 @ 18" O.C. VERT.  $\cdot 0.31 \times 14 = 4.31 \text{ in}^2$

$$A_s/A_c \text{ (HORIZ.)} = 0.0025 \text{ OK}$$

$$A_s/A_c \text{ (VERT.)} = 0.0021 \text{ OK}$$

WALL (4):  $A_{c1} = 1824 \text{ in}^2$   
(19')

$$A_s/A_c \text{ (HORIZ.)} = 0.0025 \text{ OK}$$

$$A_s/A_c \text{ (VERT.)} = (0.31 \times 13) / 1824 = 0.0022 \text{ OK}$$

WALL (2):  $A_{c1} = 9216 \text{ in}^2$   
(36')

$$A_s/A_c \text{ (HORIZ.)} = 0.0025 \text{ OK}$$

$$A_s/A_c \text{ (VERT.)} = (0.31 \times 64) / 9216 = 0.0022 \text{ OK}$$



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APPENDIX B3

TIER 1 SEISMIC  
CHECKLISTS AND  
HAND  
CALCULATIONS:  
LOT 3 PARKING  
STRUCTURE

### 3.7.4 Basic Structural Checklist for Building Type S2: Steel Braced Frames with Stiff Diaphragms

E-W DIRECTION

This Basic Structural Checklist shall be completed where required by Table 3-2.

Each of the evaluation statements on this checklist shall be marked Compliant (C), Non-compliant (NC), or Not Applicable (N/A) for a Tier 1 Evaluation. Compliant statements identify issues that are acceptable according to the criteria of this standard, while non-compliant statements identify issues that require further investigation. Certain statements may not apply to the buildings being evaluated. For non-compliant evaluation statements, the design professional may choose to conduct further investigation using the corresponding Tier 2 Evaluation procedure; corresponding section numbers are in parentheses following each evaluation statement.

#### C3.7.4 Basic Structural Checklist for Building Type S2

These buildings have a frame of steel columns, beams, and braces. Braced frames develop resistance to lateral forces by the bracing action of the diagonal members. The braces induce forces in the associated beams and columns such that all elements work together in a manner similar to a truss with all element stresses being primarily axial. Where the braces do not completely triangulate the panel, some of the members are subjected to shear and flexural stresses; eccentrically braced frames are one such case (refer to Sec. 4.4.3.3). Diaphragms transfer lateral loads to braced frames. The diaphragms consist of concrete or metal deck with concrete fill and are stiff relative to the frames.

#### Building System

- |     |      |       |  |
|-----|------|-------|--|
| (C) | NC   | N/A   | <b>LOAD PATH:</b> The structure shall contain a minimum of one complete load path for Life Safety and Immediate Occupancy for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation. (Tier 2: Sec. 4.3.1.1)  |
| (C) | NC   | N/A   | <b>ADJACENT BUILDINGS:</b> The clear distance between the building being evaluated and any adjacent building shall be greater than 4 percent of the height of the shorter building for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.1.2)   |
| C   | NC   | (N/A) | <b>MEZZANINES:</b> Interior mezzanine levels shall be braced independently from the main structure, or shall be anchored to the lateral-force-resisting elements of the main structure. (Tier 2: Sec. 4.3.1.3)   |
| (C) | NC   | N/A   | <b>WEAK STORY:</b> The strength of the lateral-force-resisting system in any story shall not be less than 80 percent of the strength in an adjacent story, above or below, for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.1)   |
| (C) | NC   | N/A   | <b>SOFT STORY:</b> The stiffness of the lateral-force-resisting system in any story shall not be less than 70 percent of the lateral-force-resisting system stiffness in an adjacent story above or below, or less than 80 percent of the average lateral-force-resisting system stiffness of the three stories above or below for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.2) |
| C   | NC   | (N/A) | <b>GEOMETRY:</b> There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30 percent in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines. (Tier 2: Sec. 4.3.2.3)  |
| C   | (NC) | N/A   | <b>VERTICAL DISCONTINUITIES:</b> All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. (Tier 2: Sec. 4.3.2.4)   |

**3.7.4S Supplemental Structural Checklist for Building Type S2: Steel Braced Frames with Stiff Diaphragms**

This Supplemental Structural Checklist shall be completed where required by Table 3-2. The Basic Structural Checklist shall be completed prior to completing this Supplemental Structural Checklist.

**Lateral-Force-Resisting System**

- C  NC  N/A COMPACT MEMBERS: All frame elements shall meet section requirements set forth by *Seismic Provisions for Structural Steel Buildings* Table I-9-1 (AISC, 1997). (Tier 2: Sec. 4.4.1.3.7)
- C  NC  N/A SLENDERNESS OF DIAGONALS: All diagonal elements required to carry compression shall have  $Kl/r$  ratios less than 120. (Tier 2: Sec. 4.4.3.1.4)
- C  NC  N/A CONNECTION STRENGTH: All the brace connections shall develop the yield capacity of the diagonals. (Tier 2: Sec. 4.4.3.1.5)
- C  NC  N/A OUT-OF-PLANE BRACING: Braced frame connections attached to beam bottom flanges located away from beam-column joints shall be braced out-of-plane at the bottom flange of the beams. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.3.1.6)
- C  NC  N/A K-BRACING: The bracing system shall not include K-braced bays. (Tier 2: Sec. 4.4.3.2.1)
- C  NC  N/A TENSION-ONLY BRACES: Tension-only braces shall not comprise more than 70 percent of the total lateral-force-resisting capacity in structures over two stories in height. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.3.2.2)
- C  NC  N/A CHEVRON BRACING: The bracing system shall not include chevron, or V-braced, bays. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.3.2.3)
- C  NC  N/A CONCENTRICALLY BRACED FRAME JOINTS: All the diagonal braces shall frame into the beam-column joints concentrically. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.3.2.4)

**Diaphragms**

- C  NC  N/A OPENINGS AT BRACED FRAMES: Diaphragm openings immediately adjacent to the braced frames shall extend less than 25 percent of the frame length for Life Safety and 15 percent of the frame length for Immediate Occupancy. (Tier 2: Sec. 4.5.1.5)
- C  NC  N/A PLAN IRREGULARITIES: There shall be tensile capacity to develop the strength of the diaphragm at re-entrant corners or other locations of plan irregularities. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.7)
- C  NC  N/A DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragm openings larger than 50 percent of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.8)

**Connections**

- C  NC  N/A UPLIFT AT PILE CAPS: Pile caps shall have top reinforcement and piles shall be anchored to the pile caps for Life Safety, and the pile cap reinforcement and pile anchorage shall be able to develop the tensile capacity of the piles for Immediate Occupancy. (Tier 2: Sec. 4.6.3.10)

## Screening Phase (Tier 1)

- |   |    |     |  |
|---|----|-----|--|
| C | NC | N/A | MASS: There shall be no change in effective mass more than 50 percent from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses, and mezzanines need not be considered. (Tier 2: Sec. 4.3.2.5)               |
| C | NC | N/A | TORSION: The estimated distance between the story center of mass and the story center of rigidity shall be less than 20 percent of the building width in either plan dimension for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.6) |
| C | NC | N/A | DETERIORATION OF STEEL: There shall be no visible rusting, corrosion, cracking, or other deterioration in any of the steel elements or connections in the vertical- or lateral-force-resisting systems. (Tier 2: Sec. 4.3.3.3)                 |
| C | NC | N/A | DETERIORATION OF CONCRETE: There shall be no visible deterioration of concrete or reinforcing steel in any of the vertical- or lateral-force-resisting elements. (Tier 2: Sec. 4.3.3.4)  |

### Lateral-Force-Resisting System

- |   |    |     |   |
|---|----|-----|---|
| C | NC | N/A | AXIAL STRESS CHECK: The axial stress due to gravity loads in columns subjected to overturning forces shall be less than $0.10F_y$ for Life Safety and Immediate Occupancy. Alternatively, the axial stress due to overturning forces alone, calculated using the Quick Check procedure of Section 3.5.3.6, shall be less than $0.30F_y$ for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.1.3.2) |
| C | NC | N/A | REDUNDANCY: The number of lines of braced frames in each principal direction shall be greater than or equal to 2 for Life Safety and Immediate Occupancy. The number of braced bays in each line shall be greater than 2 for Life Safety and 3 for Immediate Occupancy. (Tier 2: Sec. 4.4.3.1.1)  |
| C | NC | N/A | AXIAL STRESS CHECK: The axial stress in the diagonals, calculated using the Quick Check procedure of Section 3.5.3.4, shall be less than $0.50F_y$ for Life Safety and for Immediate Occupancy. (Tier 2: Sec. 4.4.3.1.2)  |
| C | NC | N/A | COLUMN SPLICES: All column splice details located in braced frames shall develop the tensile strength of the column. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.3.1.3)   |

### Connections

- |   |    |     |  |
|---|----|-----|--|
| C | NC | N/A | TRANSFER TO STEEL FRAMES: Diaphragms shall be connected for transfer of loads to the steel frames for Life Safety, and the connections shall be able to develop the lesser of the strength of the frames or the diaphragms for Immediate Occupancy. (Tier 2: Sec. 4.6.2.2)   |
| C | NC | N/A | STEEL COLUMNS: The columns in lateral-force-resisting frames shall be anchored to the building foundation for Life Safety, and the anchorage shall be able to develop the lesser of the tensile capacity of the column, the tensile capacity of the lowest level column splice (if any), or the uplift capacity of the foundation, for Immediate Occupancy. (Tier 2: Sec. 4.6.3.1) |

**3.7.14 Basic Structural Checklist for Building Type RM2: Reinforced Masonry Bearing Walls with Stiff Diaphragms**

This Basic Structural Checklist shall be completed where required by Table 3-2.

Each of the evaluation statements on this checklist shall be marked Compliant (C), Non-compliant (NC), or Not Applicable (N/A) for a Tier 1 Evaluation. Compliant statements identify issues that are acceptable according to the criteria of this standard, while non-compliant statements identify issues that require further investigation. Certain statements may not apply to the buildings being evaluated. For non-compliant evaluation statements, the design professional may choose to conduct further investigation using the corresponding Tier 2 Evaluation procedure; corresponding section numbers are in parentheses following each evaluation statement.

**C3.7.14 Basic Structural Checklist for Building Type RM2**

These buildings have bearing walls that consist of reinforced brick or concrete block masonry. Diaphragms consist of metal deck with concrete fill, precast concrete planks, tees, or double-tees, with or without a cast-in-place concrete topping slab, and are stiff relative to the walls. The floor and roof framing is supported on interior steel or concrete frames or interior reinforced masonry walls.

**Building System**

- (C) NC N/A **LOAD PATH:** The structure shall contain a minimum of one complete load path for Life Safety and Immediate Occupancy for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation. (Tier 2: Sec. 4.3.1.1)
- C NC (N/A) **MEZZANINES:** Interior mezzanine levels shall be braced independently from the main structure, or shall be anchored to the lateral-force-resisting elements of the main structure. (Tier 2: Sec. 4.3.1.3)
- (C) NC N/A **WEAK STORY:** The strength of the lateral-force-resisting system in any story shall not be less than 80 percent of the strength in an adjacent story, above or below, for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.1)
- (C) NC N/A **SOFT STORY:** The stiffness of the lateral-force-resisting system in any story shall not be less than 70 percent of the lateral-force-resisting system stiffness in an adjacent story above or below, or less than 80 percent of the average lateral-force-resisting system stiffness of the three stories above or below for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.2)
- (C) NC N/A **GEOMETRY:** There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30 percent in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines. (Tier 2: Sec. 4.3.2.3)
- (C) NC N/A **VERTICAL DISCONTINUITIES:** All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. (Tier 2: Sec. 4.3.2.4)
- (C) NC N/A **MASS:** There shall be no change in effective mass more than 50 percent from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses, and mezzanines need not be considered. (Tier 2: Sec. 4.3.2.5)
- (C) NC N/A **TORSION:** The estimated distance between the story center of mass and the story center of rigidity shall be less than 20 percent of the building width in either plan dimension for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.6)

## Screening Phase (Tier 1)

- (C) NC N/A DETERIORATION OF CONCRETE: There shall be no visible deterioration of concrete or reinforcing steel in any of the vertical- or lateral-force-resisting elements. (Tier 2: Sec. 4.3.3.4)
- (C) NC N/A MASONRY UNITS: There shall be no visible deterioration of masonry units. (Tier 2: Sec. 4.3.3.7)
- (C) NC N/A MASONRY JOINTS: The mortar shall not be easily scraped away from the joints by hand with a metal tool, and there shall be no areas of eroded mortar. (Tier 2: Sec. 4.3.3.8)
- (C) NC N/A REINFORCED MASONRY WALL CRACKS: All existing diagonal cracks in wall elements shall be less than 1/8 inch for Life Safety and 1/16 inch for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern. (Tier 2: Sec. 4.3.3.10)

### Lateral-Force-Resisting System

- (C) NC N/A REDUNDANCY: The number of lines of shear walls in each principal direction shall be greater than or equal to 2 for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.1.1)
- (C) NC N/A SHEAR STRESS CHECK: The shear stress in the reinforced masonry shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 70 psi for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.4.1)
- (C) NC N/A REINFORCING STEEL: The total vertical and horizontal reinforcing steel ratio in reinforced masonry walls shall be greater than 0.002 for Life Safety and Immediate Occupancy of the wall with the minimum of 0.0007 for Life Safety and Immediate Occupancy in either of the two directions; the spacing of reinforcing steel shall be less than 48 inches for Life Safety and Immediate Occupancy; and all vertical bars shall extend to the top of the walls. (Tier 2: Sec. 4.4.2.4.2)

### Diaphragms

- (C) NC N/A TOPPING SLAB: Precast concrete diaphragm elements shall be interconnected by a continuous reinforced concrete topping slab. (Tier 2: Sec. 4.5.5.1)

### Connections

- (C) NC N/A WALL ANCHORAGE: Exterior concrete or masonry walls that are dependent on the diaphragm for lateral support shall be anchored for out-of-plane forces at each diaphragm level with steel anchors, reinforcing dowels, or straps that are developed into the diaphragm. Connections shall have adequate strength to resist the connection force calculated in the Quick Check procedure of Section 3.5.3.7. (Tier 2: Sec. 4.6.1.1)
- (C) NC N/A TRANSFER TO SHEAR WALLS: Diaphragms shall be connected for transfer of loads to the shear walls for Life Safety and the connections shall be able to develop the lesser of the shear strength of the walls or diaphragms for Immediate Occupancy. (Tier 2: Sec. 4.6.2.1)
- (C) NC N/A TOPPING SLAB TO WALLS OR FRAMES: Reinforced concrete topping slabs that interconnect the precast concrete diaphragm elements shall be doweled for transfer of forces into the shear wall or frame elements for Life Safety, and the dowels shall be able to develop the lesser of the shear strength of the walls, frames, or slabs for Immediate Occupancy. (Tier 2: Sec. 4.6.2.3)
- (C) NC N/A FOUNDATION DOWELS: Wall reinforcement shall be doweled into the foundation for Life Safety, and the dowels shall be able to develop the lesser of the strength of the walls or the uplift capacity of the foundation for Immediate Occupancy. (Tier 2: Sec. 4.6.3.5)
- (C) NC N/A GIRDER/COLUMN CONNECTION: There shall be a positive connection utilizing plates, connection hardware, or straps between the girder and the column support. (Tier 2: Sec. 4.6.4.1)

**3.7.14S Supplemental Structural Checklist for Building Type RM2: Reinforced Masonry Bearing Walls with Stiff Diaphragms**

This Supplemental Structural Checklist shall be completed where required by Table 3-2. The Basic Structural Checklist shall be completed prior to completing this Supplemental Structural Checklist.

**Lateral-Force-Resisting System**

- C NC  N/A REINFORCING AT OPENINGS: There shall be added trim reinforcement around all wall openings with a dimension greater than three times the thickness of the wall. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.2.6)
- C NC  N/A PROPORTIONS: The height-to-thickness ratio of the shear walls at each story shall be less than 30. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.4.4)

**Diaphragms**

- C NC  N/A OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls shall be less than 25 percent of the wall length for Life Safety and 15 percent of the wall length for Immediate Occupancy. (Tier 2: Sec. 4.5.1.4)
- C NC  N/A OPENINGS AT EXTERIOR MASONRY SHEAR WALLS: Diaphragm openings immediately adjacent to exterior masonry shear walls shall not be greater than 8 feet long for Life Safety and 4 feet long for Immediate Occupancy. (Tier 2: Sec. 4.5.1.6)
- C NC  N/A PLAN IRREGULARITIES: There shall be tensile capacity to develop the strength of the diaphragm at re-entrant corners or other locations of plan irregularities. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.7)
- C NC  N/A DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragm openings larger than 50 percent of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.8)

### 3.8 Geologic Site Hazards and Foundations Checklist

This Geologic Site Hazards and Foundations Checklist shall be completed where required by Table 3-2.

Each of the evaluation statements on this checklist shall be marked Compliant (C), Non-compliant (NC), or Not Applicable (N/A) for a Tier 1 Evaluation. Compliant statements identify issues that are acceptable according to the criteria of this standard, while non-compliant statements identify issues that require further investigation. Certain statements may not apply to the buildings being evaluated. For non-compliant evaluation statements, the design professional may choose to conduct further investigation using the corresponding Tier 2 Evaluation procedure; corresponding section numbers are in parentheses following each evaluation statement.

#### Geologic Site Hazards

The following statements shall be completed for buildings in levels of high or moderate seismicity.

- C NC N/A LIQUEFACTION: Liquefaction-susceptible, saturated, loose granular soils that could jeopardize the building's seismic performance shall not exist in the foundation soils at depths within 50 feet under the building for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.7.1.1)
- C NC N/A SLOPE FAILURE: The building site shall be sufficiently remote from potential earthquake-induced slope failures or rockfalls to be unaffected by such failures or shall be capable of accommodating any predicted movements without failure. (Tier 2: Sec. 4.7.1.2)
- C NC N/A SURFACE FAULT RUPTURE: Surface fault rupture and surface displacement at the building site is not anticipated. (Tier 2: Sec. 4.7.1.3)

#### Condition of Foundations

The following statement shall be completed for all Tier 1 building evaluations.

- C NC N/A FOUNDATION PERFORMANCE: There shall be no evidence of excessive foundation movement such as settlement or heave that would affect the integrity or strength of the structure. (Tier 2: Sec. 4.7.2.1)

The following statement shall be completed for buildings in levels of high or moderate seismicity being evaluated to the Immediate Occupancy Performance Level.

- C  NC  N/A DETERIORATION: There shall not be evidence that foundation elements have deteriorated due to corrosion, sulfate attack, material breakdown, or other reasons in a manner that would affect the integrity or strength of the structure. (Tier 2: Sec. 4.7.2.2)

#### Capacity of Foundations

The following statement shall be completed for all Tier 1 building evaluations.

- C  NC  N/A POLE FOUNDATIONS: Pole foundations shall have a minimum embedment depth of 4 feet for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.7.3.1)

The following statements shall be completed for buildings in levels of moderate seismicity being evaluated to the Immediate Occupancy Performance Level and for buildings in levels of high seismicity.

- C NC N/A OVERTURNING: The ratio of the horizontal dimension of the lateral-force-resisting system at the foundation level to the building height (base/height) shall be greater than  $0.6S_a$ . (Tier 2: Sec. 4.7.3.2)

$$E-W: 37' / 22' = 1.68$$

$$0.6S_a = 0.6S_{D5} = 0.6(1.178) = 0.71$$

∴ COMPLIANT.

Screening Phase (Tier 1)

- |   |    |     |  |
|---|----|-----|--|
| C | NC | N/A | TIES BETWEEN FOUNDATION ELEMENTS: The foundation shall have ties adequate to resist seismic forces where footings, piles, and piers are not restrained by beams, slabs, or soils classified as Class A, B, or C. (Section 3.5.2.3.1, Tier 2: Sec. 4.7.3.3) |
| C | NC | N/A | DEEP FOUNDATIONS: Piles and piers shall be capable of transferring the lateral forces between the structure and the soil. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.7.3.4)                             |
| C | NC | N/A | SLOPING SITES: The difference in foundation embedment depth from one side of the building to another shall not exceed one story in height. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.7.3.5)            |

**3.9.1 Basic Nonstructural Component Checklist**

This Basic Nonstructural Component Checklist shall be completed where required by Table 3-2.

Each of the evaluation statements on this checklist shall be marked **Compliant (C)**, **Non-compliant (NC)**, or **Not Applicable (N/A)** for a Tier 1 Evaluation. **Compliant statements** identify issues that are acceptable according to the criteria of this standard, while **non-compliant statements** identify issues that require further investigation. Certain statements may not apply to the buildings being evaluated. For non-compliant evaluation statements, the design professional may choose to conduct further investigation using the corresponding Tier 2 Evaluation procedure; corresponding section numbers are in parentheses following each evaluation statement.

**Partitions**

- C NC  N/A UNREINFORCED MASONRY: Unreinforced masonry or hollow clay tile partitions shall be braced at a spacing equal to or less than 10 feet in levels of low or moderate seismicity and 6 feet in levels of high seismicity. (Tier 2: Sec. 4.8.1.1)

**Ceiling Systems**

- C NC  N/A SUPPORT: The integrated suspended ceiling system shall not be used to laterally support the tops of gypsum board, masonry, or hollow clay tile partitions. Gypsum board partitions need not be evaluated where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.2.1)

**Light Fixtures**

- C NC  N/A EMERGENCY LIGHTING: Emergency lighting shall be anchored or braced to prevent falling during an earthquake. (Tier 2: Sec. 4.8.3.1)  
*NO EMERGENCY LIGHTING NOTED.*

**Cladding and Glazing**

- C NC  N/A CLADDING ANCHORS: Cladding components weighing more than 10 psf shall be mechanically anchored to the exterior wall framing at a spacing equal to or less than 4 feet. A spacing of up to 6 feet is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.4.1)
- C NC  N/A DETERIORATION: There shall be no evidence of deterioration, damage or corrosion in any of the connection elements. (Tier 2: Sec. 4.8.4.2)
- C NC  N/A CLADDING ISOLATION: For moment frame buildings of steel or concrete, panel connections shall be detailed to accommodate a story drift ratio of 0.02. Panel connection detailing for a story drift ratio of 0.01 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.4.3)
- C NC  N/A MULTI-STORY PANELS: For multi-story panels attached at each floor level, panel connections shall be detailed to accommodate a story drift ratio of 0.02. Panel connection detailing for a story drift ratio of 0.01 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.4.4)
- C NC  N/A BEARING CONNECTIONS: Where bearing connections are required, there shall be a minimum of two bearing connections for each wall panel. (Tier 2: Sec. 4.8.4.5)

## Screening Phase (Tier 1)

- C NC **N/A** INSERTS: Where inserts are used in concrete connections, the inserts shall be anchored to reinforcing steel or other positive anchorage. (Tier 2: Sec. 4.8.4.6)
- C NC **N/A** PANEL CONNECTIONS: Exterior cladding panels shall be anchored out-of-plane with a minimum of 4 connections for each wall panel. Two connections per wall panel are permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.4.7)

### Masonry Veneer

- C NC **N/A** SHELF ANGLES: Masonry veneer shall be supported by shelf angles or other elements at each floor 30 feet or more above ground for Life Safety and at each floor above the first floor for Immediate Occupancy. (Tier 2: Sec. 4.8.5.1)
- C NC **N/A** TIES: Masonry veneer shall be connected to the back-up with corrosion-resistant ties. The ties shall have a spacing equal to or less than 24 inches with a minimum of one tie for every 2-2/3 square feet. A spacing of up to 36 inches is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.5.2)
- C NC **N/A** WEAKENED PLANES: Masonry veneer shall be anchored to the back-up adjacent to weakened planes, such as at the locations of flashing. (Tier 2: Sec. 4.8.5.3)
- C NC **N/A** DETRIORATION: There shall be no evidence of deterioration, damage, or corrosion in any of the connection elements. (Tier 2: Sec. 4.8.5.4)

### Parapets, Cornices, Ornamentation, and Appendages

- C NC **N/A** URM PARAPETS: There shall be no laterally unsupported unreinforced masonry parapets or cornices with height-to-thickness ratios greater than 1.5. A height-to-thickness ratio of up to 2.5 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.8.1)
- C NC **N/A** CANOPIES: Canopies located at building exits shall be anchored to the structural framing at a spacing of 6 feet or less. An anchorage spacing of up to 10 feet is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.8.2)

### Masonry Chimneys

- C NC **N/A** URM CHIMNEYS: No unreinforced masonry chimney shall extend above the roof surface more than twice the least dimension of the chimney. A height above the roof surface of up to three times the least dimension of the chimney is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.9.1)

### Stairs

- C NC **N/A** URM WALLS: Walls around stair enclosures shall not consist of unbraced hollow clay tile or unreinforced masonry with a height-to-thickness ratio greater than 12-to-1. A height-to-thickness ratio of up to 15-to-1 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.10.1)
- C NC **N/A** STAIR DETAILS: In moment frame structures, the connection between the stairs and the structure shall not rely on shallow anchors in concrete. Alternatively, the stair details shall be capable of accommodating the drift calculated using the Quick Check procedure of Section 3.5.3.1 without including tension in the anchors. (Tier 2: Sec. 4.8.10.2)

**Building Contents and Furnishing**

- C NC **N/A** TALL NARROW CONTENTS: Contents over 4 feet in height with a height-to-depth or height-to-width ratio greater than 3-to-1 shall be anchored to the floor slab or adjacent structural walls. A height-to-depth or height-to-width ratio of up to 4-to-1 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.11.1)

**Mechanical and Electrical Equipment**

- C NC **N/A** EMERGENCY POWER: Equipment used as part of an emergency power system shall be mounted to maintain continued operation after an earthquake. (Tier 2: Sec. 4.8.12.1)
- C NC **N/A** HAZARDOUS MATERIAL EQUIPMENT: HVAC or other equipment containing hazardous material shall not have damaged supply lines or unbraced isolation supports. (Tier 2: Sec. 4.8.12.2)
- C** NC **N/A** DETERIORATION: There shall be no evidence of deterioration, damage, or corrosion in any of the anchorage or supports of mechanical or electrical equipment. (Tier 2: Sec. 4.8.12.3)
- C NC **N/A** ATTACHED EQUIPMENT: Equipment weighing over 20 lb that is attached to ceilings, walls, or other supports 4 feet above the floor level shall be braced. (Tier 2: Sec. 4.8.12.4)

**Piping**

- C NC **N/A** FIRE SUPPRESSION PIPING: Fire suppression piping shall be anchored and braced in accordance with NFPA-13 (NFPA, 1996). (Tier 2: Sec. 4.8.13.1)
- C NC **N/A** FLEXIBLE COUPLINGS: Fluid, gas, and fire suppression piping shall have flexible couplings. (Tier 2: Sec. 4.8.13.2)

**Hazardous Materials Storage and Distribution**

- C NC **N/A** TOXIC SUBSTANCES: Toxic and hazardous substances stored in breakable containers shall be restrained from falling by latched doors, shelf lips, wires, or other methods. (Tier 2: Sec. 4.8.15.1)

### 3.9.2 Intermediate Nonstructural Component Checklist

This Intermediate Nonstructural Component Checklist shall be completed where required by Table 3-2. The Basic Nonstructural Component Checklist shall be completed prior to completing this Intermediate Nonstructural Component Checklist.

#### Ceiling Systems

- C NC  N/A LAY-IN TILES: Lay-in tiles used in ceiling panels located at exits and corridors shall be secured with clips. (Tier 2: Sec. 4.8.2.2)
- C NC  N/A INTEGRATED CEILINGS: Integrated suspended ceilings at exits and corridors or weighing more than 2 pounds per square foot shall be laterally restrained with a minimum of four diagonal wires or rigid members attached to the structure above at a spacing equal to or less than 12 feet. (Tier 2: Sec. 4.8.2.3)
- C NC  N/A SUSPENDED LATH AND PLASTER: Ceilings consisting of suspended lath and plaster or gypsum board shall be attached to resist seismic forces for every 12 square feet of area. (Tier 2: Sec. 4.8.2.4)

#### Light Fixtures

- C NC  N/A INDEPENDENT SUPPORT: Light fixtures in suspended grid ceilings shall be supported independently of the ceiling suspension system by a minimum of two wires at diagonally opposite corners of the fixtures. (Tier 2: Sec. 4.8.3.2)

#### Cladding and Glazing

- C NC  N/A GLAZING: Glazing in curtain walls and individual panes over 16 square feet in area, located up to a height of 10 feet above an exterior walking surface, shall have safety glazing. Such glazing located over 10 feet above an exterior walking surface shall be laminated annealed or laminated heat-strengthened safety glass or other glazing system that will remain in the frame when glass is cracked. (Tier 2: Sec. 4.8.4.8)

#### Parapets, Cornices, Ornamentation, and Appendages

- C NC  N/A CONCRETE PARAPETS: Concrete parapets with height-to-thickness ratios greater than 2.5 shall have vertical reinforcement. (Tier 2: Sec. 4.8.8.3)
- C NC  N/A APPENDAGES: Cornices, parapets, signs, and other appendages that extend above the highest point of anchorage to the structure or cantilever from exterior wall faces and other exterior wall ornamentation shall be reinforced and anchored to the structural system at a spacing equal to or less than 10 feet for Life Safety and 6 feet for Immediate Occupancy. This requirement need not apply to parapets or cornices compliant with Section 4.8.8.1 or 4.8.8.3. (Tier 2: Sec. 4.8.8.4)

#### Masonry Chimneys

- C NC  N/A ANCHORAGE: Masonry chimneys shall be anchored at each floor level and the roof. (Tier 2: Sec. 4.8.9.2)

**Mechanical and Electrical Equipment**

- C NC  VIBRATION ISOLATORS: Equipment mounted on vibration isolators shall be equipped with restraints or snubbers. (Tier 2: Sec. 4.8.12.5)

**Ducts**

- C NC  STAIR AND SMOKE DUCTS: Stair pressurization and smoke control ducts shall be braced and shall have flexible connections at seismic joints. (Tier 2: Sec. 4.8.14.1)



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APPENDIX B4

TIER 1 SEISMIC  
CHECKLISTS AND  
HAND  
CALCULATIONS:  
LOT 4 PARKING  
STRUCTURE

**3.7.9 Basic Structural Checklist for Building Type C2: Concrete Shear Walls with Stiff Diaphragms**

This Basic Structural Checklist shall be completed where required by Table 3-2.

Each of the evaluation statements on this checklist shall be marked **Compliant (C)**, **Non-compliant (NC)**, or **Not Applicable (N/A)** for a Tier 1 Evaluation. **Compliant statements identify issues that are acceptable according to the criteria of this standard, while non-compliant statements identify issues that require further investigation. Certain statements may not apply to the buildings being evaluated. For non-compliant evaluation statements, the design professional may choose to conduct further investigation using the corresponding Tier 2 Evaluation procedure; corresponding section numbers are in parentheses following each evaluation statement.**

**C3.7.9 Basic Structural Checklist for Building Type C2**

These buildings have floor and roof framing that consists of cast-in-place concrete slabs, concrete beams, one-way joists, two-way waffle joists, or flat slabs. Floors are supported on concrete columns or bearing walls. Lateral forces are resisted by cast-in-place concrete shear walls. In older construction, shear walls are lightly reinforced but often extend throughout the building. In more recent construction, shear walls occur in isolated locations and are more heavily reinforced with boundary elements and closely spaced ties to provide ductile performance. The diaphragms consist of concrete slabs and are stiff relative to the walls. Foundations consist of concrete spread footings, mat foundations, or deep foundations.

**Building System**

- (C)** NC N/A **LOAD PATH:** The structure shall contain a minimum of one complete load path for Life Safety and Immediate Occupancy for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation. (Tier 2: Sec. 4.3.1.1)
- C NC **(N/A)** **MEZZANINES:** Interior mezzanine levels shall be braced independently from the main structure, or shall be anchored to the lateral-force-resisting elements of the main structure. (Tier 2: Sec. 4.3.1.3)
- C NC **(N/A)** **WEAK STORY:** The strength of the lateral-force-resisting system in any story shall not be less than 80 percent of the strength in an adjacent story, above or below, for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.1)
- C NC **(N/A)** **SOFT STORY:** The stiffness of the lateral-force-resisting system in any story shall not be less than 70 percent of the lateral-force-resisting system stiffness in an adjacent story above or below, or less than 80 percent of the average lateral-force-resisting system stiffness of the three stories above or below for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.2)
- C NC **(N/A)** **GEOMETRY:** There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30 percent in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines. (Tier 2: Sec. 4.3.2.3)
- (C)** NC N/A **VERTICAL DISCONTINUITIES:** All vertical elements in the lateral-force-resisting system shall be continuous to the foundation. (Tier 2: Sec. 4.3.2.4)
- C NC **(N/A)** **MASS:** There shall be no change in effective mass more than 50 percent from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses, and mezzanines need not be considered. (Tier 2: Sec. 4.3.2.5)

## Screening Phase (Tier 1)

- (C) (NC) N/A TORSION: The estimated distance between the story center of mass and the story center of rigidity shall be less than 20 percent of the building width in either plan dimension for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.6)
- (C) NC N/A DETERIORATION OF CONCRETE: There shall be no visible deterioration of concrete or reinforcing steel in any of the vertical- or lateral-force-resisting elements. (Tier 2: Sec. 4.3.3.4)
- (C) NC N/A POST-TENSIONING ANCHORS: There shall be no evidence of corrosion or spalling in the vicinity of post-tensioning or end fittings. Coil anchors shall not have been used. (Tier 2: Sec. 4.3.3.5)
- (C) NC N/A CONCRETE WALL CRACKS: All existing diagonal cracks in wall elements shall be less than 1/8 inch for Life Safety and 1/16 inch for Immediate Occupancy, shall not be concentrated in one location, and shall not form an X pattern. (Tier 2: Sec. 4.3.3.9)

### Lateral-Force-Resisting System

- (C) NC N/A COMPLETE FRAMES: Steel or concrete frames classified as secondary components shall form a complete vertical-load-carrying system. (Tier 2: Sec. 4.4.1.6.1)
- (C) NC N/A REDUNDANCY: The number of lines of shear walls in each principal direction shall be greater than or equal to 2 for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.1.1)
- (C) NC N/A SHEAR STRESS CHECK: The shear stress in the concrete shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than the greater of 100 psi or  $2\sqrt{f'_c}$  for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.2.1)
- (C) NC N/A REINFORCING STEEL: The ratio of reinforcing steel area to gross concrete area shall be not less than 0.0015 in the vertical direction and 0.0025 in the horizontal direction for Life Safety and Immediate Occupancy. The spacing of reinforcing steel shall be equal to or less than 16 inches for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.2.2)

### Connections

- (C) NC N/A TRANSFER TO SHEAR WALLS: Diaphragms shall be connected for transfer of loads to the shear walls for Life Safety and the connections shall be able to develop the lesser of the shear strength of the walls or diaphragms for Immediate Occupancy. (Tier 2: Sec. 4.6.2.1)
- (C) NC N/A FOUNDATION DOWELS: Wall reinforcement shall be doweled into the foundation for Life Safety, and the dowels shall be able to develop the lesser of the strength of the walls or the uplift capacity of the foundation for Immediate Occupancy. (Tier 2: Sec. 4.6.3.5)

**3.7.9S Supplemental Structural Checklist for Building Type C2: Concrete Shear Walls with Stiff Diaphragms**

This Supplemental Structural Checklist shall be completed where required by Table 3-2. The Basic Structural Checklist shall be completed prior to completing this Supplemental Structural Checklist.

**Lateral-Force-Resisting System**

- C NC (N/A) DEFLECTION COMPATIBILITY: Secondary components shall have the shear capacity to develop the flexural strength of the components for Life Safety and shall meet the requirements of Sections 4.4.1.4.9, 4.4.1.4.10, 4.4.1.4.11, 4.4.1.4.12 and 4.4.1.4.15 for Immediate Occupancy. (Tier 2: Sec. 4.4.1.6.2)
- C NC (N/A) FLAT SLABS: Flat slabs/plates not part of lateral-force-resisting system shall have continuous bottom steel through the column joints for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.1.6.3)
- C NC (N/A) COUPLING BEAMS: The stirrups in coupling beams over means of egress shall be spaced at or less than  $d/2$  and shall be anchored into the confined core of the beam with hooks of 135° or more for Life Safety. All coupling beams shall comply with the requirements above and shall have the capacity in shear to develop the uplift capacity of the adjacent wall for Immediate Occupancy. (Tier 2: Sec. 4.4.2.2.3)
- C NC (N/A) OVERTURNING: All shear walls shall have aspect ratios less than 4-to-1. Wall piers need not be considered. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.2.4)
- C NC (N/A) CONFINEMENT REINFORCING: For shear walls with aspect ratios greater than 2-to-1, the boundary elements shall be confined with spirals or ties with spacing less than  $8d_b$ . This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.2.5)
- C NC (N/A) REINFORCING AT OPENINGS: There shall be added trim reinforcement around all wall openings with a dimension greater than three times the thickness of the wall. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.2.6)
- C NC (N/A) WALL THICKNESS: Thickness of bearing walls shall not be less than 1/25 the unsupported height or length, whichever is shorter, nor less than 4 inches. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.4.2.2.7)

**Diaphragms**

- C NC (N/A) DIAPHRAGM CONTINUITY: The diaphragms shall not be composed of split-level floors and shall not have expansion joints. (Tier 2: Sec. 4.5.1.1)
- C NC (N/A) OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls shall be less than 25 percent of the wall length for Life Safety and 15 percent of the wall length for Immediate Occupancy. (Tier 2: Sec. 4.5.1.4)
- C NC (N/A) PLAN IRREGULARITIES: There shall be tensile capacity to develop the strength of the diaphragm at re-entrant corners or other locations of plan irregularities. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.7)
- C NC (N/A) DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragm openings larger than 50 percent of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.8)

Screening Phase (Tier 1)

Connections

C NC / **N/A**

UPLIFT AT PILE CAPS: Pile caps shall have top reinforcement and piles shall be anchored to the pile caps for Life Safety, and the pile cap reinforcement and pile anchorage shall be able to develop the tensile capacity of the piles for Immediate Occupancy. (Tier 2: Sec. 4.6.3.10)

### 3.8 Geologic Site Hazards and Foundations Checklist

This Geologic Site Hazards and Foundations Checklist shall be completed where required by Table 3-2.

Each of the evaluation statements on this checklist shall be marked Compliant (C), Non-compliant (NC), or Not Applicable (N/A) for a Tier 1 Evaluation. Compliant statements identify issues that are acceptable according to the criteria of this standard, while non-compliant statements identify issues that require further investigation. Certain statements may not apply to the buildings being evaluated. For non-compliant evaluation statements, the design professional may choose to conduct further investigation using the corresponding Tier 2 Evaluation procedure: corresponding section numbers are in parentheses following each evaluation statement.

#### Geologic Site Hazards

The following statements shall be completed for buildings in levels of high or moderate seismicity.

- C  NC  N/A LIQUEFACTION: Liquefaction-susceptible, saturated, loose granular soils that could jeopardize the building's seismic performance shall not exist in the foundation soils at depths within 50 feet under the building for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.7.1.1)
- C  NC  N/A SLOPE FAILURE: The building site shall be sufficiently remote from potential earthquake-induced slope failures or rockfalls to be unaffected by such failures or shall be capable of accommodating any predicted movements without failure. (Tier 2: Sec. 4.7.1.2)
- C  NC  N/A SURFACE FAULT RUPTURE: Surface fault rupture and surface displacement at the building site is not anticipated. (Tier 2: Sec. 4.7.1.3)

#### Condition of Foundations

The following statement shall be completed for all Tier 1 building evaluations.

- C  NC  N/A FOUNDATION PERFORMANCE: There shall be no evidence of excessive foundation movement such as settlement or heave that would affect the integrity or strength of the structure. (Tier 2: Sec. 4.7.2.1)

The following statement shall be completed for buildings in levels of high or moderate seismicity being evaluated to the Immediate Occupancy Performance Level.

- C  NC  N/A DETERIORATION: There shall not be evidence that foundation elements have deteriorated due to corrosion, sulfate attack, material breakdown, or other reasons in a manner that would affect the integrity or strength of the structure. (Tier 2: Sec. 4.7.2.2)

#### Capacity of Foundations

The following statement shall be completed for all Tier 1 building evaluations.

- C  NC  N/A POLE FOUNDATIONS: Pole foundations shall have a minimum embedment depth of 4 feet for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.7.3.1)

The following statements shall be completed for buildings in levels of moderate seismicity being evaluated to the Immediate Occupancy Performance Level and for buildings in levels of high seismicity.

- C  NC  N/A OVERTURNING: The ratio of the horizontal dimension of the lateral-force-resisting system at the foundation level to the building height (base/height) shall be greater than  $0.6S_a$ . (Tier 2: Sec. 4.7.3.2)

$$S_a = 1.108, \quad 0.6S_a = 0.6648$$

$$\frac{\text{BASE}}{\text{HEIGHT}} = \frac{43'}{9'} > 0.6648$$

### Screening Phase (Tier 1)

- C NC N/A TIES BETWEEN FOUNDATION ELEMENTS: The foundation shall have ties adequate to resist seismic forces where footings, piles, and piers are not restrained by beams, slabs, or soils classified as Class A, B, or C. (Section 3.5.2.3.1, Tier 2: Sec. 4.7.3.3)
- C NC N/A DEEP FOUNDATIONS: Piles and piers shall be capable of transferring the lateral forces between the structure and the soil. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.7.3.4)
- C NC N/A SLOPING SITES: The difference in foundation embedment depth from one side of the building to another shall not exceed one story in height. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.7.3.5)

### 3.9.1 Basic Nonstructural Component Checklist

This Basic Nonstructural Component Checklist shall be completed where required by Table 3-2.

Each of the evaluation statements on this checklist shall be marked **Compliant (C)**, **Non-compliant (NC)**, or **Not Applicable (N/A)** for a Tier 1 Evaluation. **Compliant statements identify issues that are acceptable according to the criteria of this standard, while non-compliant statements identify issues that require further investigation. Certain statements may not apply to the buildings being evaluated. For non-compliant evaluation statements, the design professional may choose to conduct further investigation using the corresponding Tier 2 Evaluation procedure; corresponding section numbers are in parentheses following each evaluation statement.**

#### Partitions

- C NC **N/A** UNREINFORCED MASONRY: Unreinforced masonry or hollow clay tile partitions shall be braced at a spacing equal to or less than 10 feet in levels of low or moderate seismicity and 6 feet in levels of high seismicity. (Tier 2: Sec. 4.8.1.1)

#### Ceiling Systems

- C NC **N/A** SUPPORT: The integrated suspended ceiling system shall not be used to laterally support the tops of gypsum board, masonry, or hollow clay tile partitions. Gypsum board partitions need not be evaluated where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.2.1)

#### Light Fixtures

- C NC **N/A** EMERGENCY LIGHTING: Emergency lighting shall be anchored or braced to prevent falling during an earthquake. (Tier 2: Sec. 4.8.3.1)

#### Cladding and Glazing

- C NC **N/A** CLADDING ANCHORS: Cladding components weighing more than 10 psf shall be mechanically anchored to the exterior wall framing at a spacing equal to or less than 4 feet. A spacing of up to 6 feet is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.4.1)
- C NC **N/A** DETERIORATION: There shall be no evidence of deterioration, damage or corrosion in any of the connection elements. (Tier 2: Sec. 4.8.4.2)
- C NC **N/A** CLADDING ISOLATION: For moment frame buildings of steel or concrete, panel connections shall be detailed to accommodate a story drift ratio of 0.02. Panel connection detailing for a story drift ratio of 0.01 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.4.3)
- C NC **N/A** MULTI-STORY PANELS: For multi-story panels attached at each floor level, panel connections shall be detailed to accommodate a story drift ratio of 0.02. Panel connection detailing for a story drift ratio of 0.01 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.4.4)
- C NC **N/A** BEARING CONNECTIONS: Where bearing connections are required, there shall be a minimum of two bearing connections for each wall panel. (Tier 2: Sec. 4.8.4.5)

- C NC (N/A) INSERTS: Where inserts are used in concrete connections, the inserts shall be anchored to reinforcing steel or other positive anchorage. (Tier 2: Sec. 4.8.4.6)
- C NC (N/A) PANEL CONNECTIONS: Exterior cladding panels shall be anchored out-of-plane with a minimum of 4 connections for each wall panel. Two connections per wall panel are permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.4.7)

**Masonry Veneer**

- C NC (N/A) SHELF ANGLES: Masonry veneer shall be supported by shelf angles or other elements at each floor 30 feet or more above ground for Life Safety and at each floor above the first floor for Immediate Occupancy. (Tier 2: Sec. 4.8.5.1)
- C NC (N/A) TIES: Masonry veneer shall be connected to the back-up with corrosion-resistant ties. The ties shall have a spacing equal to or less than 24 inches with a minimum of one tie for every 2-2/3 square feet. A spacing of up to 36 inches is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.5.2)
- C NC (N/A) WEAKENED PLANES: Masonry veneer shall be anchored to the back-up adjacent to weakened planes, such as at the locations of flashing. (Tier 2: Sec. 4.8.5.3)
- C NC (N/A) DETERIORATION: There shall be no evidence of deterioration, damage, or corrosion in any of the connection elements. (Tier 2: Sec. 4.8.5.4)

**Parapets, Cornices, Ornamentation, and Appendages**

- C NC (N/A) URM PARAPETS: There shall be no laterally unsupported unreinforced masonry parapets or cornices with height-to-thickness ratios greater than 1.5. A height-to-thickness ratio of up to 2.5 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.8.1)
- C NC (N/A) CANOPIES: Canopies located at building exits shall be anchored to the structural framing at a spacing of 6 feet or less. An anchorage spacing of up to 10 feet is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.8.2)

**Masonry Chimneys**

- C NC (N/A) URM CHIMNEYS: No unreinforced masonry chimney shall extend above the roof surface more than twice the least dimension of the chimney. A height above the roof surface of up to three times the least dimension of the chimney is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.9.1)

**Stairs**

- C NC (N/A) URM WALLS: Walls around stair enclosures shall not consist of unbraced hollow clay tile or unreinforced masonry with a height-to-thickness ratio greater than 12-to-1. A height-to-thickness ratio of up to 15-to-1 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.10.1)
- C NC (N/A) STAIR DETAILS: In moment frame structures, the connection between the stairs and the structure shall not rely on shallow anchors in concrete. Alternatively, the stair details shall be capable of accommodating the drift calculated using the Quick Check procedure of Section 3.5.3.1 without including tension in the anchors. (Tier 2: Sec. 4.8.10.2)

## Screening Phase (Tier 1)

### Building Contents and Furnishing

- C NC (N/A) TALL NARROW CONTENTS: Contents over 4 feet in height with a height-to-depth or height-to-width ratio greater than 3-to-1 shall be anchored to the floor slab or adjacent structural walls. A height-to-depth or height-to-width ratio of up to 4-to-1 is permitted where only the Basic Nonstructural Component Checklist is required by Table 3-2. (Tier 2: Sec. 4.8.11.1)

### Mechanical and Electrical Equipment

- C NC (N/A) EMERGENCY POWER: Equipment used as part of an emergency power system shall be mounted to maintain continued operation after an earthquake. (Tier 2: Sec. 4.8.12.1)

- C NC (N/A) HAZARDOUS MATERIAL EQUIPMENT: HVAC or other equipment containing hazardous material shall not have damaged supply lines or unbraced isolation supports. (Tier 2: Sec. 4.8.12.2)

- (C) NC N/A DETERIORATION: There shall be no evidence of deterioration, damage, or corrosion in any of the anchorage or supports of mechanical or electrical equipment. (Tier 2: Sec. 4.8.12.3)

- C NC (N/A) ATTACHED EQUIPMENT: Equipment weighing over 20 lb that is attached to ceilings, walls, or other supports 4 feet above the floor level shall be braced. (Tier 2: Sec. 4.8.12.4)

### Piping

- C NC (N/A) FIRE SUPPRESSION PIPING: Fire suppression piping shall be anchored and braced in accordance with NFPA-13 (NFPA, 1996). (Tier 2: Sec. 4.8.13.1)

- C NC (N/A) FLEXIBLE COUPLINGS: Fluid, gas, and fire suppression piping shall have flexible couplings. (Tier 2: Sec. 4.8.13.2)

### Hazardous Materials Storage and Distribution

- C NC (N/A) TOXIC SUBSTANCES: Toxic and hazardous substances stored in breakable containers shall be restrained from falling by latched doors, shelf lips, wires, or other methods. (Tier 2: Sec. 4.8.15.1)

### 3.9.2 Intermediate Nonstructural Component Checklist

This Intermediate Nonstructural Component Checklist shall be completed where required by Table 3-2. The Basic Nonstructural Component Checklist shall be completed prior to completing this Intermediate Nonstructural Component Checklist.

#### Ceiling Systems

- C NC **N/A** LAY-IN TILES: Lay-in tiles used in ceiling panels located at exits and corridors shall be secured with clips. (Tier 2: Sec. 4.8.2.2)
- C NC **N/A** INTEGRATED CEILINGS: Integrated suspended ceilings at exits and corridors or weighing more than 2 pounds per square foot shall be laterally restrained with a minimum of four diagonal wires or rigid members attached to the structure above at a spacing equal to or less than 12 feet. (Tier 2: Sec. 4.8.2.3)
- C NC **N/A** SUSPENDED LATH AND PLASTER: Ceilings consisting of suspended lath and plaster or gypsum board shall be attached to resist seismic forces for every 12 square feet of area. (Tier 2: Sec. 4.8.2.4)

#### Light Fixtures

- C NC **N/A** INDEPENDENT SUPPORT: Light fixtures in suspended grid ceilings shall be supported independently of the ceiling suspension system by a minimum of two wires at diagonally opposite corners of the fixtures. (Tier 2: Sec. 4.8.3.2)

#### Cladding and Glazing

- C NC **N/A** GLAZING: Glazing in curtain walls and individual panes over 16 square feet in area, located up to a height of 10 feet above an exterior walking surface, shall have safety glazing. Such glazing located over 10 feet above an exterior walking surface shall be laminated annealed or laminated heat-strengthened safety glass or other glazing system that will remain in the frame when glass is cracked. (Tier 2: Sec. 4.8.4.8)

#### Parapets, Cornices, Ornamentation, and Appendages

- C NC **N/A** CONCRETE PARAPETS: Concrete parapets with height-to-thickness ratios greater than 2.5 shall have vertical reinforcement. (Tier 2: Sec. 4.8.8.3)
- C NC **N/A** APPENDAGES: Cornices, parapets, signs, and other appendages that extend above the highest point of anchorage to the structure or cantilever from exterior wall faces and other exterior wall ornamentation shall be reinforced and anchored to the structural system at a spacing equal to or less than 10 feet for Life Safety and 6 feet for Immediate Occupancy. This requirement need not apply to parapets or cornices compliant with Section 4.8.8.1 or 4.8.8.3. (Tier 2: Sec. 4.8.8.4)

#### Masonry Chimneys

- C NC **N/A** ANCHORAGE: Masonry chimneys shall be anchored at each floor level and the roof. (Tier 2: Sec. 4.8.9.2)

**Mechanical and Electrical Equipment**

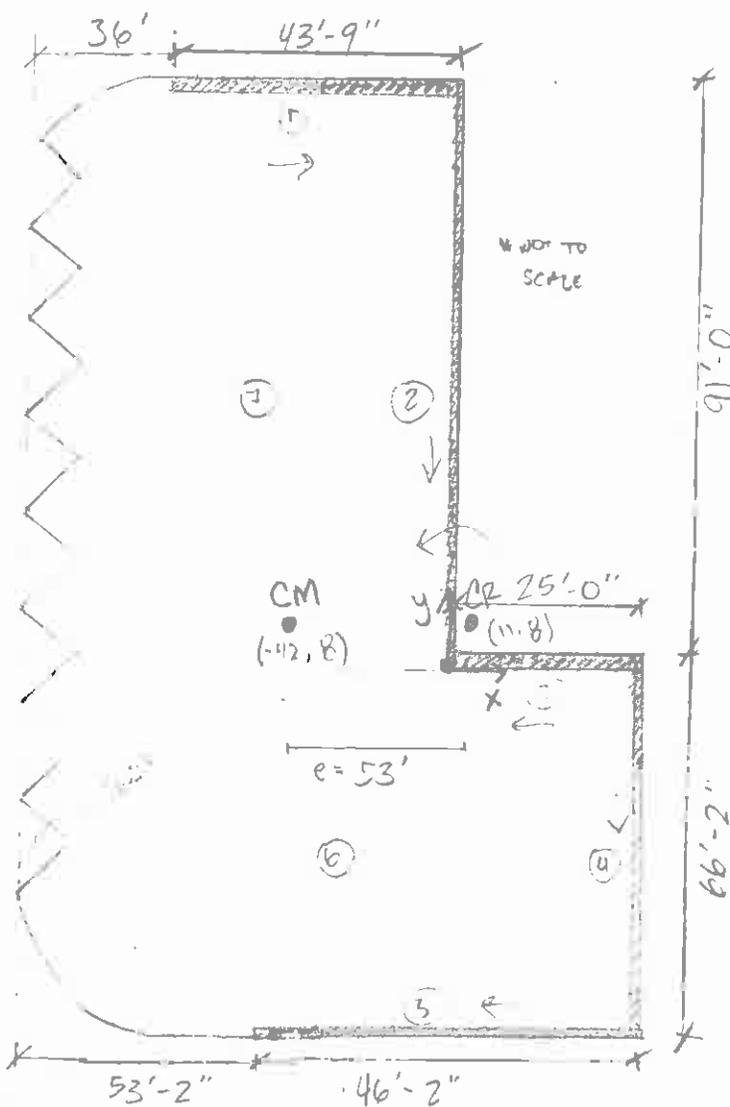
- C NC **N/A** VIBRATION ISOLATORS: Equipment mounted on vibration isolators shall be equipped with restraints or snubbers. (Tier 2: Sec. 4.8.12.5)

**Ducts**

- C NC **N/A** STAIR AND SMOKE DUCTS: Stair pressurization and smoke control ducts shall be braced and shall have flexible connections at seismic joints. (Tier 2: Sec. 4-8.14.1)



PARKING STRUCTURE #1 - TORSION CHECK



SLAB THICKNESS: 6.5"  
WALL THICKNESS: (t) = 8"  
WALL HEIGHT: (h) = 7'-0"

CENTER OF MASS

$$X_{cm} = \frac{\sum (m_i x_i)}{\sum m_i}$$

$$Y_{cm} = \frac{\sum (m_i y_i)}{\sum m_i}$$

$$m_1 = \rho_{wall} \times V$$

$$= 150 \times (44 \times 7 \times 6.5)$$

$$= 30800 \text{ lb}$$

$$m_2 = 150 \times (91.0 \times 7 \times 6.5)$$

$$= 63700 \text{ lb}$$

$$m_3 = 150 \times (25 \times 7 \times 3/12)$$

$$= 17,500 \text{ lb}$$

$$m_4 = 150 \times (66 \times 7 \times 6.5)$$

$$= 46,200 \text{ lb}$$

$$m_5 = 150 \times (46 \times 7 \times 6.5)$$

$$= 32,200 \text{ lb}$$

$$m_6 = 150 \times (66 \times 100 \times 6.5/12)$$

$$= 990000 \text{ lb}$$

$$m_7 = 150 \times (91 \times 80 \times 6.5/12)$$

$$= 1092000 \text{ lb}$$

$$X_{cm} = \frac{(63.7 \times 0) + (46.2 \times 25) + (990 \times -50) + (692 \times -40)}{63.7 + 46.2 + 990 + 1092}$$

$$\approx -42'$$

$$Y_{cm} = \frac{(30.8 \times 91) + (17.5 \times 0) + (32.2 \times -66) + (1190 \times -33) + (1092 \times 45.5)}{30.8 + 17.5 + 32.2 + 990 + 1092}$$

$$\approx 8'$$



CENTER OF RIGIDITY

$$R = \frac{1}{(0.1)\left(\frac{h}{d}\right)^3 + (0.3)\left(\frac{h}{f}\right)}$$

$$x_{CR} = \frac{\sum (R_i x_i)}{\sum R_i}, \quad y_{CR} = \frac{\sum (R_i y_i)}{\sum R_i}$$

$$R_1 = \frac{1}{(0.1)\left(\frac{7}{44}\right)^3 + (0.3)\left(\frac{7}{44}\right)} = 21$$

$$R_2 = \frac{1}{(0.1)\left(\frac{7}{91}\right)^3 + (0.3)\left(\frac{7}{91}\right)} = 43$$

$$R_3 = \frac{1}{(0.1)\left(\frac{7}{25}\right)^3 + (0.3)\left(\frac{7}{25}\right)} = 12$$

$$R_4 = \frac{1}{(0.1)\left(\frac{7}{46}\right)^3 + (0.3)\left(\frac{7}{46}\right)} = 31$$

$$R_5 = \frac{1}{(0.1)\left(\frac{7}{46}\right)^3 + (0.3)\left(\frac{7}{46}\right)} = 22$$

$$x_{CR} = \frac{43 \times 0 + 31 \times 25}{43 + 25} \approx 11'$$

$$y_{CR} = \frac{21 \times 91 + 12 \times 0 + 22 \times (-66)}{21 + 12 + 22} \approx 8'$$



THE ESTIMATED DISTANCE BETWEEN CENTER OF MASS AND CENTER OF RIGIDITY IN PARKING STRUCTURE 4/ IS APPROX. 53'. THIS IS GREATER THAN 20% OF THE BUILDING WIDTH IN THE DIRECTION OF ANALYSIS.

$$(53' > 99' \times 0.2 = 20')$$

∴ STRUCTURE NOT COMPLIANT FOR TORSION.

→ TIER 2 EVALUATION RECOMMENDED.



PARKING STRUCTURE 4 - SHEAR STRESS CHECK

BUILDING WEIGHT: 2272.4 kips. = W

$$v_j^{avg} = \frac{1}{m} \left( \frac{V_j}{A_w} \right) \quad (\text{EQ. 3-12}) \quad m = 4.0 \quad (\text{TABLE 3-7})$$

$$V_j = \sum F_x = \sum \frac{w_x h_x^k}{\sum w_i h_i^k} V$$

$S_{D1} = 0.680$   
 $S_{D5} = 1.108$   
 $T = 0.15 \text{ s}$

$$V = C S_a W$$

$$S_a = S_{D1} / T \quad \text{NOT TO EXCEED } S_{D5}$$

$$\rightarrow S_a = S_{D5} = 1.108$$

$$V = 1.4(1.108)(2272.4) = 3525 \text{ kips.}$$

$$T_x = V = 3525 \text{ kips (one story)}$$

Shear stress limit = 100 psi.

WALL A.G. SHEAR STRESS

E-W (1)	33.7	psi	<	100	psi
E-W (3)	33.7	psi	<	100	psi
E-W (5)	33.7	psi	<	100	psi
N-S (2)	33.7	psi	<	100	psi
N-S (4)	33.7	psi	<	100	psi

COMPLIANT



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APPENDIX C

UCT MATERIAL  
TESTING FINDINGS  
SUMMARY

Two (2) samples of concrete from the upper/roof level slabs were collected from each lot on site by Walker Restoration Consultants and sent to an independent testing laboratory, Universal Construction Testing LTD (UCT), for testing and analysis.

### COMPRESSIVE STRENGTH TESTS

Compressive strength testing was performed in accordance with ATM C42-13, Standard Test Method for Obtaining and testing Drilled Cores of Concrete.

Compressive strengths quantify the relative quality of concrete in the floor slab and can confirm results obtained from a visual analysis.

Results of the testing showed reasonable to good compressive strength values in all three garages. Refer to Table C-1 on page C-5 for a full summary of the compressive strength testing results.

### CHLORIDE ION CONTENT OF CONCRETE

Water-Soluble Chloride Content was determined according to the applicable provisions of ASTM C128-99, Standard Test Method for Water-Soluble Chloride in Mortar and Concrete.

Chloride ion content is indicative of the corrosion potential within the concrete, which relates to the likelihood of future corrosion-related floor slab deterioration.

Test results from UCT indicated higher than suggested chloride levels in the roof deck of the Lot 3 Parking Structure. Chloride levels were acceptable in the samples tested from the Lot 2 and Lot 4 Parking Structures.

The American Concrete Institute recommends the maximum water-soluble chloride content by weight of cement of 0.15% for a reinforced concrete structure. Moderately aggressive environments are areas where the concrete is exposed to moisture but not to external sources of chlorides. Roofs of parking structures in Southern California can generally be classified in this environment category.

Refer to Table C-2 on page C-5 for a full summary of the chloride content testing results.

## APPENDIX C: MATERIALS TESTING



## CARBONATION TESTING

Carbonation of concrete occurs when the carbon dioxide in the atmosphere reacts with hydrated cement minerals to produce calcium carbonate. Carbonation can be detrimental because it neutralizes the alkalinity present in the concrete. If it travels deep enough, carbonation can make the embedded reinforcement more susceptible to corrosion.

Results indicated carbonation reaching the level of the embedded steel reinforcement in Lots 2 and 3. This is consistent, particularly in Lot 3, with the amount of spalling that was observed in the elevated slabs.

The Lot 4 Parking Structure did not exhibit levels of carbonation that would be a cause for concern.

Refer to Table C-3 on page C-6 for a full summary of the chloride content testing results.

## PETROGRAPHIC EXAMINATION

A petrographic examination was conducted on cores taken from the Lot 2 and Lot 3 Parking Structures to determine the microscopic characteristics of the concrete. A petrographic examination can provide valuable information on the depth and nature of cracks and the presence of other chemical materials that may affect repairs.

A small representative rectangular block was cut from each core sample, placed on individual glass microscope slides with epoxy, and reduced to a thickness of approximately 20 micrometers. These thin sections were studied using a polarized-light (petrographic) microscope at magnifications up to 400X to determine aggregate and paste mineralogy and microstructure.

The results are summarized as follows:

### **Lot 2 (4.2" dia. core, approx. 5.1" long, full slab thickness):**

#### **Cracks**

- Randomly-oriented microcracks are common throughout the body of the concrete.



**Unit Weight**

- The unit weight of the core sample as received was 140 pcf (normal-weight concrete).

**Air Content**

- The concrete is non-air-entrained. Air content is estimated at 1-2%.

**Secondary Deposits:**

- No Secondary deposits were observed in voids or other available surfaces.

**Water-Cementitious Materials Ratio**

- The water-cementitious materials (cement plus fly ash) ratio is estimated at 0.55.

**Paste-Aggregate Bond**

- Moderately weak; freshly fractured surfaces of concrete pass around a majority of aggregate particles.

**Aggregates**

- The aggregates are relatively well graded and distribution is fairly uniform. The aggregates appear sound, exhibiting no evidence of deleterious reactions with the paste.
- The coarse aggregate is 3/4" top size siliceous gravel composed of a variety of igneous rocks. Individual particles are angular to sub-rounded and bladed to elongate.
- The fine aggregate is natural siliceous sand composed mainly of quartz, feldspar and various other rocks and minerals. Individual particles are angular to well-rounded and elongate to spherical.

**Lot 3 (4.2" dia. core, approx. 5.1" long, full slab thickness):**

**Cracks**

- Limited microcracking is observed. The microcracks extend vertically not much past the surface; other randomly-oriented microcracks are seen in the body of the core sample.

**Unit Weight**

- The unit weight of the core sample as received was 110 pcf (light-weight concrete).

**Air Content**

- The concrete is improperly air-entrained. Air content is estimated at 3-5%. Air-void distribution is non-uniform and coarse; occasional small, spherical voids are observed.

**Secondary Deposits:**



PROJECT #37-8377.00

- No Secondary deposits were observed lining or filling.

**Water-Cementitious Materials Ratio**

- The water-cementitious materials (cement plus fly ash) ratio is estimated at 0.50.

**Paste-Aggregate Bond**

- Moderately tight; freshly fractured surfaces of course aggregate particles pass around fine aggregate particles.

**Aggregates**

- The aggregates are relatively well graded and distribution is fairly uniform. The aggregates appear sound, exhibiting no evidence of deleterious reactions with the paste.
- The coarse aggregate is 1/2" top size expanded shale lightweight rock. Individual particles are sub-rounded to well-rounded and prolate to spherical.
- The fine aggregate is natural siliceous sand composed mainly of quartz, feldspar and various other rocks and minerals. Individual particles are angular to well-rounded and elongate to spherical.



Table C-1: Compressive Strength Test Results

Core No.	Location	Length, L (in)	Diameter, D (in)	L/D Ratio K	Total Load (lbs)	Uncorrected Compressive Strength (psi)	Corrected Compressive Strength (psi)
<b>L2C1</b>	222 12 <sup>th</sup> Street Lot #2	4.75	4.21	<u>1.13</u> 0.91	46,440	3,340	<b>3,040</b>
<b>L3C1</b>	1155 Morningside Drive Lot #3	4.21	4.21	<u>1.00</u> 0.87	63,440	4,560	<b>3,970</b>
<b>L4C1</b>	3714 Highland Avenue Lot #4	6.13	4.21	<u>1.45</u> 0.95	65,340	4,690	<b>4,460</b>
<b>L4C2</b>	3714 Highland Avenue Lot #4	6.36	4.21	<u>1.51</u> 0.96	92,740	6,660	<b>6,400</b>
Remarks: The cores were tested in air-dry conditions.							

Table C-2: Chloride Content Analysis Results

Sample Number	Location in Structure	Level tested, inch from top	Chloride ion (CL <sup>-</sup> ) Content		
			by weight of concrete %	by weight of cement* %	by weight of concrete (ppm)
<b>L2C1 (*)</b>	222 12 <sup>th</sup> Street Lot #2	0-1	0.012	<b>0.08</b>	120
		1-2	0.004	<b>0.03</b>	40
		2-3	0.002	<b>0.01</b>	20
<b>L3C1 (**)</b>	1155 Morningside Drive, Lot #3	0-1	0.032	<b>0.16</b>	320
		1-2	0.030	<b>0.15</b>	300
		2-3	0.022	<b>0.11</b>	220
		3-1/2 - 4-1/2	0.020	<b>0.10</b>	200
<b>L4C1 (*)</b>	3714 Highland Avenue Lot #4	0-1	0.017	<b>0.11</b>	170
		1-2	0.002	<b>0.01</b>	20
		2-3	0.002	<b>0.01</b>	20
Remarks: *) Assumed cement content 600 lbs/cu.yd. and U.W. = 3780 pcy. **) Assumed cement content 600 lbs/cu.yd. and U.W. = 2970 pcy.					



Table C-3: Carbonation Content Analysis Results

<b>Structure</b>	<b>Carbonation Depth from Top Surface (in.)</b>	<b>Carbonation Depth from Bottom Surface (in.)</b>
Lot 2		
Sample 1*	1.30	2.00
Sample 2**	0.00	1.00
Lot 3		
Sample 1*	0.90	1.40
Sample 2**	1.00	1.75
Lot 4		
Sample 1**	0.00	0.00
Sample 2**	0.00	0.75

\*UCT Laboratory Results

\*\*Walker Field Results



August 20, 2013

UCT Project No.: 23161

Mr. Nima Patel  
 Project Engineer II  
**Walker Restoration Consultants**  
 606 S. Olive Street, Suite 1100  
 Los Angeles, CA 90014

Re: Laboratory Studies of Concrete Core Samples  
**Manhattan Beach**  
 Manhattan Beach, California

Dear Mr. Patel:

Universal Construction Testing (UCT) has completed laboratory studies of six (6) core samples from the referenced project, which were delivered to our laboratories on August 6, 2013.

The scope of our work, as outlined in your transmittal letter of August 1, 2013, consisted of compressive strength testing, chloride content analysis, and petrographic examination.

Refer to Table 1 below for core sample identification, location and testing performed.

**Table 1. Core Sample Identification, Location and Test Program**

Core ID	Location	Compression Test	Chloride Content Analysis 1", 2" 3" depth	Petrographic Examination
L2C1	222 12 <sup>th</sup> Street Lot #2	X	X	
L2C2				X
L3C1	1155 Morningside Drive Lot #3	X	X	
L3C2				X
L4C1	3714 Highland Avenue Lot #4	X	X	
L4C2		X		

## SUMMARY OF FINDINGS

*Overview: The core samples examined indicate that the concrete was placed on a form and the surface received a broom finish. The top surface is worn as evidenced by exposed aggregates. The slab ranges in thickness from approximately 4" to 7". The aggregates appear sound and in good condition. The concrete is well consolidated. Paste properties are judged to be good.*

**CHICAGO**  
 236 Egidi Drive, Ste D  
 Wheeling, IL 60090  
 P 847.459.9090

[www.uctgroup.com](http://www.uctgroup.com)

**HOUSTON**  
 1036 1st St E, Ste A3  
 Humble, TX 77338  
 P 281.446.7363

[www.radarviewllc.com](http://www.radarviewllc.com)

**MIAMI**  
 1850 S. Ocean Drive, Ste 3804  
 Hallandale, FL 33009  
 P 954.676.4147

**222 12<sup>th</sup> Street:**

*The compressive strength of Core L2C1 is 3,040 psi.*

*Chloride content of Core L2C1 is 0.08% at the top surface.*

*Petrographic examination revealed Core Sample L2C2 was produced using normal-weight concrete (140 pcf density). The normal-weight aggregate is siliceous gravel with a top size of 3/4".*

*Distress is essentially limited to the bottom approximately 1" of the core sample. The distress is manifested as a sub-surface crack similar in appearance to a delamination. A clear cause of this crack was not determined; no steel is observed in the general vicinity.*

*The paste is carbonated to a depth of up to 1.3" from the existing top surface. Also carbonation reaches upward as much as 2" from the bottom surface.*

*Interpreted water-cementitious (cement plus fly) ratio, based on paste properties is approximately 0.55. Cement paste along surfaces of freshly fractured surfaces is light gray, moderately soft to moderately hard and exhibits dull luster. Paste-aggregate bond is moderately weak.*

*Concrete is non-air-entrained, based on the scarcity of small, spherical voids; concrete is well consolidated. Air content is estimated less than <2.*

**1155 Morningside Drive:**

*The compressive strength of Core L3C1 is 3,970 psi.*

*Chloride content of Core L3C1 is 0.16% at the top surface.*

*Petrographic examination revealed Core Sample L3C2 was produced using lightweight concrete (110 pcf density). The lightweight rock is expanded shale with a top size of 1/2".*

*The general quality and condition of this core sample is good, no distress or major abnormalities are observed.*

*The paste is carbonated to a depth of 0.9" from the existing top surface and upward from the bottom surface 1.4".*

*Estimated water-cement ratio, based on paste properties, is around 0.50. The concrete contains scarce amounts of fly ash as well as portland cement.*

*Cement paste is light-whitish gray, moderately hard and exhibits dull to subvitreous luster. Paste-aggregate bond is moderately tight.*

*The concrete is air-entrained, based on the presence of small, spherical voids. Air content is estimated at 3% to 5%, by volume of concrete.*

**3714 Highland Avenue:**

*The compressive strength of Core L4C1 is 4,460 psi and the compressive strength of Core L4C2 is 6,400 psi.*

*Chloride content of Core L4C1 is 0.11% at the top surface.*

**Compressive Strength**

Compressive Strength Testing was performed in accordance with ASTM C42-13, *Standard Test Method for Obtaining and Testing Drilled Cores of Concrete*.

Refer to Table 2 below for concrete compressive strength test results of the core samples.

**Table 2. Compressive Strength Test Results**

Core No.	Location	Length, L (in)	Diameter, D (in)	L/D Ratio K	Total Load (lbs)	Uncorrected Compressive Strength (psi)	Corrected Compressive Strength (psi)
<b>L2C1</b>	222 12 <sup>th</sup> Street Lot #2	4.75	4.21	$\frac{1.13}{0.91}$	46,440	3,340	<b>3,040</b>
<b>L3C1</b>	1155 Morningside Drive Lot #3	4.21	4.21	$\frac{1.00}{0.87}$	63,440	4,560	<b>3,970</b>
<b>L4C1</b>	3714 Highland Avenue Lot #4	6.13	4.21	$\frac{1.45}{0.95}$	65,340	4,690	<b>4,460</b>
<b>L4C2</b>	3714 Highland Avenue Lot #4	6.36	4.21	$\frac{1.51}{0.96}$	92,740	6,660	<b>6,400</b>

Remarks: The cores were tested in air-dry conditions.

**Chloride Content Analysis**

Water-Soluble Chloride Content was determined according to the applicable provisions of ASTM C1218-99, *Standard Test Method for Water-Soluble Chloride in Mortar and Concrete*.

Refer to Table 3 below for chloride content ion analysis test results of the cores analyzed.

**Table 3. Chloride Content Analysis Results**

Sample Number	Location in Structure	Level tested, inch from top	Chloride ion (CL <sup>-</sup> ) Content		
			by weight of concrete %	by weight of cement* %	by weight of concrete (ppm)
<b>L2C1 (*)</b>	222 12 <sup>th</sup> Street Lot #2	0-1	0.012	<b>0.08</b>	120
		1-2	0.004	<b>0.03</b>	40
		2-3	0.002	<b>0.01</b>	20
<b>L3C1 (**)</b>	1155 Morningside Drive, Lot #3	0-1	0.032	<b>0.16</b>	320
		1-2	0.030	<b>0.15</b>	300
		2-3	0.022	<b>0.11</b>	220
		3-½ - 4-½	0.020	<b>0.10</b>	200
<b>L4C1 (*)</b>	3714 Highland Avenue Lot #4	0-1	0.017	<b>0.11</b>	170
		1-2	0.002	<b>0.01</b>	20
		2-3	0.002	<b>0.01</b>	20
Remarks: *) Assumed cement content 600 lbs/cu.yd. and U.W. = 3780 pcy. * *) Assumed cement content 600 lbs/cu.yd. and U.W. = 2970 pcy.					

The analyses of the concrete core samples measured chloride levels ranging from 0.08% to 0.16% at the top surface. The chloride contamination decreases with core depth. The exception is Core L3C1, at the 1-2" depth chloride levels are still at the corrosion threshold.

Significant decrease in chloride ingress with depth suggests an external source of chlorides, such as deicer salts. At the 2-3" depth, the chloride ingress diminishes to levels below the corrosion threshold.

Based upon the present state of knowledge, 0.15% maximum water-soluble chloride content expressed by weight of cement is suggested by American Concrete Institute to minimize the risk of chloride-induced corrosion conventionally reinforced concrete.

### **Petrographic Studies**

Petrographic Examinations were conducted in general accordance with provisions of ASTM C856-11, *Standard Practice for Petrographic Examination of Hardened Concrete*.

- The core samples were visually examined and photographed as received. The samples were then cut and one of the resulting surfaces of each was lapped and examined using a stereomicroscope at magnifications up to 45X. Surfaces of freshly fractured concrete were also studied using the stereomicroscope.

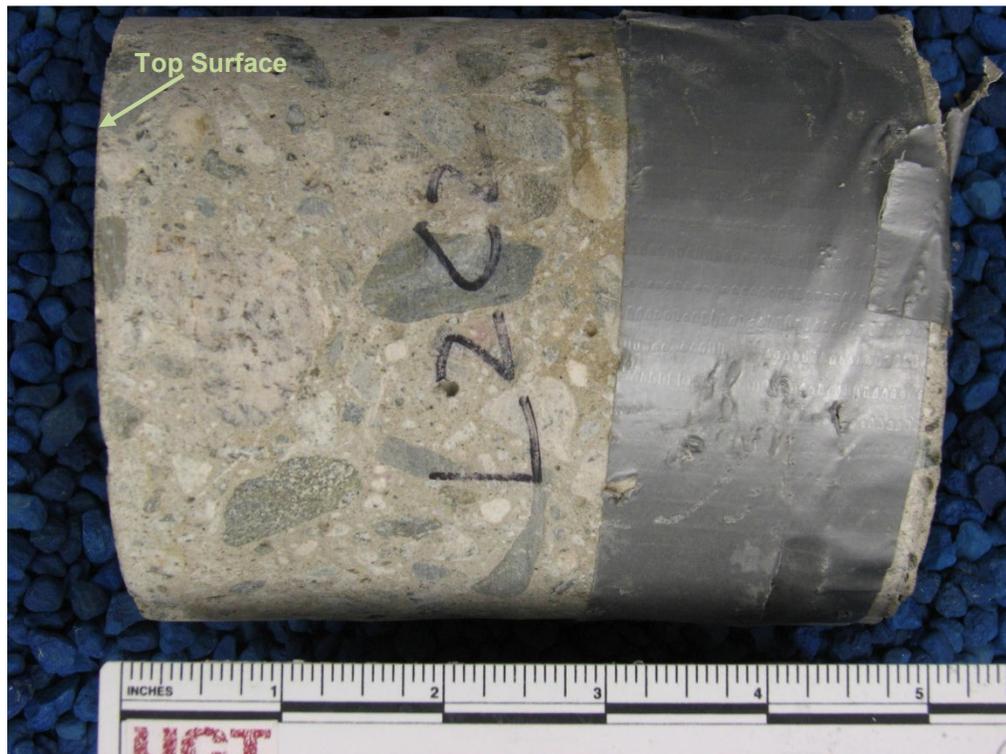
- A small representative rectangular block was cut from each core sample, placed on individual glass microscope slides with epoxy, and reduced to a thickness of approximately 20 micrometers. These thin sections were studied using a polarized-light (petrographic) microscope at magnifications up to 400X to determine aggregate and paste mineralogy and microstructure.

Results of the petrographic examinations are summarized below.

### **Core Sample L2C2 (12<sup>th</sup> Street)**

#### **General**

The core sample is 4.2" in diameter and approximately 5.1" long; full slab thickness. The paste of the top of this core sample is worn; originally a broom-finished surface exhibits exposed sand grains. The bottom of the core is a formed surface showing deterioration (1" depth delamination). Consolidation of the concrete is good with no evidence of segregation.



**Figure 1 – Core Sample L2C2, as received for examination. The top surface of the core sample is to the left.**

#### **Reinforcement**

Neither embedded steel reinforcement nor synthetic fibers are present in this core sample.

### Cracks

The bottom approximately 1" of concrete is delaminated in this core sample. Randomly-oriented microcracks are common throughout the body of the concrete.

### Unit Weight

The unit weight of the core sample as received is **140 pcf** (normal-weight concrete).

### Air Content

The concrete is non-air-entrained. Air content is estimated at **1-2%**.

### Secondary Deposits

No secondary deposits are observed in voids or other available surfaces.

### Carbonation

The paste is carbonated to a depth of up to **1.3"** from the existing top surface and upward as much as **2"** from the bottom surface.

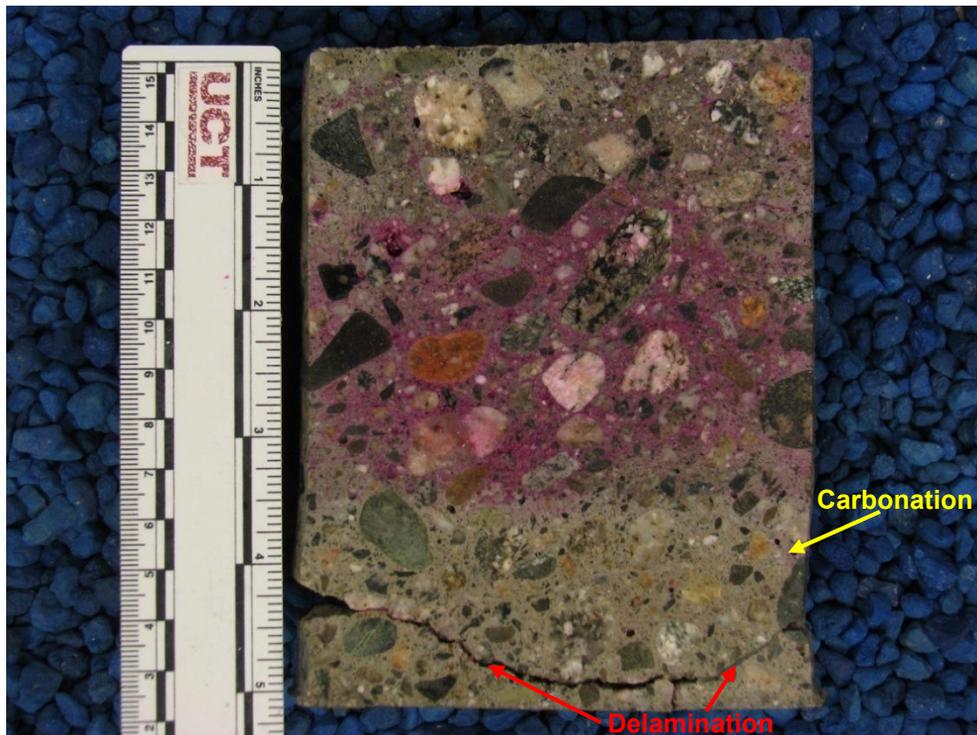


Figure 2 – Photomicrograph showing the depth of carbonation at the top and bottom surfaces of Core Sample L2C2. Note location of delamination near the bottom surface of the core sample.

### Water-Cementitious Materials Ratio

The water-cementitious materials (cement plus fly ash) ratio is estimated at **0.55 ± 0.05**.

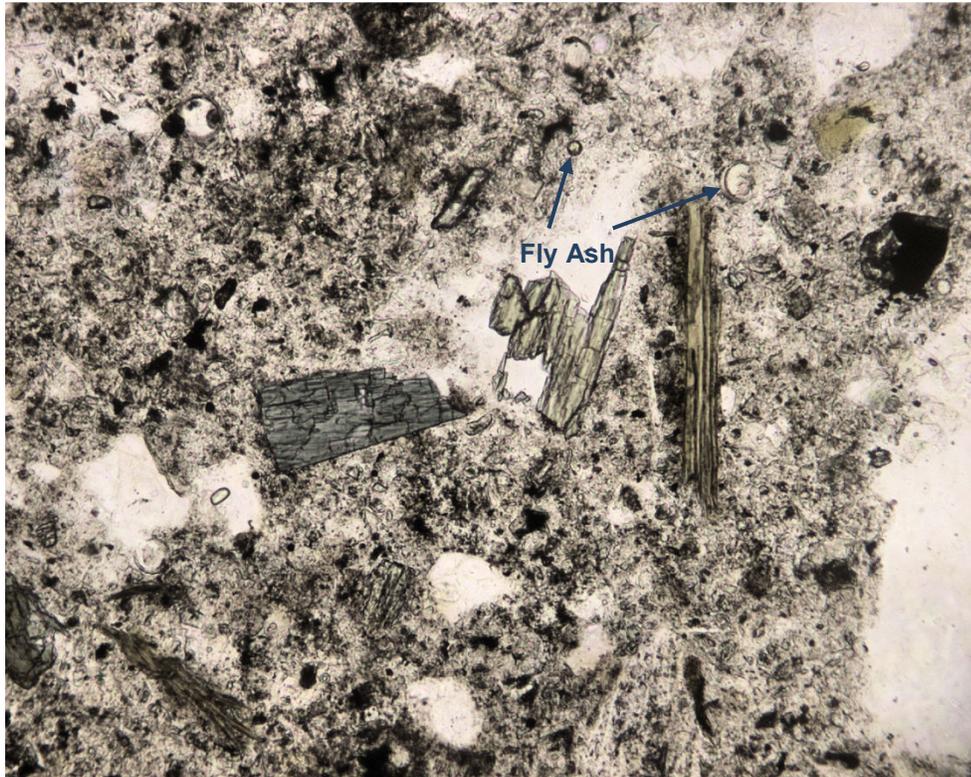


Figure 3 – Thin-section photomicrograph taken in plane-polarized light showing the cementitious-paste microstructure in Core Sample L2C2. Concrete paste contains residual cement and fly ash spheres. 100X magnification.

### Paste Properties

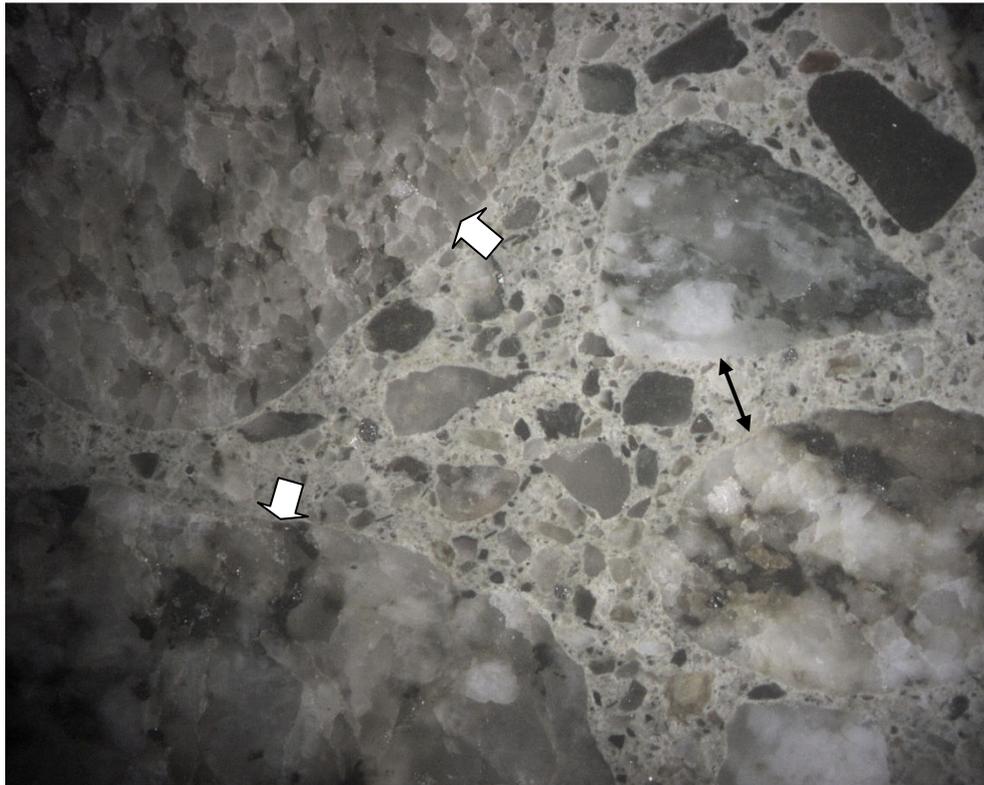
<i>Color</i>	<i>Light gray</i>
<i>Hardness</i>	<i>Moderately soft to moderately hard</i>
<i>Luster</i>	<i>Dull (and chalky)</i>
<i>Paste Volume</i>	<i>Average</i>
<i>Morphology of Calcium Hydroxide</i>	<i>Medium-size crystals</i>
<i>Mineralogy of the Cement</i>	<i>Portland cement (C-S-H)</i>
<i>Hydration</i>	<i>Normal</i>
<i>Residual Portland Cement Grains</i>	<i>3% to 8% clinker particles</i>
<i>Supplementary Cementitious Materials</i>	<i>1% to 4% residual fly ash</i>

### **Paste-Aggregate Bond**

Moderately weak; freshly fractured surfaces of concrete pass around a majority of aggregate particles.

### **Aggregates**

The aggregates are relatively well graded and distribution is fairly uniform. The aggregates appear sound, exhibiting no evidence of deleterious reactions with the paste.



**Figure 4 – Cut and lapped cross section of Core Sample L2C2 showing the general characteristics of the normal-weight siliceous aggregates (arrows). Length of view, left to right, is approximately 0.7".**

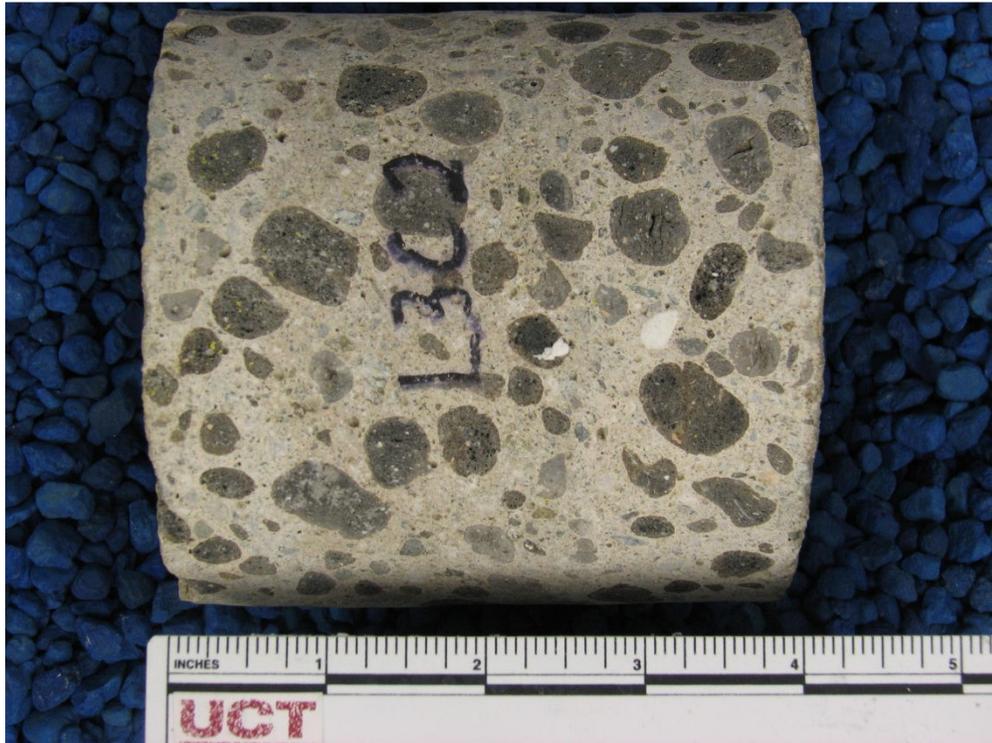
The coarse aggregate is 3/4" top size siliceous gravel composed of a variety of igneous rocks. Individual particles are angular to sub-rounded and bladed to elongate.

The fine aggregate is natural siliceous sand composed mainly of quartz, feldspar and various other rocks and minerals. Individual particles are angular to well rounded and elongate to spherical.

### **Core Sample L3C2 (1155 Morningside Drive)**

#### **General**

The core sample is 4.2" in diameter and approximately 4.2" long; full slab thickness. The top surface of the core sample is worn with exposed aggregates; the original surface appears to have been broom finished. The bottom of the core is a formed surface. Consolidation of the concrete is good with no signs of segregation.



**Figure 5 – Core Sample L3C2, as received for examination. Lightweight coarse aggregates (dark rocks) are generally spherical and rounded. The top surface of the core is to the left.**

#### **Reinforcement**

Neither embedded steel reinforcement nor are synthetic fibers present in this core sample.

#### **Cracks**

Limited microcracking is observed. The microcracks extend vertically not much past the surface; other randomly-oriented microcracks are seen in the body of the core sample.

#### **Secondary Deposits**

No secondary deposits are observed lining or filling voids.

### Unit Weight

The unit weight of the core sample as received is **110 pcf** (lightweight concrete).

### Air Content

The concrete is improperly air-entrained. Air content is estimated at **3-5%**. Air-void distribution is non-uniform and coarse; occasional small, spherical voids are observed.

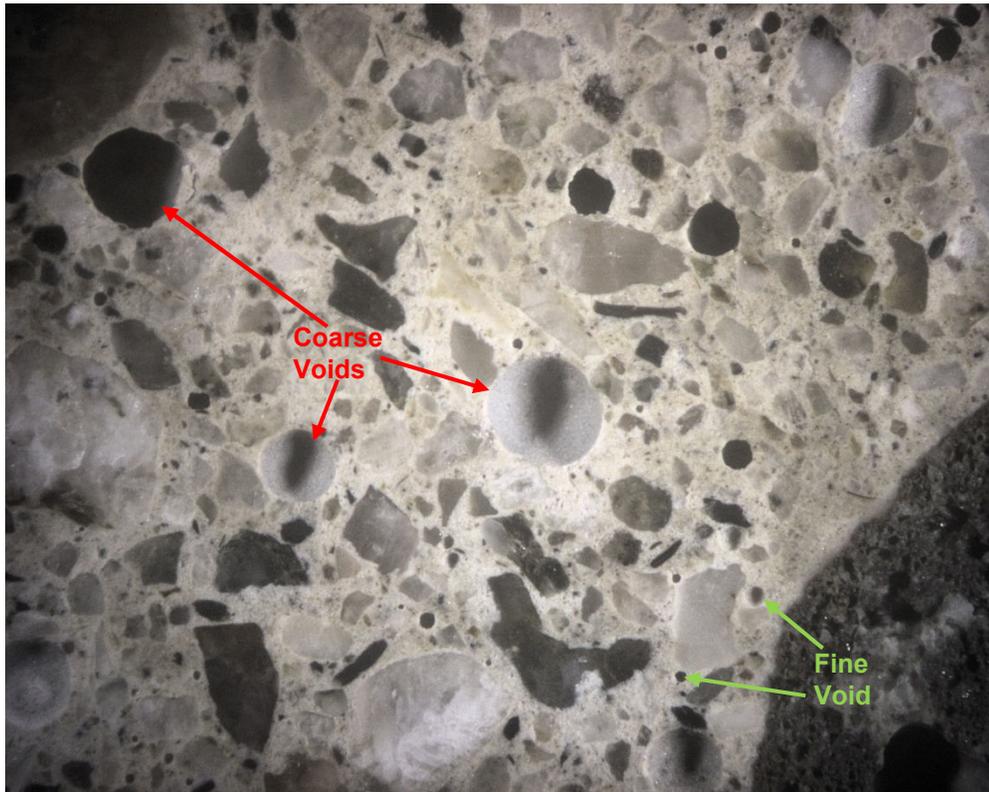
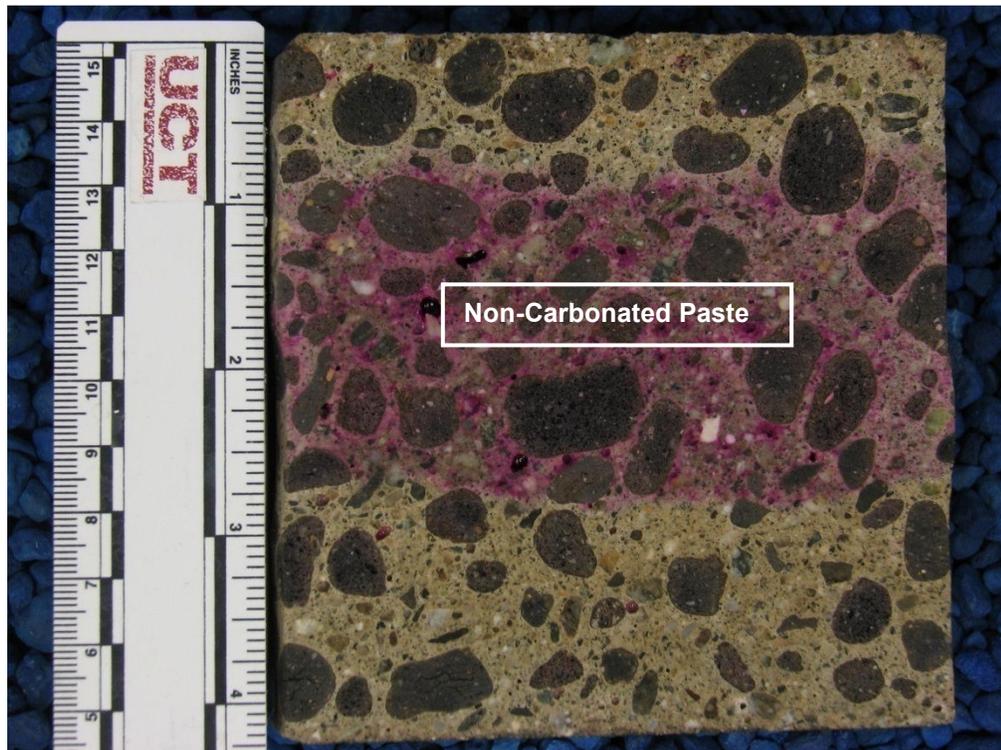


Figure 6 – Photomicrograph showing the air-void system in Core Sample L3C2. The air-void system is comprised of coarse air voids and some small, spherical voids. Length of view is approximately 0.35".

### Carbonation

The paste is carbonated to a depth of **0.9"** from the existing top surface and upward **1.4"** from the bottom surface.



**Figure 5 – Photomicrograph showing the depth of carbonation at the top and bottom surfaces of Core Sample L3C2. The freshly cut surface was treated with a pH indicator (phenolphthalein) solution. Phenolphthalein reacts with non-carbonated paste turning it magenta while carbonated paste for the most part remains unaffected.**

#### **Water-Cementitious materials Ratio**

The water-cementitious materials (cement plus fly ash) ratio is estimated at around 0.50.

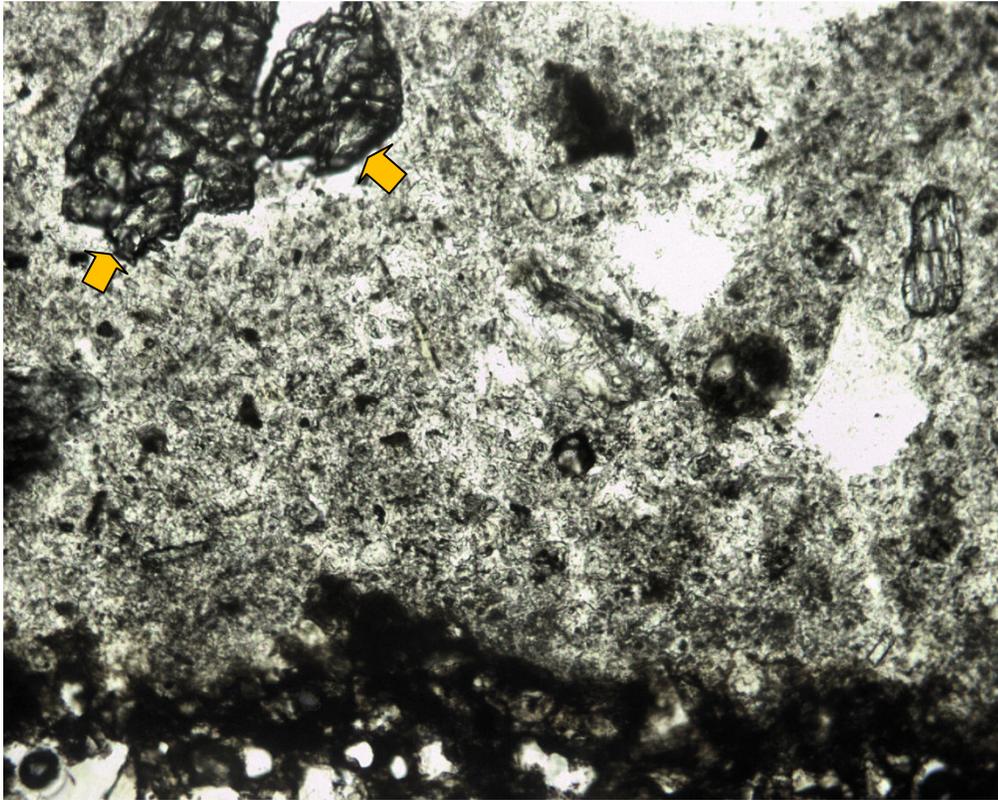


Figure 7 – Thin-section photomicrograph taken in plane-polarized light showing the cement-paste microstructure in Core Sample L3C2. Concrete is predominately residual portland cement particles; note two coarse cement grains (arrows). Fly ash spheres are rare to infrequently. 100X magnification.

### Paste Properties

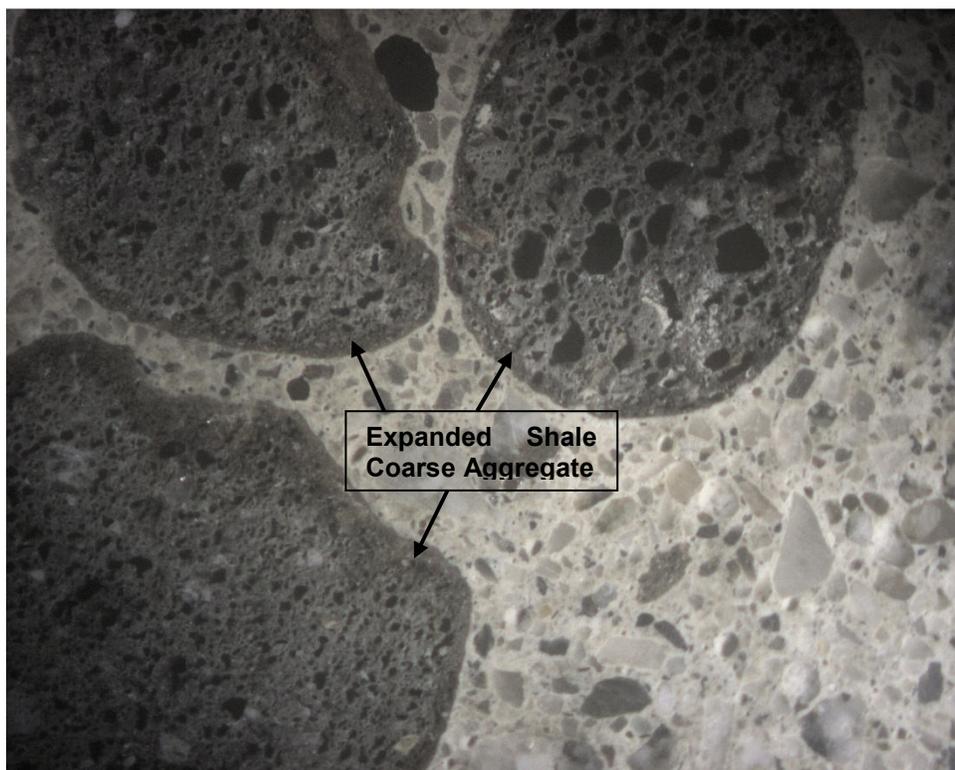
<i>Color</i>	<i>Light-whitish gray; darker surface</i>
<i>Hardness</i>	<i>Moderately hard</i>
<i>Luster</i>	<i>Dull to subvitreous</i>
<i>Paste Volume</i>	<i>Average</i>
<i>Morphology of Calcium Hydroxide</i>	<i>Medium-size crystals</i>
<i>Mineralogy of the Cement</i>	<i>Portland cement (C-S-H)</i>
<i>Hydration</i>	<i>Normal</i>
<i>Residual Portland Cement Grains</i>	<i>5% to 10% clinker particles</i>
<i>Supplementary Cementitious Materials</i>	<i>Traces (&lt;1%) residual fly ash</i>

### **Paste-Aggregate Bond**

Moderately tight; freshly fractured surfaces of concrete pass through coarse aggregate particles and around fine aggregate particles.

### **Aggregates**

The aggregates are relatively well graded and distribution is fairly uniform. The aggregates appear sound, exhibiting no signs of deleterious reactions with the paste.



**Figure 8 – Cut and lapped cross section of Core Sample L3C2 showing the general characteristics of the aggregates (size, shape and distribution); note the lightweight coarse aggregate and natural siliceous sand in the hardened paste. Length of view is approximately 0.7".**

The coarse aggregate is 1/2" top size expanded shale lightweight rock. Individual particles are sub-rounded to well rounded and prolate to spherical.

The fine aggregate is natural siliceous sand composed mainly of quartz, feldspar and various other rocks and minerals. Individual particles are angular to well rounded and elongate to spherical.

\*\*\*\*\*

We appreciate this opportunity to be of continued service to you.

Sincerely yours,  
**Universal Construction Testing, Ltd.**



Elena Emerson  
Director of Laboratory Services



David B. Vollmer  
Senior Consultant - Petrographic Services



Mark E. Hughes, P.E.  
General Manager

mh-dv-ee / Report 23161

Samples will be discarded after ninety (90) days unless other disposition is requested by you.



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APPENDIX D

SCOPE OF SERVICES

**WALKER RESTORATION CONSULTANTS**

The following Scope of Services provides a phased breakdown of the proposed work plan for development of a Ten Year Capital improvement and Protection Program for the parking structure.

**TASK 1 ----- CONDITION APPRAISAL**

- 1.1. Review existing drawings, specifications, shop drawings, and previous repair documents if available.
- 1.2. Conduct an evaluation of the parking facility to document the current physical condition of structural and operational elements within the structure. This will include visual observations to review the following elements:
  - a. Floors, columns, beams, walls, ceilings and other structural elements. The visual review will document noticeable distress such as cracks, leaks, spalls, scaling, joint deterioration, and other similar adverse conditions. In addition to documenting the nature of noticeable adverse conditions, this review will be utilized to project restoration quantities.
  - b. Mechanical systems, including the observable drainage and plumbing.
  - c. Architectural elements including exterior facades.
  - d. Stairs towers along with other similar operational elements.
  - e. Other elements that are noted during the field evaluation.
- 1.3. The field evaluation will include limited field-testing of concrete members. The scope and extent of the testing will be coordinated to evaluate viable repair approaches and alternatives. Existing data will be used wherever possible. The final testing program for the structure will be coordinated with the long-term budget requirements. The following field tests will be considered in the development of the testing program:

**APPENDIX D:  
SCOPE OF SERVICES**



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- a. Chain drag delamination survey of select locations of supported floor surfaces to estimate bid quantities for concrete floor repair.
  - b. Chloride ion content of concrete core samples at equal increments to determine the chloride contamination at various depths of the floor slab. Two locations within each structure will be selected.
  - c. Petrographic examination of concrete core samples from two of the structures to determine microscopic characteristics of the concrete.
- 1.4. Submit written notification to you and your staff of any items requiring immediate repairs for the continued safe use of the parking facility.
- 1.5. Compile and analyze field examination data to generate repair alternatives, recommendations, and estimates of probable costs of construction.

**TASK 2 – CAPITAL IMPROVEMENT AND PROTECTION PROGRAM (CIPP)**

- 2.1. Meet with you and your staff to discuss our observations, findings, repair recommendations, alternatives, budget constraints, and schedule constraints.
- a. Identify immediate repairs to structural elements necessary to maintain safety and serviceability.
  - b. Recommend solutions for the identified problems and provide a cost estimate and repair priority. Where necessary, selection of most cost-effective repair recommendations will be based on cost/benefit and life cycle cost analysis.
  - c. Recommend preventive repair actions necessary to extend the service life of the structure based on our evaluation and test data.



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- d. Recommend other operational and/or aesthetic upgrades and improvements, where appropriate.
  - e. Identify the need for any other structural evaluation and/or study (if any) that may be required to develop or implement the program.
- 2.2. Prepare a preliminary plan to implement identified repair actions over a ten year period. This repair programming will be based on considerations of the estimates of probable construction cost, available funds, schedule constraints, repair priority, feasibility, practicality, and level of occupancy and phasing during construction.
- 2.3. Discuss with you and your staff the final details of the CIPP.
- 2.4. Submit copies of the draft report package and CIPP for your review. Once we receive your coordinated comments we will make appropriate changes and finalize the CIPP report. We will provide up to three hard copies as well as an electronic version of the final CIPP report.



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APPENDIX E

TERMINOLOGY,  
NOTES, AND  
GLOSSARY



TERMINOLOGY

We define condition terms used in the report below. Please note that when terms are applied to an overall system, certain portions of the system may be in a different condition.

**Excellent:** Item is in “as new” condition requiring no rehabilitation and should perform in full accordance with its useful expected life.

**Good:** Item is sound and performing its function, although it may show signs of normal wear and tear. Some incidental rehabilitation work may be recommended.

**Fair:** Item is performing adequately at this time but exhibits deferred maintenance, evidence of previous rehabilitation, substandard workmanship, is obsolete, or is approaching the end of its typical useful expected life. Rehabilitation, replacement, or maintenance is necessary to prevent further deterioration, or to prolong its useful life.

**Poor:** Item has either failed or cannot be relied upon to continue performing its original function. Present condition could contribute or cause the deterioration of other adjoining elements or systems. Rehabilitation or replacement is required.

**APPENDIX E:  
TERMINOLOGY,  
NOTES AND  
GLOSSARY**

**GLOSSARY**

**ABRASION RESISTANCE:** Ability to resist being worn away by rubbing and friction.

**AIR ENTRAINMENT:** The inclusion of air in the form of minute bubbles, (generally smaller than 1 mm), during the mixing of concrete to help prevent scaling.

**CONCRETE:** Mixture of portland cement, fine aggregate, coarse aggregate, and water, with or without admixtures.

**CORROSION:** Disintegration or deterioration of concrete or reinforcement by electrolysis or by chemical attack.

**CRAZE CRACKS:** Fine, random cracks, or fissures caused by shrinkage, which may appear in a surface of plaster, cement paste, mortar, or concrete.

**DEFLECTION:** A variation in position or shape of a structure or element due to effects of loads or volume change, usually measured as a linear deviation from an established plane.

**DELAMINATION:** In the case of a concrete slab, a delamination is the horizontal splitting, cracking, or separation of a slab in a plane roughly parallel to, and generally near, the upper surface. Delaminations are typically caused by corrosion of reinforcing steel or separation between concrete topping and underlying elements.

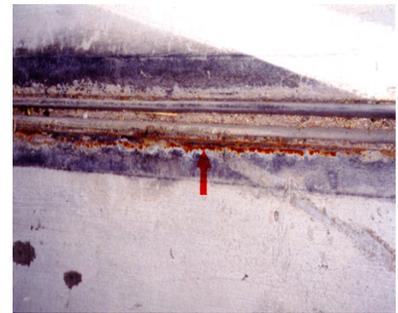
**DETERIORATION:** Disintegration or chemical decomposition of a material during service exposure.

**DIAGONAL CRACK:** An inclined crack caused by shear stress, usually at about 45 degrees to the neutral axis of a concrete member; or a crack in a slab, not parallel to the lateral or longitudinal dimensions.

**DURABILITY:** The ability of concrete to resist weathering action, chemical attack, abrasion, and other conditions of service.

**EFFLORESCENCE:** A deposit of mineral salts, usually white in color, formed on a concrete or masonry surface.

REPRESENTATIVE PHOTOS IN APPENDIX E ARE NOT TAKEN FROM THE AUTOPARK#29 PARKING STRUCTURE



EXPANSION JOINT CORROSION



CONCRETE WAFFLE SLAB CORROSION



CRACKING



PROJECT #37-8377.00

**ENTRAINED AIR:** Microscopic air bubbles intentionally incorporated in concrete during mixing by the use of chemical agents or specialty cement.

**ENTRAPPED AIR:** Air voids in concrete that are not purposely entrained and which are significantly larger and less useful than those of entrained air.

**EPOXY CONCRETE:** A mixture of epoxy resin, catalyst, fine aggregate and coarse aggregate.

**HAIRLINE CRACKING:** Small cracks of random pattern in an exposed concrete surface.

**JOINT SEALANT:** Compressible material used to exclude water and solid foreign material from joints.

**MAINTENANCE:** Taking periodic actions that will either prevent or delay damage or deterioration or both.

**MICROCRACKS:** Microscopic cracks within concrete.

**OVERLAY:** A layer of concrete or mortar, seldom thinner than 1 inch, placed on and usually bonded to the worn or cracked surface of a concrete slab to either restore or improve the function of the previous surface.

**PACHOMETER:** Instrument for nondestructively locating and estimating concrete cover and/or diameter of embedded reinforcement.

**PATTERN CRACKING:** Fine openings on concrete surfaces in the form of a pattern resulting from a decrease in volume of the material near the surface, or increase in volume of the material below the surface, or both.

**PEELING:** A process in which thin flakes of mortar are broken away from a concrete surface, such as by deterioration or by adherence of surface mortar to forms as they are removed.

**PITTING:** Development of relatively small cavities in a surface, due to phenomena such as corrosion or cavitation, or, in concrete, localized disintegration. (See also POPOUT)

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**PLASTIC CRACKING:** Cracking that occurs in the surface of fresh concrete soon after it is placed and while it is still plastic.

**POPOUT:** The breaking away of small portions of concrete surface due to internal pressure which leaves a shallow, typically conical, depression.

**PRECAST CONCRETE:** Concrete cast elsewhere than in its final position.

**PRESTRESSED CONCRETE:** Concrete in which stresses of such magnitude and distribution are introduced that the tensile stresses resulting from the service loads are counteracted to the desired degree.

*Pretensioned* concrete is prestressed concrete in which stressing tendons are tensioned *before* the concrete hardens.

*Post-Tensioned* concrete is prestressed concrete in which stressing tendons are tensioned *after* the concrete hardens.

**REINFORCEMENT:** Bars, (smooth or deformed), wires, strands, tendons and other elements that are embedded in concrete in such a manner that reinforcement and concrete act together to resist applied forces.

*Conventional* reinforcement is non-prestressed smooth or deformed bar or wire reinforcement with yield strengths in the 40,000-75,000 psi range.

*Prestressed* reinforcement is steel bars, wires or strands with ultimate strengths in the 250,000-270,000 psi range, strong enough to permit effective pre- or post-tensioning.

**SANDBLASTING:** A system of cutting or abrading a surface, such as concrete, by a stream of sand ejected from a nozzle at high speed by compressed air; often used for cleanup or for exposure of aggregate in architectural concrete.

**SCALING:** Local flaking or peeling away of the near-surface portion of hardened concrete or mortar; also of a layer from metal. (Note: Light scaling of concrete does not expose coarse aggregate; medium scaling involves loss of surface



POPOUT



SURFACE SCALING



HEAVY SURFACE SCALING

PROJECT #37-8377.00

mortar of 5-10 mm in depth and exposure of coarse aggregate; severe scaling involves loss of surface mortar of 5-10 mm in depth with some loss of mortar surrounding aggregate particles 10-20 mm in depth; very severe scaling involves loss of coarse aggregate particles as well as mortar generally to a depth greater than 20 mm.).

**SHORT SPAN:** A structural system that doesn't span the full parking module, resulting in columns between parked vehicles.

**SHOTCRETE:** Process in which all ingredients, including mixing water, are mixed before introduction into the delivery hose; it may be pneumatically conveyed or moved by displacement.

**SHRINKAGE CRACKING:** Cracking of a structure or member due to failure in tension caused by external or internal restraints as reduction in moisture content develops, or as carbonation occurs, or both.

**SPALL:** A dish-shaped cavity or void formed by the broken surface, edge, or corner of a larger mass such as a floor slab, beam, column, wall, etc. Spalls are usually the result of weathering, pressure, or volume change of the larger mass.

**TENDON:** A steel element such as a wire, cable, bar, rod, strand, or group of such elements used to impart prestress to concrete when the element is tensioned.

**TRANSVERSE CRACKS:** Cracks that develop at right angles to the long direction of a member.



FLOOR SLAB SPALLING



**WALKER**  
RESTORATION CONSULTANTS

