

# CONDITION APPRAISAL

## HAVILAND STREET PARKING GARAGE

NORWALK, CONNECTICUT

Prepared for:



**PARK NORWALK**

11 NORTH WATER STREET  
NORWALK, CT 06854

Submitted by:

# DESMAN

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## 1. INTRODUCTION

### A. AUTHORIZATION:

**DESMAN** was retained by **Park Norwalk (PN)**, c/o City of Norwalk (the City) to provide consulting engineering services to perform a condition appraisal update at the Haviland Street Parking Garage, Norwalk, Connecticut. This appraisal was performed in accordance with **DESMAN**'s proposal, dated March 27, 2025 and authorized to proceed by the **PN** on April 24, 2025.

### SCOPE OF SERVICES:

The scope of services is outlined in detail in **DESMAN**'s proposal. In summary, these services primarily consisted of the following work:

#### TASK 1: VISUAL RECONNAISSANCE/SURVEY:

- **DESMAN** will evaluate all available historical documents pertaining to this project inclusive of, but not limited to, original design drawings, condition assessment reports, and repair documents, paying particular attention to structural framing, expansion/construction joints and architectural/waterproofing detailing (i.e., drainage slopes, caulking details, etc.).
- **DESMAN** will then conduct a visual reconnaissance of the parking garage to identify and quantify the areas of deterioration, distress, corrosion, moisture infiltration, or unusual conditions. Issues to be reviewed include the following:
  - **DESMAN** will document the condition of concrete construction with respect to erection tolerances, bearing conditions at column corbels, corrosion of pre-cast concrete shear connector assemblies, cracking, spalling, surface scaling, and water leakage.
  - **DESMAN** will review the condition of concrete beam and column framing along with cast-in-place floor slab or topping concrete.
  - **DESMAN** will review the condition of joint detailing (tee joints, expansion joints, construction joints, control joints, cove joints), crack detailing, and other waterproofing components as may be appropriate.
  - **DESMAN** will review the condition of the facade, elevations, exterior perimeter walls, spandrel panels, exterior connections, etc. as may be exposed.



- **DESMAN** will review the condition and configuration of deck drainage (i.e., the locations of floor drains, locations of standing water/ponding conditions, condition of drainage piping, etc.), and overall apparent drainage performance.
  - **DESMAN** will review the condition of the lighting and electrical components (i.e. locations of deteriorated conduit and boxes, locations of damaged light fixtures). **DESMAN** notes that it is not our intent to measure and comment on the actual lighting levels, but rather to provide general comments that may be determined by visual observation. If requested by the City, we can provide services to measure and comment further on the lighting levels of the garage as an additional service.
  - **DESMAN** will review the general condition of the stairwells (i.e. treads, risers and landings, handrails/guardrails, etc.) and elevators. It is not our intent, however, to evaluate the elevators for recommended modernization or compliance with code requirements, except that which may be determined by visual observance. We recommend that a qualified elevator consultant review the elevator systems for recommended repairs and/or improvements. If requested by the City, we can arrange and procure the services of a specialized elevator consultant to review the elevators further for potential repairs and/or improvements as an additional service.
  - **DESMAN** will identify and comment on areas of miscellaneous construction that may require specific and/or specialized maintenance.
- **DESMAN** will provide an evaluation of the results of the visual reconnaissance. To the greatest extent possible, general recommendations for the repair of the facility will be developed. These repairs will be presented in order of priority for further review, to be adjusted according to immediate needs and the availability of funds.
  - **DESMAN** will provide the condition appraisal reports summarizing the various observations and recommendations. We will discuss the findings and recommendations with **PN** as appropriate and revisions will be made to the report if necessary prior to submission. We will then forward final reports to **PN** in PDF-format.

## **Task 2: Material & Field Testing:**

**DESMAN** may perform a limited delamination survey over select cast-concrete surfaces of limited portions of the supported slabs, that are deemed necessary and appropriate, that are easily accessible using the chain-drag method; **DESMAN** notes that the intent is not to perform a comprehensive delamination survey over 100% of the surfaces but rather only as may be representative or appropriate to supplement our visual observations as determined by **DESMAN** at the time of our visual reconnaissance. This will help estimate the amount of delaminations or hollow areas in the concrete floor slab which require repair. These soundings will help to detect



subsurface horizontal cracking within the slabs caused by corrosion of embedded ferrous materials, but which are not typically visibly detectable.

**C. OBJECTIVE:**

It is the intent of this condition survey and assessment to: (1) document the current condition and determine the influence of deterioration on safety; (2) determine the causes and extent of the deterioration, to the extent possible utilizing the proposed testing techniques and visual observations; (3) develop a recommended program of repair, and (4) estimate probable construction costs of the repair program. A visual observation and review of original design documents are utilized to gain an understanding of the structure and how it should be expected to perform as compared to what is identified in the field. Typically in the performance of a condition assessment an assumption is made that the structure was designed and constructed in compliance with industry standards and building code requirements in effect at the time the building was designed and constructed. If certain conditions are observed during an inspection/evaluation of a building it is sometimes necessary to do a more thorough engineering evaluation to determine an underlying cause of distress or failure; it is also sometimes necessary to perform supplemental destructive and/or non-destructive testing to determine an underlying cause of distress or failure. Due to the age of the structure and the fact that no significant structural distress was observed during the assessment, it has been determined that extensive structural evaluation or analysis is currently not deemed necessary. Similarly, no extensive destructive and non-destructive testing needed to be performed at this time.

As with any building assessment and the resultant repair program developed as a result of such an assessment, it is wise to include or anticipate within any estimated repair cost or budget a nominal construction contingency to account for concealed, unknown, or unanticipated conditions which may be encountered in performing the recommended repairs as outlined in this report.

**D. QUALIFICATIONS:**

**DESMAN** was retained to perform an appraisal of the Haviland Street Parking Garage, Norwalk, Connecticut. The conclusions, recommendations, and opinions of costs represented in this report are based on discussions with personnel familiar with this facility, our field observations and our experience with similar projects.

It is not the intent of this appraisal to perform an exhaustive study to locate every existing defect in the structure. Nor is it the intent to perform an extensive structural evaluation or analysis except as noted.



Similarly, no extensive destructive or non-destructive testing needed to be performed at this time except as noted. A team of trained professionals conducted "walk-through" observations; however, there may be defects at the facility that were not readily accessible or visible. Additionally, conditions may develop in the future that were not evident at the time of this survey.

Opinions of cost for repairs are approximations only and should not be interpreted as bids or offers to perform work. Actual costs can be affected by the extent of work done as one project, the quality of contractors, the quality of materials chosen and specific work conditions. These conditions are based on design criteria which are not known at the time of this report.

#### **E. PARKING GARAGE REPAIR AND RESTORATION – AN OVERVIEW:**

As stated by the American Concrete Institute (ACI) Committee 362.1R-97 in their report titled Guide for the Design of Durable Parking Structures, (reapproved in 2002), *"The durability of parking structures is related to many factors, including weather, the use of deicer salts, concrete materials, concrete cover over reinforcement, drainage, design and construction practices, and the response of the structural system to loads and volume change. The most common types of deterioration and undesirable performance of parking structures are due to corrosion of reinforcement, freezing and thawing, cracking, ponding of water and water penetration. Even walls and columns suffer distress from leakage, splash, and spray of salt-contaminated water."*

Concrete is a stone-like material obtained by permitting carefully proportioned mixture of cement, sand and stone or other aggregate and water to harden in forms of the shape and dimensions of the desire structure. The advantages of this building material include its high fire and weather resistance, local availability at low cost and high compressive strength. On the other hand, it is a relatively brittle material whose tensile strength is low compared to its compressive strength. This limitation is overcome by using reinforcing steel in combination with concrete in order to reinforce it where its low tensile strength would normally limit the carrying capacity of the prismatic member or element.

With the widespread use of deicing chemicals and road salt on our nation's highways and roadways, the condition of our bridge decks, parking garages and other reinforced concrete structures directly exposed to these materials began to change. The relationship between the deterioration and use of deicing chemicals and road salt was most evident by the extent of deterioration found in the "snow belt" states. With the development of this deterioration, programs were initiated to study the cause and effect of the problem in order that repair procedures and preventive maintenance could be instituted to assure the long term viability of these structures.



Research has confirmed that corrosion of the embedded reinforcing steel was the primary cause of the structural deterioration. It was further determined that the presence of chloride in the concrete (from both external and internal sources) greatly accelerated the development of the corrosion process. External sources of chlorides mainly occur from deicing chemical and road salt applications. Internal sources consisted of calcium chloride admixtures to the concrete used historically in winter months to speed up the temperature sensitive curing of the concrete mix. Repair programs began to consider that the only method to stop all subsequent corrosion deterioration was one where all concrete containing threshold values of the chlorides necessary to cause corrosion was removed and chlorides were further prevented from entering the new concrete. However, removal of all concrete containing significant chlorides is seldom a practical or cost effective solution.

The service environment of parking structures is more severe than most other buildings and is more nearly like that of highway bridges. In many cases, these structures are exposed to seasonal and daily ambient temperature variations. Deicing chemicals and road salts may be spread directly on the slab floors or they may be deposited from vehicles coming into the parking facility from surface streets where the chemicals are extensively used. Extreme temperature and volume changes can cause cracking of the floors, beams, columns, and walls which can lead to the ingress of water and chlorides leading eventually to deterioration. Use of deicing chemicals and road salt, and chloride contamination within the concrete can also increase freeze-thaw damage due to a fluctuation between freezing and thawing at the concrete's surface or near its surface causing localized spalling and loose of cement paste binding the concrete aggregate together. Deterioration of the concrete surface due to freeze thaw causes further moisture and chloride contaminated moisture intrusion into the concrete, down to the level of the embedded reinforcing steel where more extensive damage can occur due to corrosion.

To the greatest extent possible, visual observations, field-testing, laboratory tests and analysis performed on the data collected are used to gain as much information about the structure as possible. As stated by the ACI Committee 362 in an earlier report titled State of the Art Report on Parking Structures, issued in 1985, *"Repairing an existing deteriorated structure involves many unknowns, uncertainties, and risks. Especially with regard to repair of deicer caused corrosion damage, the process is considered an extension of the useful life of the deteriorated structure. It is not equivalent to building a new structure with current technology."* Therefore, in the development of repair programs within this report, contingency funds must be anticipated and included in any budget for repairs to account for concealed, unknown, or unanticipated conditions which may be encountered.



## 2. EXECUTIVE SUMMARY

***CORROSION:*** Corrosion is the oxidation, or rusting of ferrous materials (i.e., embedded reinforcing steel), and the creation of iron oxide which has an increased volume compared to the base ferrous material. Besides the loss of steel strength and a loss of cross-sectional area of the steel, this chemical reaction and the resultant expansion in volume exerts great pressure on surrounding concrete causing concrete spalling and potentially a loss of structural load carrying capacity.

***DELAMINATION:*** A delamination is a subsurface failure or cracking within concrete construction at the level of the embedded reinforcing steel; typically caused by the corrosion of the embedded concrete reinforcement, but can also be the result of cyclical freeze-thaw damage.

***SPALL:*** Concrete spalling is the direct result of the corrosion or freeze-thaw process causing delaminated concrete to eventually break away, leaving a hole, and exposing embedded reinforcing steel to the effects of continued and progressive corrosion. Spalled concrete, often presents a potential tripping hazard to pedestrians, either due to the hole created or exposure of embedded steel reinforcing. Excessive spalling is clear

The Haviland Street Parking Garage is in good structural condition; although no major structural deficiencies were identified during **DESMAN**'s site investigation at this time, conditions do exist, such as wearing of the membrane and expansion joint failure, that if left untreated or unaddressed may result in additional premature concrete deterioration.

Understanding that various concrete repair and waterproofing projects have been programmed over time, **DESMAN** had recommended that a comprehensive program be implemented as funds become available; we note that this project is now in progress.

Various enhancements has also been recommended, spanning the disciplines of the plumbing systems, miscellaneous metals, as well as architectural improvements such as painting, all of which are also now in progress

A more complete outline and description of **DESMAN**'s visual observations is presented within Section 4 of this report. Section 5 of this report presents a breakdown of projected costs of recommended capital repairs and improvements. Projected repairs and capital improvement costs are prioritized into three (3) separate phases (Prioritized Repairs, Programmed Repairs, and Long-Term Repairs), with appropriate construction contingencies, and is summarized as follows:



## PROJECTED REPAIRS AND CAPITAL IMPROVEMENT COSTS:

▪ Prioritized Repairs:	<b>\$0.00</b>
▪ Programmed Repairs:	<b>\$18,300.00</b>
▪ Long-Term Repairs:	<b>\$290,400.00</b>
<b>TOTAL:</b>	<b>\$308,700.00.</b>

The projected capital improvement costs presented here and more fully described later in this report are based upon current prices in the New England area for labor, equipment, and materials to implement similar work as currently recommended for implementation to the Haviland Street Parking Garage. The estimated construction costs includes a  $\pm 10\%$  construction contingency allowance to account for uncertainties in the restoration market at the time of bidding, and to address possible unforeseen conditions which might arise during the complete design development of the repair documents and repair procedures.

Costs associated with providing engineering design services, bidding assistance, and contract administrative & sight observation services have not been provided as the exact scope of repairs and the scheduling of when and how they might be implemented has not yet been determined. Should **PN** wish to budget for design and construction management fees, **PN** should assume an additional 12% to 15% of total construction cost as a reasonable estimate for these services.



The design fees would vary depending on the magnitude and complexity of the repairs actually undertaken, and the suggested percentages for engineering services are meant only as a budgeting tool, and not as an actual proposed engineering fee for **DESMAN** to perform the engineering services. Should **PN** wish to proceed with any portion of the recommended repairs, **DESMAN** will gladly provide a proposal for the designated engineering services.

Due to certain economies of scale, the total cost of capital repairs could be reduced if the recommended repairs are implemented as part of a single phase repair program in lieu of the repairs being implemented in a phased or prioritized repair program. Additionally, it should be noted that a phased type of repair needs to account for a limited increase in repair quantities and associated repair costs to address an anticipated increase in deterioration which might occur in the intervening period of time between phases of the work. A phased repair program also results in increased costs due to the need for multiple mobilizations by contractors onto the work site.



### 3. DESCRIPTION OF FACILITY



Photo No. 1

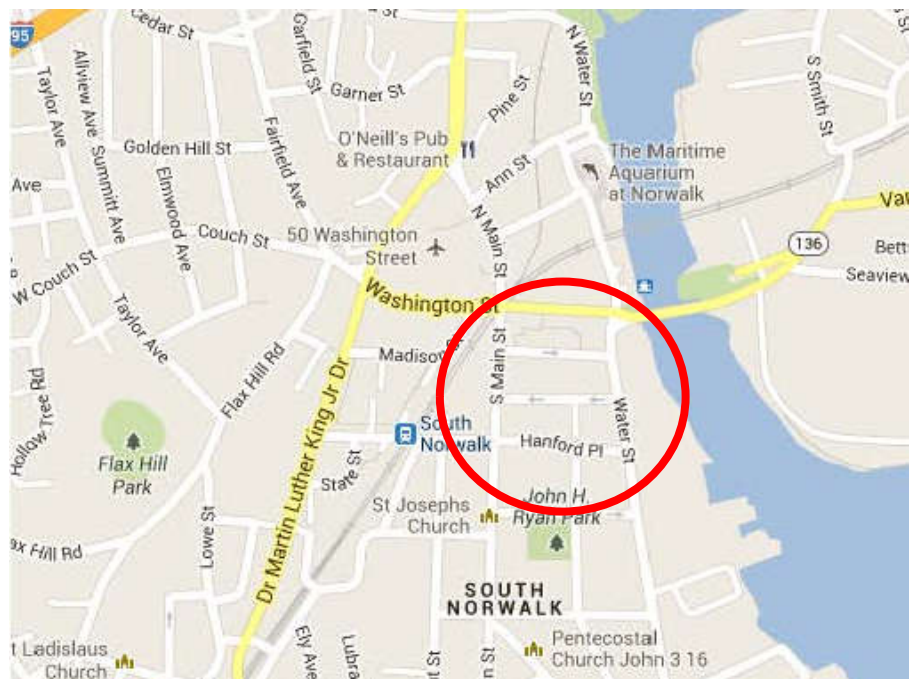


Photo No. 2



Photo No.3

The Haviland Street Parking Garage is located at 8 Haviland Street, South Norwalk, Connecticut. The structure consists of a supported deck and a slab on-grade, and was constructed in 1982. The south façade is adjacent to Haviland Street; the north, east and west façade are adjacent to various buildings (*reference Location Map below*).



*Location Map: courtesy of www.google.com*

The parking garage is roughly rectangular in shape and measures approximately 390' x 110' in plan. There are two main entrances/exits to the parking garage. There is an entrance/exit from Haviland Street onto the supported deck at the southwest corner of the garage and another entrance/exit from Haviland Street to the grade level, at the





Photo No. 4



Photo No. 5



Photo No. 6

eastern end of the garage. There are no internal ramps in the parking garage for vehicle access between levels. All traffic in the garage is one-way and the parking stalls are typically angled with some parallel spaces on the supported deck and 90° compact spaces on grade.

The structural system of the parking garage consists of a one way cast-in-place concrete slab, which is reinforced by post-tensioned, un-bonded, tendons and conventional bar reinforcing. The slab is supported by steel beams and columns with spread footings. The slab is 7" thick and each column bay has a typical span of 19'. The beams span 55' from column to column. Directly below the framed deck, there is an on-grade asphalt parking surface.

There are two expansion joints in the garage, which allow for movement due to temperature change, shrinkage, creep, etc. These joints run from north to south, and divide the deck into three approximately equal sections. A third expansion joint gland was installed at the entrance/exit to the supported deck. A traffic bearing waterproofing membrane covers the supported deck in its entirety.

Post-tensioning is a method of reinforcing concrete slabs that uses steel cables to induce forces into the slab that work opposite to the forces placed on the slab from vehicles, etc. Current building codes provide for the use of additional mild steel reinforcing bars to help control cracking. The steel p/t cables are typically ½" diameter and are made of 7 individual steel wires. The cables are greased and a plastic sheathing is placed on the cables to provide protection against corrosion causing elements.

During construction the cables are draped within the form work. They are set near the top of the slab at the column lines and near the bottom at the mid-point between columns. Once the slabs are placed and cured, the cables are stressed to provide an internal force in the slab that counters the internal force developed by superimposed loads (vehicles, self-weight, etc.) placed on the deck. Figure 1 (below) depicts the layout and forces of the slab tendons and how these forces resist the deflection of the slab under loading.

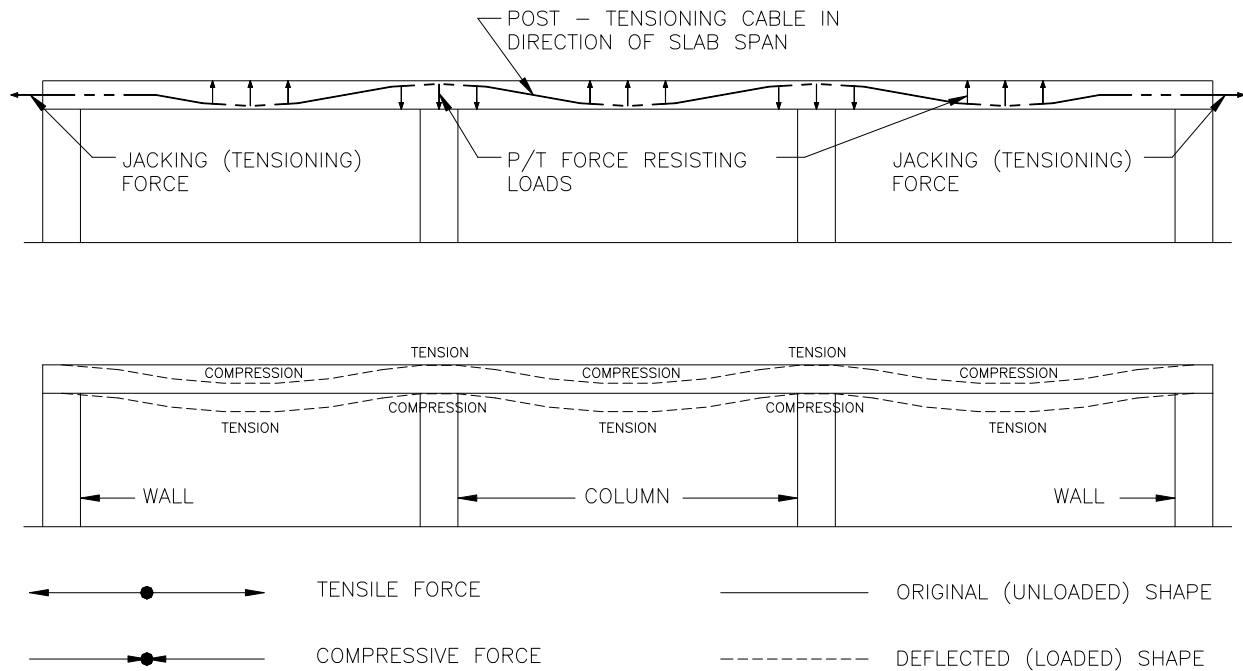




Photo No. 7



Photo No. 8

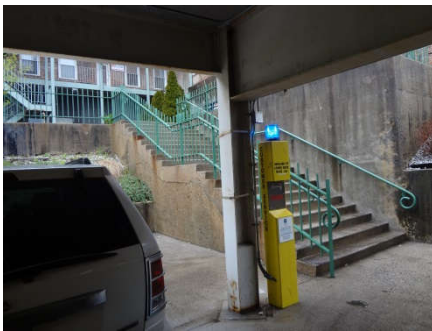


Photo No. 9

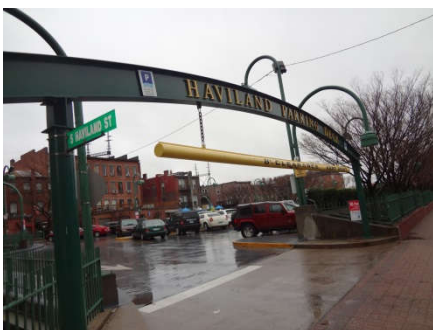


Photo No. 10

The figure above indicates that tensioning is performed at the edge of the slabs, which is typical in this type of construction. The tendons are also anchored at the expansion joint and there are intermediate anchors at the construction joint, where one concrete placement abuts a subsequent placement.

A wrought iron fence with equally spaced bollards runs along the north, east, and west façades of the parking structure. The south façade is made up of a concrete wall with a parged fascia supported by steel columns. Built into the south façade of the garage are a series of concrete planters. A smaller wall consisting of brick masonry and concrete columns runs a few feet in front of and parallel to the south façade, adjacent to the Haviland Street sidewalk.

There are a series of concrete stairs with metal railings that lead from the parking deck to the on-grade level below at the north and east facades of the structure. Lighting in the parking garage is provided by ceiling and wall mounted high-pressure sodium light fixtures at grade level and pole mounted fixtures at the supported deck.

In order to prohibit oversized vehicles from entering the supported deck, a steel beam clearance bar assembly was installed 2009; the assembly was configured and painted to match the existing aesthetics. A comprehensive repair program, consisting of concrete repair, waterproofing, drainage improvements and painting is now in progress.

## 4. VISUAL OBSERVATIONS AND RECOMMENDATIONS

During the summer of 2025, **DESMAN** performed a detailed visual observation of the facility's structural systems and waterproofing components, along with the general condition of the drainage system.

While **DESMAN** does offer comment on the general condition of miscellaneous electrical components and their relationship and potential impact to the garage's structural system and waterproofing components, **DESMAN** did not review the apparent lighting levels or the placement of the light fixtures. While **DESMAN** does offer comment on the general condition of the signage, **DESMAN** does not comment on the placement and/or functionality of the signage except where recommendations that **DESMAN** may consider typical areas of improvements are warranted. **DESMAN** also did not review the mechanical systems (i.e. fire standpipe, etc. as applicable) beyond general or visual conditions which may benefit from comment by **DESMAN**; **DESMAN** recommends that these systems be reviewed by a qualified engineer and/or maintenance company as appropriate.

Observations made were documented on copies of floor plans. An extensive number of photographs were also taken to help document the various conditions observed.

The following is a listing of observed conditions and issues of concern, along with recommendations to rectify them.



A summary of **DESMAN**'s visual observations is as follows:



Photo No. 11



Photo No. 12



Photo No. 13



Photo No. 16

## CONCRETE AND STRUCTURAL FRAMING WORK:

Upon a prior chain-drag of the floor surfaces, **DESMAN** encountered delaminations throughout the deck, subsequently resulting in **DESMAN** recommending that all deteriorated concrete be repaired per our previous condition appraisal report. Currently, a comprehensive repair program is now in progress. (*reference Photo Nos. 13, 14 & 15*) That said, though, due to the nature of the structural elements, **DESMAN** does anticipate that maintenance and capital repairs will be required in the future, so therefore **DESMAN** recommends that **PN** budget accordingly.



Photo No. 14



Photo No. 15

- Replacement of the previous waterproofing membrane system with a new system, at the time, has assisted the deck in preventing further moisture penetration, a common deterioration mechanism of concrete slabs. As part of the current repair program, the membrane system will be replaced with a new system. **DESMAN** recommends that **PN** continue with maintenance as required since it will be critical to maintain its waterproofing integrity.



Photo No. 17



Photo No. 18



Photo No. 19

- Miscellaneous concrete spalling was observed in a limited number of areas of raised concrete curbs and vertical/wall surfaces located around the parking deck, and is being addressed as part of the current repair program (*reference Photo Nos., 16 & 17*). **DESMAN** does anticipate, though that maintenance and capital repairs will be required in the future, so therefore **DESMAN** recommends that **PN** budget accordingly
- Minor cracking, scaling, and other deterioration mechanisms exist throughout the slab-on-grade (Level 1), and is currently being addressed as part of the current repair program (*reference Photo No. 18*). **DESMAN** does anticipate, though that maintenance and capital repairs will be required in the future, so therefore **DESMAN** recommends that **PN** budget accordingly.
- The garage has a steel structural frame of beams and columns, which support the concrete deck; the steel frame was observed to be in good condition (*reference Photo Nos. 19 & 20*). Re-painting of the framing is being addressed as part of the current repair program, and **DESMAN** recommends that all framing be programmed for re-painting as needed, to both protect and enhance its appearance.



Photo No. 20



Photo No. 21



Photo No. 22

## WATERPROOFING:

- Two expansion joints are currently installed at third points along the deck as well as the entry/exit apron. Expansion joints are typically created within a structure to allow for thermal movements within the structure in response to ambient temperature variation and are also sometimes necessary to separate structural elements which are anticipated to move contrary to one another due to differential settlement or potential seismic activity (such as stair towers). These expansion joints need to be closed off to prevent water infiltration through the joint opening or to allow for a smooth transition between adjoining structural elements; typically, a flexible material or gland is designed to handle the extent of movements experienced. These glands can be comprised of any number of materials and need to be tough enough to handle vehicular and/or pedestrian traffic as may be required and still allow for unimpeded pedestrian access.

The replacement of these two expansion joint systems is being addressed as part of the current repair program (**reference Photo Nos. 21 & 22**).

All expansion joint glands located throughout the facility would benefit from periodic cleaning to remove dirt and debris which tends to accumulate within the folds of the accordion shaped glands. Debris which collects within the expansion joints can restrict proper joint movement and cause premature failure of the joint. It is recommended that this expansion joint cleaning be performed on a weekly basis, or as a minimum on a monthly basis.



Photo No. 23



Photo No. 24



Photo No. 25



Photo No. 26

- A traffic bearing membrane has been installed over the concrete slab (*reference Photo Nos. 23, 24, 25 & 26*). Traffic bearing membranes are approximately 85%-90% effective as moisture and chloride screens inhibiting future chloride-ion migration into the deck. An elastomeric membrane will also traverse cracks that may form and joints that may be tooled.

**DESMAN** considers repair of the system critical to maintain its waterproofing integrity and protect the concrete substrate below; following the repair of the concrete, repair and recoating of the membrane system is being addressed as part of the current repair program.

Upon completion of a membrane installation, **DESMAN** suggests developing a yearly service contract with a qualified waterproofing contractor to assure that damaged portions of the membrane are successfully repaired each spring and autumn. It is important that all damage to waterproofing membranes be repaired, as continued and progressive de-bonding of the membrane will result if left unattended. **DESMAN** therefore cautions that installation of a membrane should be considered along with adequate funding for long-term maintenance.



Photo No. 27



Photo No. 28

In the future, **DESMAN** recommends that the performance of the membrane continue to be monitored on a regular basis, with limited full system "spot" repair budgeted accordingly.

Along with repair of the membrane system, new cove joint sealant will also be installed.

#### **PLUMBING REPAIRS AND IMPROVEMENTS:**

- The existing floor drains and piping will all be replaced as part of the current repair program; the existing cast iron piping will be replaced with new PVC piping (*reference Photo Nos. 27 & 28*)
- **DESMAN** recommends that the drainage system be flushed and cleaned twice yearly, in the Fall and again in the spring, to remove all debris, dirt and contaminants.
- **DESMAN** recommends that the fire protection system monitored, tested, and repaired as required, all in accordance with the appropriate operation and maintenance manuals and NFPA guidelines.



Photo No. 29



Photo No. 30



Photo No. 31

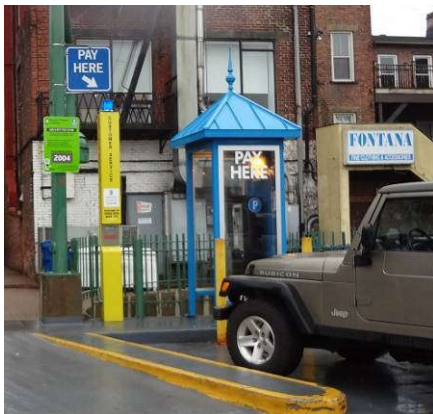


Photo No. 32

## MISCELLANEOUS REPAIRS AND IMPROVEMENTS:

- Although the garage appears to be maintained regularly, oil and debris, as well as bird guano, does collect in isolated areas. Although the Haviland Street Garage generally appears to be in a clean condition, grease and oil drippings from vehicles are inevitable and birds will seek any nesting opportunity.

With typical degreasers employed on a semi-annual basis, **DESMAN** recommends that a washing of the deck be performed to eliminate dirt and debris that hold moisture and chlorides which can be damaging to the concrete deck. At the time of the garage cleaning, **DESMAN** also recommends that all ledges and other nesting locations be cleaned, removing any bird guano that may provide a health hazard.

- Generally speaking, the electrical system is in good condition; miscellaneous repair is required to replace corroded boxes and segments of steel conduit. **DESMAN** recommends that funds be programmed for miscellaneous electrical repairs (i.e. deteriorated conduit, damaged fixtures, etc.) that may be necessary over time (*reference Photo Nos. 30 & 31*)

Although review of the lighting system was not included in **DESMAN**'s scope of review, **DESMAN** did note that the lighting levels appear to be lower than **DESMAN** typically recommends. **DESMAN** did not



Photo No. 33



Photo No. 34



Photo No. 35

measure the lighting levels, but did observe an apparent lack of uniformity of the lighting which appears to be related to the spacing of the fixtures. In some locations, the lack of uniformity can make visibility difficult. Therefore, **DESMAN** recommends that an allowance be programmed to address the light levels, as well as, due to improvements in technology, address various efficient improvements that may be available.

**DESMAN** recommends that the emergency callbox system and pay-on-foot stations be monitored, tested, and repaired as required, all in accordance with the appropriate operation and maintenance manuals. (*reference Photo No. 32*)

- As noted previously, **DESMAN** recommends that the metal framing be primed and repainted to both protect and enhance its appearance. Besides the framing, there are various other metal structures and materials throughout the garage, such as the clearance bar assembly by the entrance, as well as fencing, stair railings, and the light poles, that **DESMAN** recommends be programmed for re-painting as well; we note that re-painting of these materials is being addressed as part of the current repair program (*reference Photo No. 33*)
- Following completion of repairs, **DESMAN** recommends that all traffic markings (i.e. parking stalls, directional arrows, etc.) be re-painted. **DESMAN** recommends that all conflicting markings



Photo No. 36



Photo No. 37



Photo No. 38

**(reference Photo Nos. 34 & 35)**, if any, first be removed prior to re-painting, and all ADA requirements be updated accordingly.

- The various architectural treatments, throughout the garage, are in good condition and continue to perform well. Minor repairs, though, are recommended to maintain the building envelop, such as miscellaneous masonry repair/re-pointing.

Although the waterproofing materials in the planters were replaced in 2008, the planters are now abandoned but the materials remain. Therefore, moisture continues to be a concern simply due to the nature of the water being collected. **DESMAN** recommends that the planter materials be removed and the planters properly waterproofed. **(reference Photo No. 36)**

**DESMAN** recommends that the vertical joints in the facade be replaced and the apparent construction joints along the perimeter be monitored and replaced as well; moisture has historically penetrated these joints thus resulting in the efflorescence exhibited throughout the perimeter. **DESMAN** recommends that this construction joints be routed and properly sealed with a hydrophilic grout material, subsequently coated with a waterproofing coating to maintain its waterproofing integrity.



Photo No. 39

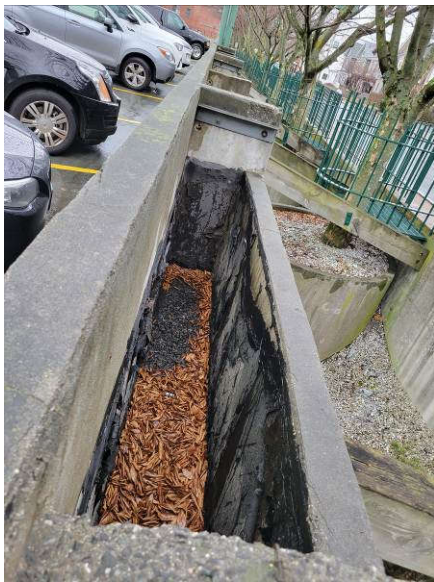


Photo No. 40

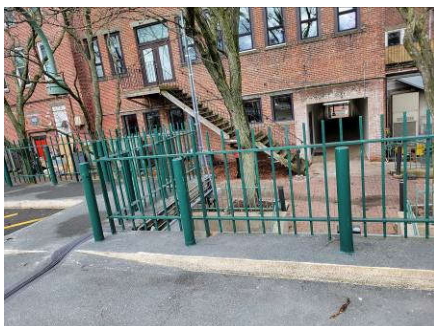


Photo No. 41

- The existing ceiling surfaces have been painted with a reflective coating system, and re-painting is being addressed as part of the current repair program.
- Although limited, damaged door frames should be repaired and/or replaced as required; re-painting is being addressed as part of the current repair program
- The stairs are generally in good condition, however, **DESMAN** understands that miscellaneous repair and re-coating of its membrane is planned to be addressed as part of the current repair program; **DESMAN** recommends that any potential trip hazards be addressed as required. While the railing systems also appear to generally be in good condition, **DESMAN** did note a void space below the northeastern stair. Although this void space does not provide a concern with the structural integrity of the stair, it does provide a maintenance concern as debris can collect within the void space and subsequently be difficult to remove. **DESMAN** recommends that a partition or barrier be provided that can block unauthorized access but allow access for maintenance.
- As part of the current repair and improvement program, a new stair is being installed, to provide a more direct access route to the corridor leading to Washington Street (**reference Photo No. 41**). Following the installation, **DESMAN** recommends

that the stair be maintained, cleaned and re-painted as required and budgeted for accordingly.

- The landscaping around the parking garage provides a valuable aesthetic enhancement to the garage but had become difficult to maintain and therefore was removed. In order to prevent further moisture damage due to the saturated soil, **DESMAN** recommends that the remaining materials all be removed and the emptied planters be repaired and properly waterproofed (due to their nature of collecting water), if not structurally removed.



## 5. PROJECTED COST OF RECOMMENDED CAPITAL REPAIRS & IMPROVEMENTS

The phased repair and improvement program as developed by **DESMAN** addresses long-term durability issues at the **Haviland Street Parking Garage**, and is intended to maintain the garage at an acceptable level of service condition while extending the useful service life of the facility.

The repair program has been formatted into specific repair items showing projected costs of implementation. Although **DESMAN** has arranged the scope of proposed restoration work for specific reasons, such as structural priorities and patron comfort, certain additional adjustments could be made should there be limits to the amount of funding that is available for any given year.

In addition to the recommended repairs and improvements noted in Section 4, **DESMAN** also has provided projected costs for the following additional related work:

- **Mobilization/Demobilization:** This work is associated with, but not limited to, the cost of a contractor mobilizing men, equipment, and materials onto the site prior to beginning work and off the site when the work is completed, as well as the costs for the provision of any and all permits, labor, material and performance bonds and insurance necessary for the implementation of the work. It is worth noting that extending recommended repairs over a period of time in lieu of all of the work being performed at once will result in an increased number of contractor mobilizations,
- **Miscellaneous Coordination Work (Traffic Control, Temporary Construction Signage, etc.:** This work is associated with, but not limited to, the costs for the provision of any and all traffic control devices and signage necessary to direct vehicular traffic around repair areas, and to provide protective/dust proof partitions around work areas.



**DESMAN** notes that certain costs in the projections presented may require adjustment if any re-prioritization of work is made. These costs would include mobilization/demobilization as well as those costs associated with miscellaneous coordination work. Impact to costs associated with an economy of scale may also need to be reconsidered.

The construction costs shown are based upon current prices in the New England area for labor, equipment and materials. The projected construction costs also include a 10% contingency factor to account for unforeseen conditions and uncertainties in the restoration market at the time of bidding. Should **PN** wish to budget for design and construction management fees, **DESMAN** recommends that **PN** assume an additional 12% to 15% of total construction cost be considered as a reasonable estimate for the provision of these services.

Design fees would vary depending on the magnitude and complexity of the repairs to be undertaken, and the suggested percentages for engineering services are meant only as a budgeting tool, not as a proposed engineering fee for **DESMAN** to actually perform the work. **DESMAN** will gladly provide an engineering fee proposal, along with a detailed scope of services, should **PN** wish to proceed with all or any portion of the repairs suggested.

Recommended repairs and improvements are subdivided in three phases of action as follows, and are further developed and explained in the following table:

- Prioritized Repairs
- Programmed Repairs
- Long-Term Repairs



## OPINION OF PROBABLE CONSTRUCTION COSTS:

Work Description	Prioritized Repairs (Phase 1)	Programmed Repairs (Phase 2)	Long-Term Repairs (Phases 3 - 5)
<b>A. Concrete Repair:</b>			
1 Partial-Depth Concrete Slab Repair	\$ -	\$ -	\$ -
2 Post-Tension Tendon Repair Allowance	\$ -	\$ -	\$ -
3 Miscellaneous Concrete Curb Repair	\$ -	\$ -	\$ -
4 Miscellaneous Vertical & Overhead Concrete Repair	\$ -	\$ -	\$ -
5 Misc. SOG Concrete Repair (including vandalism)	\$ -	\$ -	\$ -
6 Miscellaneous Stair Repair (treads, risers)	\$ -	\$ -	\$ -
<b>B. Waterproofing:</b>			
1 Repair/Recoat of Traffic Bearing Membrane (including joint sealants)	\$ -	\$ -	\$ -
2 Repair/Recoat of Traffic Bearing Membrane at Stairs	\$ -	\$ -	\$ -
4 Repair/Replacement of Expansion Joints (main deck)	\$ -	\$ -	\$ -
5 Repair/Replacement of Expansion Joints (main entry)	\$ -	\$ -	\$ -
6 Ext Joint Repair/Coating Appl/Waterproofing/Installation of Planter Closures	\$ -	\$ -	\$ 75,000.00
<b>C. Plumbing, Mechanical &amp; Electrical Repairs and Improvements:</b>			
1 Drain Pipe Flushing and Cleaning ( <i>before &amp; after deck repairs</i> )	\$ -	\$ -	\$ 50,000.00
2 Replacement of Floor Drains & Piping/Installation of Supplemental	\$ -	\$ -	\$ -
3 Miscellaneous Electrical Repairs	\$ -	\$ -	\$ -
4 Replacement of Light Fixtures on Light Poles	\$ -	\$ -	\$ 100,000.00
<b>D. Architectural Repairs and Enhancements:</b>			
1 Painting of Metal Surfaces (fencing, bollards, light poles)	\$ -	\$ -	\$ -
2 Door and Hardware Repair/Replacement	\$ -	\$ -	\$ -
3 Painting of Ceiling with Reflective Coating	\$ -	\$ -	\$ -
4 Re-painting of Steel Framing	\$ -	\$ -	\$ -
5 Re-Painting of Traffic Markings	\$ -	\$ 15,000.00	\$ 15,000.00
<b>E. Miscellaneous Coordination Work:</b>			
	\$ -	\$ 800.00	\$ 12,000.00
<b>F. Mobilization/Demobilization</b>			
	\$ -	\$ 800.00	\$ 12,000.00
<b>Sub-TOTAL:</b>	<b>\$0.00</b>	<b>\$16,600.00</b>	<b>\$264,000.00</b>
Construction Contingencies @ +/-10%:	\$0.00	\$1,700.00	\$26,400.00
<b>Total Phased Construction Costs with Contingencies:</b>	<b>\$0.00</b>	<b>\$18,300.00</b>	<b>\$290,400.00</b>
<b>TOTAL Construction Cost with Contingencies:</b>			<b>\$308,700.00</b>



## 6. DETERIORATION MECHANISMS

Reinforced concrete deterioration is typically caused by one or more factors of deterioration mechanisms including corrosion of reinforcement, water penetration, freeze-thaw cycling, volume change, or chemical attack. Any one or combination of these deterioration mechanisms can adversely affect the behavior/performance of a reinforced concrete structure. These adverse impacts include corrosion-induced distress, loss of reinforcing cross section, scaling, leaking, cracking, and delamination of concrete. The following is a brief discussion of each of the mechanisms noted above, and their effect on reinforced concrete structures.

### WATER PENETRATION:

The primary cause of the majority of reinforced concrete deterioration within parking structures is directly related to the penetration of water into the concrete. Reinforcing corrosion, concrete scaling, water leakage, leaching, and concrete delamination are all caused at least partially by water penetration.

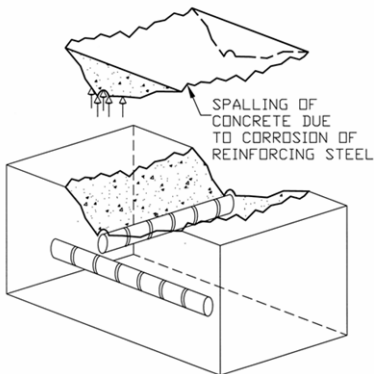


Fig. A

Concrete is a porous material, susceptible to water penetration which can result in increased potential for deterioration. Corrosion of reinforcing steel is an electrochemical process accelerated by the presence of water acting as an electrolyte. In addition, water penetrating into concrete (**Reference Fig. A**) can carry water-soluble chlorides (de-icing salts) to the reinforcing. The combination of chlorides and water further accelerates this corrosion process.

Scaling is also directly related to water penetration into concrete. Scaling is a surface deterioration resulting from pressures by freeze-thaw cycling of saturated concrete. These pressures within the pore structure cause progressive failure of the cement/sand paste. This progressive failure begins with degradation of the exposed surface, advances to the exposure of coarse aggregate, and in severe cases, causes paste failure surrounding the coarse aggregate, destroying the paste/aggregate bond.

Water penetration through a concrete section, cracked or not, can cause leaching of minerals from within the concrete matrix. Leaking of the parking deck exposes embedded reinforcing steel and underlying structural members to water and chloride ions (road salt) resulting in structural deterioration and potentially a loss of load carrying capacity of these building elements. Leaching is the result of frequent water penetration carrying water-soluble products from within the concrete to the surface below. Leached materials that tend to collect on overhead concrete surfaces are unsightly and potentially damaging to patron's vehicles using the parking facility.

Water penetration can also cause delamination of concrete along subsurface fractures through pressures generated during freeze-thaw cycling.

#### **CORROSION OF REINFORCEMENT:**

Corrosion of reinforcing steel or other embedded ferrous items such as electrical conduit is a second major factor contributing to deterioration of reinforced concrete (*Reference Fig B*).

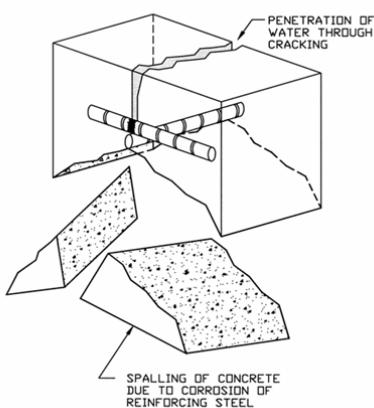


Fig. B

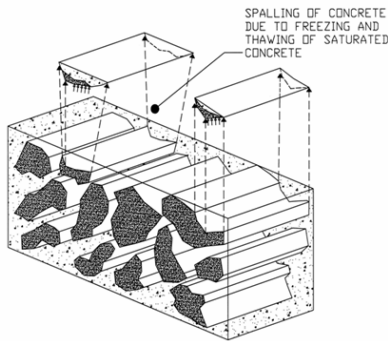


Fig. C

The corrosion process is an electrochemical process, which produces iron oxide (rust) and other by-products. These by-products occupy a minimum of 250% of the volume of the parent metal. This increase in volume produces tensile stresses within the surrounding concrete.

Because concrete has poor tensile strength properties, cracking occurs within the concrete matrix allowing additional moisture and chlorides to reach the reinforcing causing acceleration of the corrosion process. The deterioration caused by this corrosion includes the reduction of cross sectional area of the reinforcing, and the delamination of concrete surrounding the reinforcement.

#### **FREEZE-THAW DAMAGE:**

Concrete deterioration caused by freeze-thaw cycles is a third major deterioration mechanism. The mechanism occurs within saturated concrete subjected to freezing and thawing due to the pressures generated within the pores of the concrete paste resulting from the volume changes of water during the freeze/thawing process. These pressures are even greater in the presence of de-icing chemicals/chlorides as these chemicals reduce the freezing point and indirectly increase the pore pressures.

As previously mentioned, these pressures can cause progressive failure of the cement paste and result in scaling of the concrete, and delamination of concrete along subsurface fracture planes **(Reference Fig. C)**.

## VOLUME CHANGES:

Volume changes are a fourth major contributing factor of deterioration of reinforced concrete structures. These volume changes occur in both plastic and cured concrete. These volume changes can cause various types of cracking within the concrete member.

These cracks allow access for water and contaminants to the concrete and reinforcing, resulting accelerated deterioration to occur. The cracking most often associated with plastic concrete is shrinkage cracking produced by the reduction in volume of the concrete during curing. Improper detailing, proportioning, placement, or curing of the concrete can affect the extent of this cracking, but the primary cause is the volume change that occurs during curing.

Volume changes due to thermal movement, shrinkage, creep, and loading can also contribute to the deterioration of reinforced concrete. These volume changes will produce stress in restrained members, often resulting in cracking of the member (**Reference Fig. D**). These cracks also provide access to water and other deterioration mechanisms to attack the member.

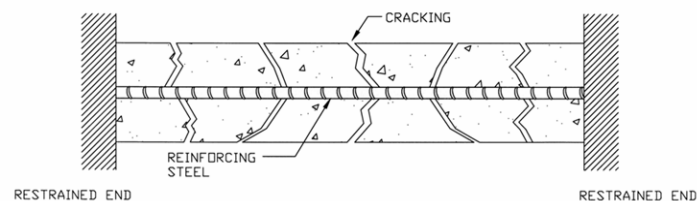


Fig. D

## **CHEMICAL ATTACK:**

Chemical attack is a fifth major deterioration mechanism affecting the performance of reinforced concrete. The effect of de-icing chemical/chlorides upon reinforcing steel and scaling is one example of chemically influenced deterioration. Severe exposure to other chemicals, notably sulfates and acids, can also cause deterioration of cement paste, cement paste/aggregate bond, and reinforcing steel. Chemical properties occurring within certain types of aggregates can also cause an adverse reaction with the cement paste. The resulting volume changes can cause cracking of the concrete.