Thornton Tomasetti

Existing Condition Assessment Report

Royal Saint Andrew, Sarasota FL

Thornton Tomasetti **K21168.00**

Prepared For
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1.0 Structural Executive Summary

Thornton Tomasetti, Inc. (TT) performed a review of specific conditions on November 9, 2023 at Royal St. Andrew Condominium. The purpose of the review was to collect information about the existing aluminum canopies that are to be replaced and other conditions requiring repair in the parking garage and mechanical slabs at the west side of the tower. The conditions reviewed were:

1. Following the Association's decision to replace the Carport Canopy structures, TT conducted an evaluation of the site conditions to gather more information about the existing structure that the new carport canopies will be connected to
2. Concrete deterioration located on the slab underside and walls of the parking garage structure.
3. Corrosion of the steel posts and metal panels for the parking canopy structures.
4. Concrete delamination and spalling have been identified on the concrete slabs within the mechanical rooms situated on the west side of the building.

Based on the observations, TT recommends that the following repairs be performed under the direction of a qualified professional Engineer (additional recommendations are provided in Section 3 of this report):

1. Parking Garage - Excavate spalled concrete to expose reinforcing steel at spalled areas and perform repairs in accordance with International Concrete Repair Institute (ICRI) standards under the guidance of a qualified structural Engineer.

2. Carport Canopy – Perform removal and replacement work as previously decided by the Board. Reinforce concrete structure as required for installation of new canopy. Preliminary checks show that the wall used for the overhang canopy and the ground level carport canopies will require additional structure beyond what was currently present on site.

3. Mechanical Space Slab Edges on the East Elevation - Remove delaminated and bulging stucco, perform ICRI compliant concrete repairs and replace stucco and paint. Apply waterproof coating at AC condenser slab areas to protect concrete from further exposure to weather and spalling. Add drainage to allow water entering the balconies to be wept to the exterior.

4. Decorative Concrete Units – Fragments of the decorative concrete units on the west façade have been reported as dislodged / missing from their original positions. TT suggests modifying pedestrian circulation in the affected area until protective measures are implemented. The recommendation includes the installation of netting to capture any falling debris. TT communicated these concerns via a letter dated November 21, 2023.

2.0 Introduction

Thornton Tomasetti, Inc. (TT) performed a site visit to review the condition of the parking garage, ancillary structures, and mechanical rooms in the main residential tower on November 9, 2023 at the Royal St. Andrew Condominium in Sarasota, Florida (**Figure 1**). TT reviewed as-built architectural, structural, and plumbing drawings for the building dated January 1, 1968.

Figure 1: Aerial view of the property (*Source: Maxar Technologies, 2021*)

2.1 Scope Description

TT conducted a comprehensive walkthrough survey, visually inspecting exposed and readily accessible areas to assess the condition of building components and identify potential repair needs. The observations were performed without utilizing scaffolds, selective demolition, or removing existing finishes. Specifically tasked by The Royal Saint Andrew Condominium Association Board (The Association), TT undertook a review of the site conditions for the replacement of metal canopies in the parking areas. The survey encompassed various canopy structures, including those within the parking garage, residential tower mechanical units, and the site drainage. Mechanical rooms on levels 15, 12, 10, 8, 6, and 4 were accessed during the survey process.

2.2 Property Description

The property consists of the condominium building adjacent to a standalone 2-story parking garage. The ground level of the parking lot consists of concrete and asphalt pavement, and the second level is a concrete parking structure. Both levels were originally constructed with the condominium in 1969, and there is an indication that the lot was either replaced or resurfaced in 2003.

The tower structure is a 15-story high-rise tower with reinforced concrete slabs supported by reinforced concrete beams and columns. Openings around the perimeter of the structure are infilled with concrete block and aluminum sliding glass doors and windows. Original balconies have been enclosed with the addition of windows and sliding glass door systems at the edge of slab. The exterior cladding of the structure is stucco with a mildly sanded finish. The main roof of the building consists of a flat reinforced concrete slab with a low-slope single-ply roofing system. There is an elevator penthouse constructed above the roof slab along the east side of the structure. On-grade, there is a parking garage structure consists of reinforced concrete waffle slab with beams and columns.

The structural as-built drawings provided by management are dated January 1968. The building was most likely constructed under the 1965 Southern Standard Building Code. The structural drawings were created by William A. Snell, Consulting Engineer.

3.0 Civil Investigation

Topographic Survey: To understand the existing condition of the pavements, TT retained a surveyor to provide a detailed topographic plan of the site so that subsidence could be mapped and fully understood. Performed by Polena Engineering, the topographic survey was completed and delivered January 11, 2024. See Appendix A.

Grading Analysis: TT studied the topographic survey to determine how some areas in the main parking lot have settled, to determine the existing direction of water runoff and to understand how the contours can be restored to direct the runoff toward either designated low spots or to the City Right-of-Way as the current conditions do. Appendix B depicts how the northern portion of the lot can be raised to mitigate the heavy asphalt erosion caused by the northern roof downspouts and to direct water towards the northern driveway.

Defect Inventory: On Thursday November 9th, 2023, TT deployed an engineer to examine and document both nature, size and width of cracking in the parking lot, as well as examine the drainage characteristics of the lot.

Review Existing Documents: The structural as-built drawings provided by management are dated January 1968. The building was most likely constructed under the 1965 Southern Standard Building Code. The structural drawings were created by William A. Snell, Consulting Engineer.

Research: Sarasota County Storm Sewers, Sarasota County Bay Watersheds Map, USGS (United States Geological Survey), the City of Sarasota, Florida DEP and Sarasota County. During this investigation phase, the following agencies were contacted:

- Florida DEP: Requested sewer records.
- City of Sarasota: Attended two calls with Public Works Department and requested available records.

- Sarasota County: Contacted the Central Records Division, the Sarasota County Communications and the Public Works Department.

4.0 Structural Observations and Repair Recommendations

4.1 Parking Garage

Observations

- The concrete at the underside of the second-floor parking garage slab was observed to be spalling in several locations.
- There were numerous areas of spalled concrete walls where the parking garage was reported to have periodic flooding.
- There was spalled concrete along the western wall of the garage where an aluminum canopy was previously anchored.
- Peeling of paint was observed along the wall at the parking garage entrance.
- TT observed evidence of previous concrete repairs throughout the parking garage.
- TT observed failures of the waterproofing membrane at the top level of the parking garage. The waterproofing topcoat was missing in several locations where inter-layer bond failures occurred between the base and the topcoat. It was reported that the failed areas were to be replaced in the near future as warranty work.

Photographs


Concrete Spalling at Underside of the Slab


Concrete Spalling at Underside of Slab

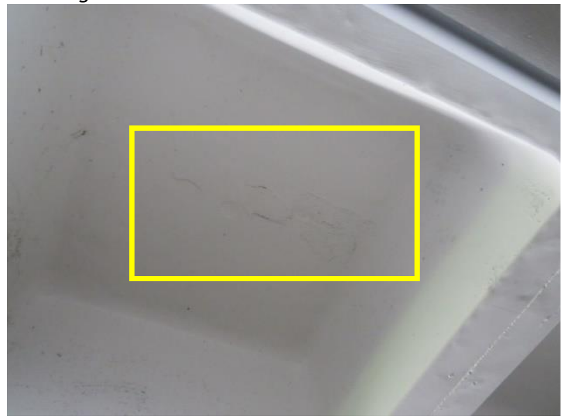

Concrete Spalling at the Walls Adjacent to the Reported


Concrete Spalling at the Walls Adjacent to the Reported

Flooding

Concrete Spalling at the Western Wall Where an Aluminum Canopy was Previously Installed

Flooding



Peeling Paint was Observed in the Slab Voids

Previous Repairs to the Underside of the Slab

Missing Waterproofing at Parking Slab

Bond Failure Between Base and Topcoat

Repair Recommendations

1. Excavate spalled concrete to expose reinforcing steel in spalled areas and perform repairs in accordance with International Concrete Repair Institute (ICRI) standards under the guidance of a qualified structural Engineer.
2. Inject Epoxy into nonmoving concrete cracks.
3. Remove and replace all failed waterproofing to protect concrete slab.
4. Monitor coating annually for additional bond failures.

4.2 Carport Canopies

Observations

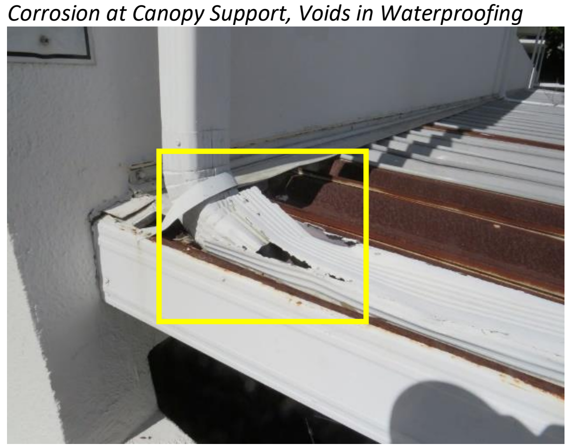
- The carport canopy at the south side of the lot was removed due to severe deterioration
- A canopy attached to the east side of the parking garage was reported to have fallen down during a past windstorm.
- Carports throughout the ground level parking area and the second floor of the parking garage are multiple independent metal canopy structures. The existing posts supporting the canopy and tie down straps were observed to be damaged and/or corroded at several locations.
- The damage to the posts was observed to be concentrated at the base of the posts.
- Segments of the existing metal deck covering a portion of the parking garage structure are corroded.
- Downspouts were identified as detached, corroded, or mis-installed throughout the parking canopies.

Photographs

Damaged Steel Canopy Support

Corrosion at Canopy Support, Voids in Waterproofing

Corroded Metal Deck



Severe Corrosion / mis-installed Down Spout

Repair Recommendations

1. Remove all existing metal canopy structures in the East parking lot.
2. Install new coated aluminum metal canopy structures meeting the requirements of the current Florida Building Code.
3. Install new structural supports and strengthen existing attachment points as required to transfer wind loads.

4.3 Mechanical Room Concrete Slab

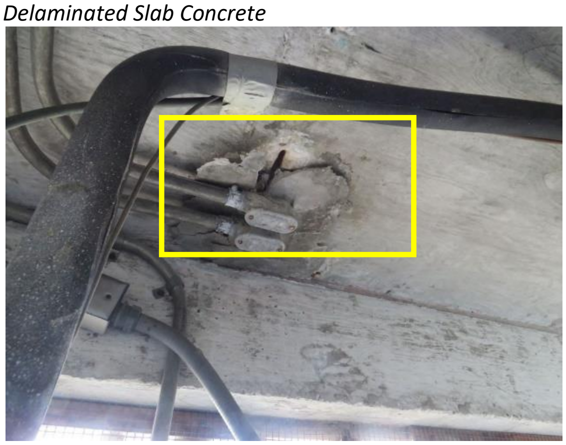
Observations

- There was delaminated/spalled concrete adjacent to the HVAC units throughout the various inspected levels.
- There was no waterproofing membrane observed on the concrete slab throughout all of the inspected levels.
- HVAC units cover roughly 50% of the slab surface and do not allow for full inspection from the topside.

Photographs

Delaminated Slab Concrete

Delaminated Concrete at the Slab Edge



Spalled Concrete to the Underside of the Slab Adjacent to the Conduit

No Waterproofing on the Concrete Slab

Repair Recommendations

1. Excavate spalled concrete to expose reinforcing steel that has lost bond to the surrounding per concrete and perform repairs in accordance with International Concrete Repair Institute (ICRI) standards under the guidance of a qualified structural Engineer.
2. Inject Epoxy into nonmoving concrete cracks.
3. Install new waterproofing membrane to protect the slab surfaces. Temporarily relocate and reinstall HVAC units as required.

5.0 Civil Observations

5.1 Pavement Defect Inventory

The existing asphalt pavement exhibits a variety of defects, to include:

1. Extensive shrinkage cracks is consistent with oxidation, which occurs with pavements at the end of their functional life. The bitumen that binds the aggregates effectively gasses off. This is caused by a variety of factors, to include sunlight and heat. This process robs the asphalt of its flexibility, and it becomes brittle. It is likely that this pavement was resurfaced/reconstructed in 2003 rather than1969 – asphalt paving typically has a functional life of 15 – 20 years unless it is consistently maintained and re-sealed to keep the bitumen from gassing off. Were this pavement 34 years old, in this climate, it would be in far worse condition. See Figure 3, below:

Figure 3: Lot shrinkage cracks.

2. Localized areas of 'alligator cracking' are consistent with subgrade failure. This means that the soil below the pavement has compressed causing the pavement section to deflect beyond the asphalt's capacity to simply bend. See Figure 4, below:

Figure 4: Lot alligator cracking.

3. Patching suggests that there was once more alligator cracking that resulted on potholes that were sawcut, excavated, and restored. See Figure 5, below:

Figure 5: Lot alligator cracking.

4. Tree roots seem to have undermined and damaged marginal areas of the asphalt portions of the lot. See Figure 6, below:

Figure 6: Asphalt cracks potentially caused by tree roots.

5. Stormwater flow over the northern portion of the asphalt lot has scoured and eroded the surface. This heavy and uncontrolled erosion starts at the outfall of the most northern roof downspout and continues all through until it meets the concrete pavement. See Figures 7A and 7B, below:

Figure 7A: Asphalt erosion, looking South.

Figure 7B: Asphalt erosion, looking West towards the building.

5.2 Concrete Pavement/Curbs Defect Inventory

The concrete pavement/curbs exhibit a variety of defects, to include:

1. Driveways in the City Right-of-Way: While the north driveway exhibits limited cracks, the south driveway exhibits significant cracking consistent with compressible soil below the pavement. The rigid concrete pavement was unable to bridge voids beneath it when loaded by vehicles – note that this driveway is the only one that can accommodate trucks which impose significantly larger loads than cars. See Figure 8, below:

Figure 8: South Driveway.

2. Parking Areas: While the surface of the concrete exhibits significant wear with exposed aggregate, and staining, it does not exhibit significant cracks or structural failure. See Figure 9, below:

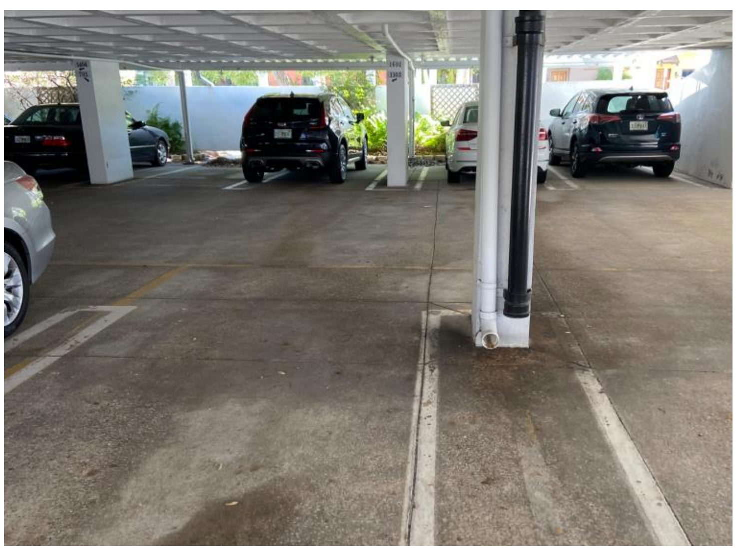


Figure 9: Parking areas.

3. Curbs: There are localized areas where the concrete curbs have cracked, a such as this area where the asphalt if also failing due to undermining roots. See figure 10, below:

Figure 10: Cracked curbs.

4. Concrete wheel Stoppers: Some wheel stoppers are broken to the point where rebar is being exposed. See Figure 11, below:

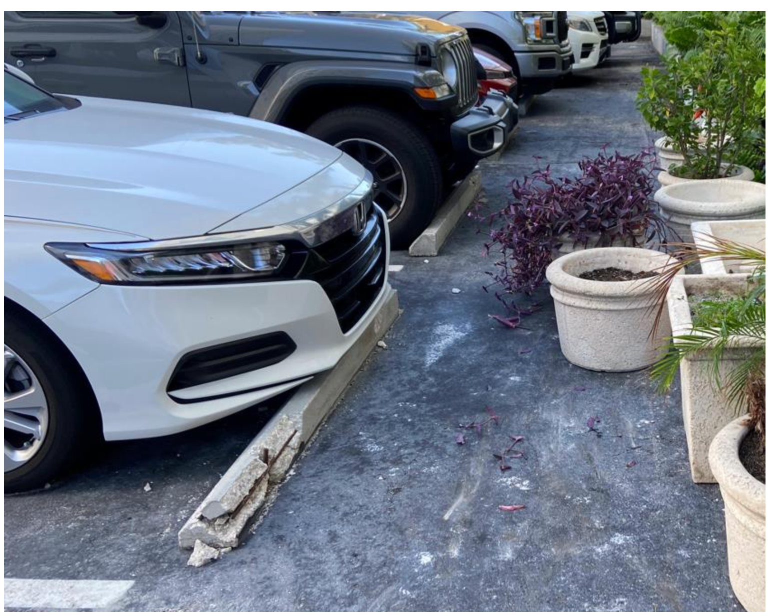


Figure 11: Broken wheel stoppers along South portion of the site

4.3 Grading and Drainage Analysis

TT studied the topographic survey to determine how stormwater runoff flows through the parking lot and reaches the existing low areas in the site and eventually the City Right of Way. The field investigation confirmed what the topography reveals, which was the following:

1. Stormwater runoff that exits the building at the North side flows down towards the concrete pavement and splits where some runoff water exits the lot through the North driveway. Some runoff water is channeled under the covered parking lot and towards the green space located between the two elevated ramps.

2. Stormwater runoff that exits the building at the South side flows down towards the concrete driveway where some runoff water is channeled under the covered parking lot and towards the green space located between the two elevated ramps.

3. There isn't a storm sewer fronting the site. No storm sewer manholes were observed during the field investigation. In addition, this was also confirmed with the City of Sarasota Public Works Department.

As part of the field investigation, TT also noted the following observations in relation to the existing drainage system:

1. Downspout locations – there are a series of downspout pipes conveying runoff from the canopy roof over the pedestrian walk onto the parking lot pavement. There are also downspout pipes conveying the runoff from the second level parking to the ground level pavement.

1.1 The location depicted in Figure 12 below shows one of the downspouts adjacent to the pedestrian path with a concrete block placed under the downspout. Perhaps the concrete block was placed here to serve as a splash block.

Figure 12: Downspout for small roof covering pedestrian path

1.2 Figure 13 also shows one of the downspouts adjacent to the pedestrian path, however this one has been cut off at approximately 6 feet above ground level.

Figure 13: Broken downspout for small roof covering the pedestrian path

1.3 There were other downspouts that have been cut and are shooting the water straight unto the asphalt pavement by the elevated concrete parking lot structure. See Figure 14 below.

Figure 14: Broken downspout from second level parking

1.4 The entire building roof also discharges onto the parking lot asphalt pavement at three downspout locations under the pedestrian path. The below photo shows the outfall farthest to the South end. The opening is clearly obstructed by debris and possibly not functioning as intended.

Figure 15: Outfall for South roof drain

1.5 The second roof downspout discharges North of the main entrance. Based on field observations, the opening at the time of the site visit seemed unobstructed. Heavy eroded and cracked asphalt was noted at this location where the water has formed a channel through the asphalt pavement. See Figure 16.

Figure 16: Outfall for roof drain North of entrance

1.6 The third roof downspout discharges just North of the second downspout. Its opening did not seem obstructed at the time of the field visit. Without comparison, this outfall is the one that has caused the worst heavy erosion and cracks in the asphalt. A channel in the pavement was also observed at this location all the way from the exit point to the concrete pavement down the site. See Figure 17. The runoff water that exits the building at the North side flows down towards the concrete pavement (under the second level parking) and seems to split where some water exits the lot through the North driveway and some water is channeled under the covered parking lot and towards the grass area located between the two ramps.

Figure 17: Outfall for roof drain at farthest North side

1.7 The ground level also receives stormwater from the second level roof parking that discharges to the North planter areas. In addition, the ground level pavement also receives stormwater from the second level drains. See Figure 18.

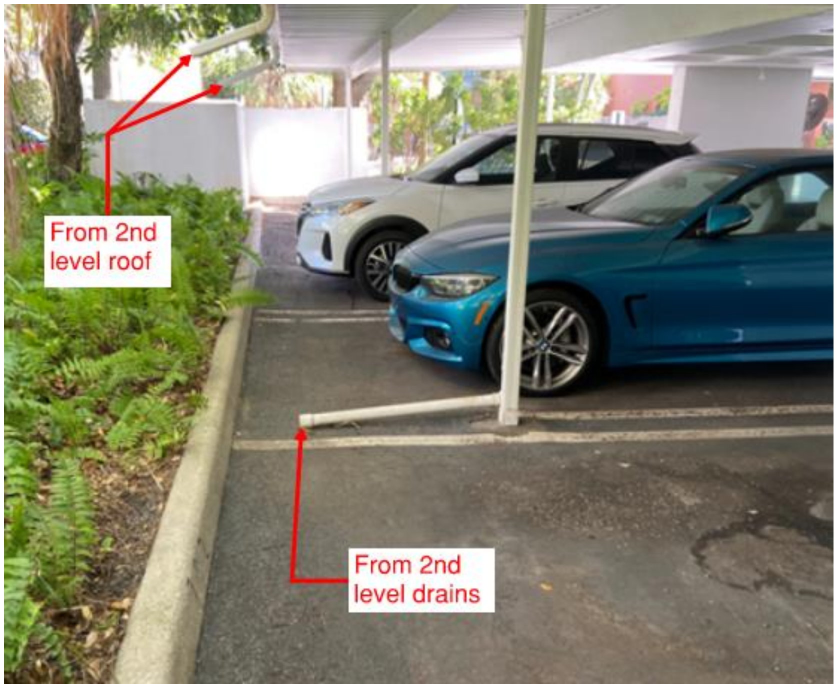


Figure 18: Upper-level drainage discharge (North of site)

1.8 Below in Figure 19 is another instance where the second level stormwater discharges to the ground level concrete pavement that later drains towards the planted area between the two ramps.

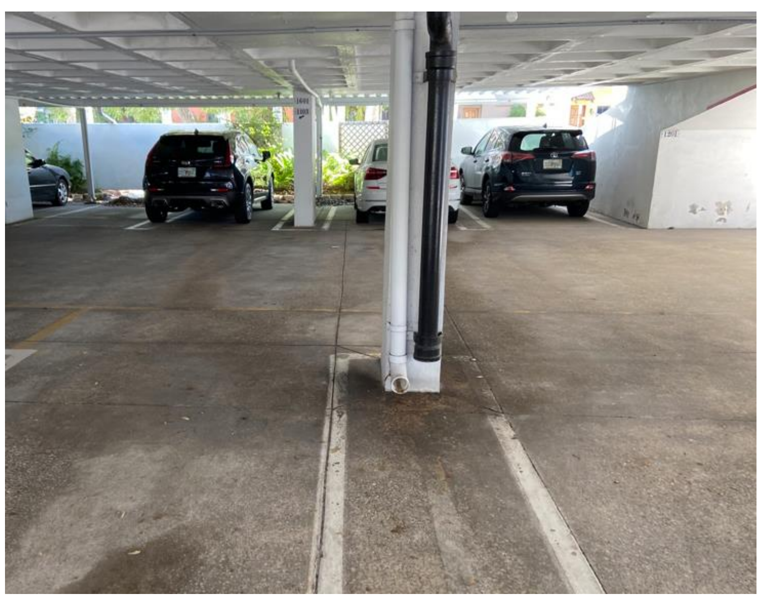


Figure 19: Upper-level drainage discharges to ground level

1.9 Towards to mid-east side of the lot, the second level parking lot discharges over the existing green space and unto the City Right of Way over the existing wall and through downspouts as depicted in Figure 20.

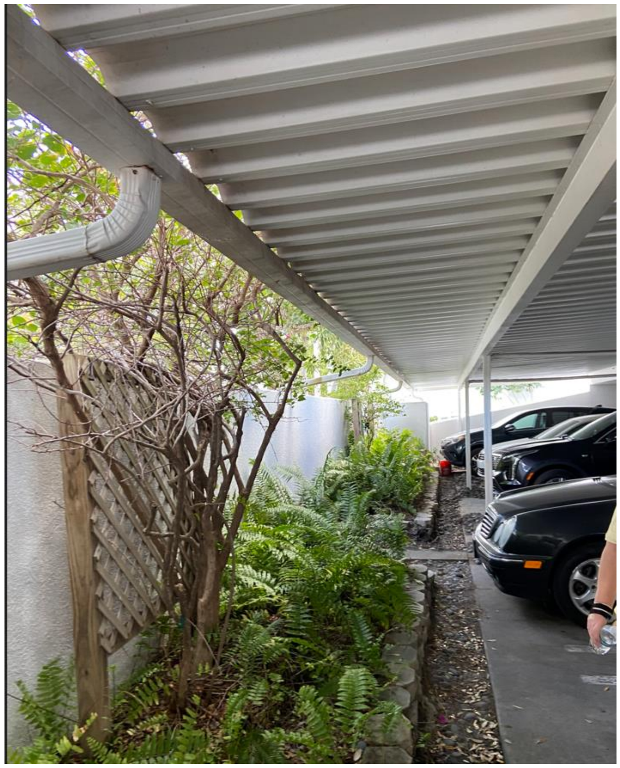


Figure 20: Upper-level drainage discharge at mid-east point

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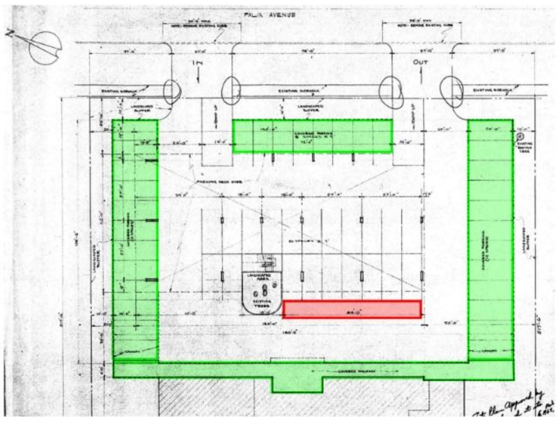
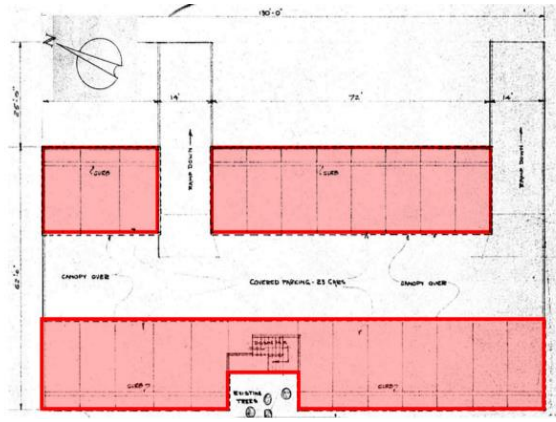
6.0 Structural Discussion

6.1 Car Port Canopies Repairs

TT conducted a field investigation of the current carports and structures in the parking area, identifying potential design considerations at three specific locations: the Ground Level Overhang Canopy, the 2nd Level Carport Canopies highlighted in red, and the Ground Carport Canopies highlighted in green. Visual references are provided in the accompanying images below.



Ground Level Carport Canopies Highlighted by TT



2nd Level Carport Canopies Highlighted by TT

6.1.1 Ground Level - Overhang Canopy

The Association requested that a six-and-a-half-foot overhang be installed at the west elevation of the parking garage to replace the existing canopy that had previously failed, see Figure 2.

Figure 2: Location of Overhang Canopy (*Source: TT*)

TT performed a preliminary structural analysis of the typical concrete wall at the parking garage. TT found that the concrete wall was comprised of 3,000 psi concrete and 60,000 psi reinforcement. This information and the dimensions were called out on the as-built drawings provided.

TT's analysis was performed in accordance with the *2020 Florida Building Code, Existing Building 7th Edition (FBC)*. FBC Section 502.4 states:

"*Any existing lateral load-carrying structural element whose demand-capacity ratio with the* ***addition*** *considered is no more than 10 percent greater than its demand-capacity ratio with the* ***addition*** *ignored shall be permitted to remained unaltered.*"

TT interprets this section to state that if the concrete railing receives an additional load that is less than 10 percent of the current loading, then the concrete wall can adequately sustain the new loading conditions in comparison to the original design loads from the time on construction.

To analyze the new loading, TT determined the assumed loadings using ASCE 7-16. TT assumed a dead load of 10 pounds per square foot (psf)[1] and a live load of 20 psf[2] on the overhang. For the wind loading, Components and Cladding Section 30.3.2 was utilized, the downward wind pressures on the new overhang were analyzed to be 34 psf[3] whereas the uplift pressures were 38 psf[4]. Additionally, a 25 psf wind pressure was applied to the concrete railing. To calculate flexural capacity of the concrete railing, TT utilized the design software ENERCALC.

Results from ENERCALC with the overhang canopy:

- Flexure Capacity – 7.10 Kip-ft
- Flexure Demand – 25.69 Kip-ft

In conclusion, the new wind load on the canopy resulted in an increase of 362% in flexure. The values are greater than 10%, which is not compliance with FBC Section 502.4. Therefore, additional reinforcement to the concrete railings is required.

6.1.2 2nd Level – Carport Canopies

TT performed a preliminary structural analysis of the typical 2nd Level Carport Canopy connection, see Figure 3. TT found that the concrete slab was comprised of 3,000 psi concrete and 60,000 psi reinforcement. This information was called out on the as-built drawings provided.

Figure 3: Existing Carport Canopy (*Source: TT*)

[1] ASCE 7-16, Table C3.1-1a gives 3 psf for aluminum roof deck, with an assumed 7psf for additional members.
[2] ASCE 7-16, Table 4.3-1.
[3] ASCE 7-16, Section 30.3.2.
[4] ASCE 7-16, Section 30.3.2.

TT's analysis was performed in accordance with the *2020 Florida Building Code, Existing Building 7th Edition* (FBC). FBC Section 602.1 states:

"*Level 1 alterations include the removal and replacement or the covering of existing materials, elements, equipment, or fixtures using new materials, elements, equipment, or fixtures that serve the same purpose*."

TT interprets this section to state that if the carport canopies are replaced with similar materials, then a Level 1 Alternation is permitted. Furthermore, a design analysis is needed to confirm the parking garage slab can adequately sustain the new loading conditions in comparison to the original design loads from the time on construction.

To analyze the loading, TT determined the assumed loadings using ASCE 7-16. TT assumed a dead load of 10 pounds per square foot (psf)[5] and a live load of 20 psf[6] on the new carport canopies. For the wind loading, Components and Cladding Section 30.7.2 was utilized, the downward wind pressures on the new carports were analyzed to be Zone 2 pressures of 22 psf[7] whereas the uplift pressures were 52 psf[8]. Additionally, the concrete slab was considered to be cracked for the means of the analysis. To calculate concrete breakout failure capacity of the structural concrete slab, TT utilized the design software Hilti PROFIS.

Results from Hilti PROFIS with the new carport canopy:

- Concrete Breakout Failure Capacity – 6,718 lbs
- Concrete Breakout Failure Demand – 6,140 lbs

In conclusion, the new canopy loads resulted in a demand load of 91% of the existing slab. The new loading is 9% less than the slabs capacity, which is in compliance with FBC. The demand capacity above is for preliminary design, this can be altered to yield less demand on the slab. It appears that no strengthening of the slab will be needed, however, these results are preliminary.

6.1.3 Ground Level - Carport Canopies

TT performed a preliminary structural analysis of the typical Ground Level Carport Canopy Foundation, see Figure 4. TT was not able to get the dimension and configuration of the canopy foundations but assumed a concrete strength of 3,000 psi and 60,000 psi reinforcement. This information was not called out on the as-built drawings provided.

[5] ASCE 7-16, Table C3.1-1a gives 3 psf for aluminum roof deck, with an assumed 7psf for additional members.
[6] ASCE 7-16, Table 4.3-1.
[7] ASCE 7-16, Section 30.7.2
[8] ASCE 7-16, Section 30.7.2.

Figure 4: Existing Carport Canopy (*Source: TT*)

TT's analysis was performed in accordance with the *2020 Florida Building Code, Existing Building 7th Edition* (FBC). FBC Section 602.1 states:

"*Level 1 alterations include the removal and replacement or the covering of existing materials, elements, equipment, or fixtures using new materials, elements, equipment, or fixtures that serve the same purpose*."

TT interprets this section to state that if the carport canopies are replaced with similar materials, then a Level 1 Alternation is permitted. Furthermore, a design analysis is needed to confirm the carport canopies foundations can adequately sustain the new loading conditions in comparison to the original design loads from the time on construction.

To analyze the loading, TT determined the assumed loadings using ASCE 7-16. TT assumed a dead load of 10 pounds per square foot (psf)[9] and a live load of 20 psf[10] on the new carport canopies. For the wind loading, Components and Cladding Section 30.7.2 was utilized, the downward wind pressures on the new carports were analyzed to be Zone 2 pressures of 28 psf[11] whereas the uplift pressures were 38 psf[12]. Additionally, the concrete foundation was considered to be cracked for the means of the analysis. To calculate the dimensions needed for the concrete foundations, TT utilized the design software ENERCalc.

Results from ENERCalc with the new carport canopy:

- Dimensions of Foundation – 12" Diameter x 11' Deep

In conclusion, the introduction of new canopy loads necessitated larger foundations compared to the ones initially observed on-site. While comprehensive documentation of the site's soil properties and existing foundations was not provided to TT, it was deduced that the amplified wind loading, as per the updated Florida Building Code (FBC) standards since the time of construction, has substantially increased, potentially causing the system to operate beyond its original design capacity.

[9] ASCE 7-16, Table C3.1-1a gives 3 psf for aluminum roof deck, with an assumed 7psf for additional members.
[10] ASCE 7-16, Table 4.3-1.
[11] ASCE 7-16, Section 30.3.2
[12] ASCE 7-16, Section 30.3.2.

6.2 Mechanical Room Slabs Repairs

TT performed an existing conditions assessment of the mechanical rooms throughout Levels 15, 12, 10, 8, 6, and 4; Section 3.3 of this report outlines the observations and repair recommendations at the mechanical rooms. TT recommends that all of the HVAC units throughout the mechanical rooms be removed so that concrete repairs and waterproofing can be applied through the entirety of the slab for long term protection. Without adequate protection, chlorides will build up in the slab until they reach the level of concentration that triggers corrosion. Long-term cost savings result from proactive waterproofing measures, preventing the need for extensive future repairs.

7.0 Civil Conclusion & Recommendations

7.1 4.1 Parking Lot: Conclusions

Asphalt pavements on a well-designed and constructed subbase typically have a functional life of 15 to 20 years before they need to be milled and resurfaced to prevent replacing the entire pavement section. If they are seal coated periodically, they can last even longer. Resurfacing typically extends the functional life of a pavement 10 to 15 years.

In this case, the pavement exhibits localized areas of poor subgrade support and significant shrinkage cracking due to oxidation/advanced age, as well as heavy erosion due to heavy water runoff. There are three basic options for restoring asphalt pavement:

Asphalt Option 1: Spot Repair and re-sealing
Functional Life 3 – 5 Years – Does not resolve grading/drainage issues. The functional life might decrease at areas with heavy water erosion.

Saw out the seam cracks and seal with asphalt emulsion. Cut and remove pavement exhibiting alligator cracking, compact subbase and patch. Cut out and repair sections of broken curb. Surface patch the asphalt where possible, cut out collapsed portions, compact / improve the subbase, and patch.

Asphalt Option 2: Resurface, Regrade
Functional life 8 – 15 years – Resolves grading issues.

Selectively cut out areas that are alligatored to improve the subgrade, then mill the entire asphalt pavement. Cracks in milled surface would be repaired with asphalt emulsion, the milled surface properly tack coated, and then resurface with new asphalt layer to improved grades. Inspectors of this work would record the temperature of the asphalt as it arrives, collect a copy of the delivery ticket, and ensure that the asphalt seams are properly sealed or heat welded. Curbs that are damaged or need to be raised to meet new elevations would be replaced.

However, if this lot was resurfaced in 2003, the base asphalt may be 34 years old. The base may be so deteriorated by age that the entire pavement section could fail during the milling process, which delivers significant pressure and friction.

Asphalt Option 3: Demolish and Replace the Entire Pavement
Functional life 15 – 20 years, longer if seal coated – Resolves grading issues

Remove all asphalt and implement wholesale improvement of the subgrade to eliminate any future or localized settlement issues that would not be remediated under Option 2. Regrade and install new base course and surface course. Inspectors of this work would record the temperature of the asphalt as it arrives, collect a copy of the delivery ticket, and ensure that the asphalt seams are properly sealed or heat welded. Curbs that are damaged or need to be raised to meet new elevations would be replaced.

7.2 Parking Lot: Recommendations

Asphalt Pavements: We would recommend Option 3 as the most economical and longer lasting pavement. After 35 years, the existing pavement has performed adequately but is well beyond its design life and coming to the end of its functional life. The Association has been fortunate to have an asphalt lot last this long.

Concrete Pavements:

- South Driveway and dropped curb: Remove, improve subgrade, replace with new concrete reinforced pavement to better withstand traffic. The intent would be to keep the existing dropped curb and carefully sawcut to remove the concrete at the driveway.
- Parking areas: If desired, have these areas cleaned and any cracks and joints re-sealed.
- Curbs: Replaced damaged sections, resolve tree root issues.
- Wheel stops: replaced damaged wheel stops.

7.3 Drainage: Recommendations for Improvement

7.3.1 Site Restrictions

Our recommendations to improve the site drainage and erosion take in consideration the requirements identified by the Royal St. Andrews Association or by the site's existing conditions. The site's restrictions are the following:

- Do not alter the existing concrete pavement of the ground level parking area.
- Maintain the building's existing plumbing system. Do not alter the existing drainage pipes and outlets behind the building wall.
- Maintain the elevations of the ground level parking area as not to adversely impact the vertical clearance between the ground and second level parking area.
- There are no public storm sewers fronting the site where stormwater runoff could be discharged.

7.3.2 Recommendations for Improvement

TT investigated the following options to remediate the drainage issues at the site:

- Permeable paving.
- Raising the pedestrian path elevation to eliminate the dip at the downspout locations and placing concrete pavement in these areas.
- Stone aprons at the downspouts
- Shallow drainage systems to convey the stormwater runoff.
- Creating paved swales to convey the stormwater runoff.
- Creating stone/gravel swales in the green spaces with potential for infiltration (pending soil investigation).

For simplicity in presenting the recommendations, we have separated the project area in two sections, North and South. The North area of the parking lot receives stormwater runoff from two roof drainage pipes as well as from approximately the northern half of the parking lot. The South area of the parking lot receives stormwater runoff from one roof drainage pipe as well as from approximately the southern half of the parking lot. For the purpose of this investigation, it is assumed that each of the three roof drainage pipes convey one-third of the runoff from the building's roof area.

7.3.3 Northern Parking Area

Option 1

Each of the two roof drainage pipes have caused erosion and settlement of the asphalt pavement and discharge significant stormwater flow toward the parking lot. Refer to Appendix C, sheet 1: we propose to install two rows of trench drains to collect the stormwater from the roof drainage pipes. The two trench drains will later be joined into a single trench drain routed along the asphalt pavement going north and then daylighted to the planting area. Within the planting area Alternative 1a, a bioretention could be explored (upon further investigation of the geotechnical and subsurface conditions). Or Alternative 1b, Gravel Swale would convey the stormwater toward the eastern side of the project. In Alternative 1a, the stormwater would then be routed to an inline basin and slab trench drain to discharge to the curb edge at the driveway and sheet flow along the driveway to exit the site. In Alternative 1b, the stormwater would be routed with a gravel swale all the way to the curb edge at the driveway and then sheet flow along the driveway to exit the site. Refer to Figures 21 and 22 for a series of trench drain systems by ACO Drain.

- Benefit: The trench drain is routed along a portion of the asphalt pavement and reduces impacts to the pavement and work area.
- Negative: Grade elevations are challenging in the site. The inlet drain by the property line could have approximately 6” of standing water. In addition, the north green space would be affected.

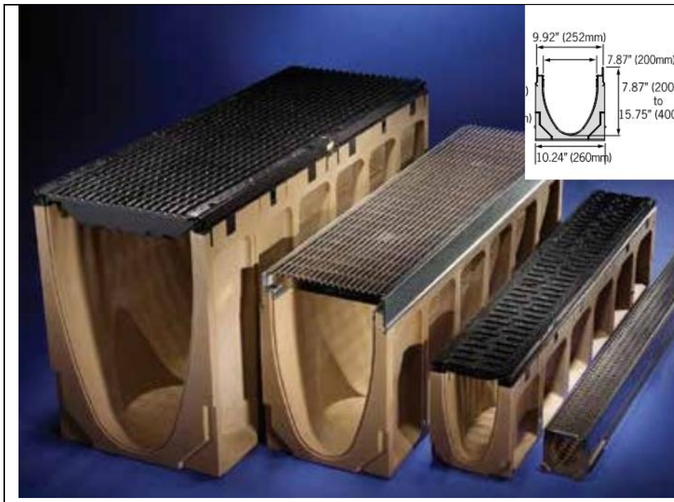


Figure 21: ACO Trench Drains (Standard)

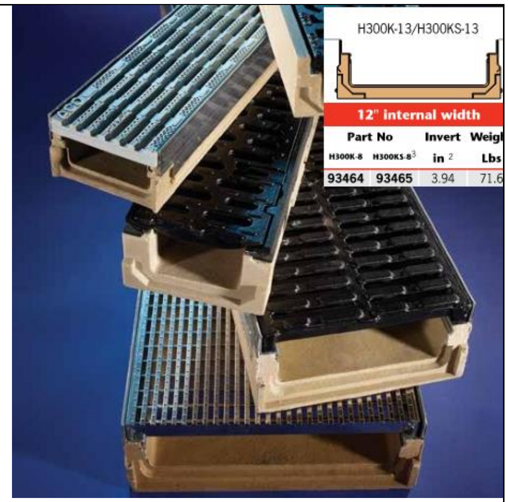


Figure 22: ACO Trench Drains (Shallow)

Option 2

Refer to Appendix C, sheet 2. Install two rows of trench drains to collect the stormwater from the roof drainage pipes. The two trench drains will later be joined into a single trench drain routed along the asphalt pavement going north and then east all the way through the property line. Install a new slab drain and curb outlet on the city sidewalk and daylight along the curb line. Refer to Figure 23 for ACO's curb outlet.

Figure 23: ACO Curb Outlet

- Benefit: Grade elevations work better in this alternative and there may not be standing water.
- Negative: This alternative requires approval from the Agency having jurisdiction.

7.3.4 Southern Parking Area

Option 1

Install a trench drain to collect the stormwater from one roof drainage pipe and route the trench drain east along the asphalt pavement. Cross the trench drain north and east, through the concrete pavement, and daylight onto the planting area between the two driveways. Bioretention could be explored (upon further investigation of the geotechnical and subsurface conditions). The stormwater runoff would discharge through a slab trench drain to a new curb and drain out to the property line along the existing concrete sidewalk. This option includes the installation of perforated piping and a few inlet drains.

- Benefit: The trench drain is routed primarily along the asphalt pavement.

- Negative: Grade elevations are challenging in the site. The inlet drain by the property line could have approximately 6” of standing water. Requires the removal of the existing planting. Requires trenching through part of the concrete pavement.

Option 2

Refer to Appendix C, sheet 3. The stormwater runoff from the building drainage pipe will be directed to either an asphalt or a concrete swale. The southern section of the parking lot’s asphalt pavement would be re-graded to create a shallow swale. The swale would direct the stormwater runoff to the east side and toward the southern driveway. The swale would be very subtle, sized for capacity and sloped in a way to create a smooth transition for pedestrians and vehicles. In preliminary calculations we see the swale could be 2-inches deep or slightly less. Refer to Figure 24 for example of paved concrete swale.

For this option, the planting area between the two driveways would not receive roof stormwater and would only handle a portion of the runoff from a portion of the site. This area could be turned into a gravel that would discharge out of the property line along the existing concrete sidewalk.

- Benefit: No impacts to the concrete pavement or introduction of new structures.

- Negatives: Requires re-grading of a portion of the asphalt pavement.

Figure 24: Paved Swale in Concrete

7.3.5 Drainage Alternatives Conclusion

In this investigation we explored a few alternatives and are presenting some feasible options. The northern section of the parking lot requires more investigation before we can recommend an alternative. The grade elevations are very challenging, and this area receives the most stormwater runoff flow. We would also recommend performing a boring and permeability test at the northern grass area to confirm the soil profile, ground water elevation, and permeability rates of the soil.

On the southern side of the parking lot we recommend the installation of a new swale. This alternative requires reconstructing the asphalt pavement to new grades. The existing asphalt pavement is coming to the end of its functional life. Re-grading and replacing the asphalt pavement would resolve the drainage and paving issues on this side of the property.

END OF REPORT