131 WEST WILSON PARKING STRUCTURE & PLAZA DECK

MADISON WISCONSIN 53703

STRUCTURAL CONDITION STUDY

Prepared For

EXECUTIVE MANAGEMENT INC.

2701 International Lane

Madison WI, 53708

GMA # 216009

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131 WEST WILSON STREET PARKING STRUCTURE & PLAZA DECK CONDITION STUDY

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I. EXECUTIVE SUMMARY

The 131 West Wilson St. parking structure is 45 years old. The configuration of the parking ramp is a three-level single helix, with a single entrance / exit on the northeast corner off W. Wilson St.. Total parking square footage (excluding P0 Plaza Deck & P3L) is 86,195 SF. Total number of parking stalls is 213. An eleven-story office building is above the parking garage.

The structural system consists of a reinforced cast-in-place concrete foundation system with reinforced cast-in-place concrete columns and a center core shear wall structure supporting a two-way reinforced 12" cast-in-place concrete slab. Major repairs, removing 2" of concrete from the entire original slab and a 2" concrete topping installation was performed approximately 26 years ago by Sullivan Builders. The concrete topping increased the overall depth of the parking structural slab to 14". Original design (from 1971 drawings) indicates load capacities for the parking slabs and plaza slabs were 50 PSF and 80 PSF, respectively. Analysis of the existing reinforced concrete slab on the original parking structure drawings indicates the load capacity of the slab, even with the additional topping weight, is capable of supporting the typical 50 psf parking requirement if reinforcing and concrete is restored.

All structural slab parking levels have been covered with some form of elastomeric waterproofing of varying conditions. 75% of the overall membrane either shows significant wear, through both top wear courses. Recommendations include full removal of badly worn membrane in order to better define topside concrete delamination areas for determination of concrete repair quantities. Six (6) expansion joints are located on each complete level of the parking structure.

While performing field work we observed water leaking from the underside of expansion joints for multiple days after a rain event. GMA also hammer tested select column bays to identify delaminated areas. Complete underside slab, column bases & column drop panels were sounded with hammers. Unit costs for these repairs takes in account the increased 4" depth of slab & high concentration of reinforcing steel. The 4" depth is understood to be the original 2" concrete cover plus 2" additional topping. The average topside delamination is

calculated at 69% of slab area. Total delaminated areas are extrapolated to 43,748 sf.

Parking Deck Repairs of the 63430 ft2 parking deck, including removal of all existing worn traffic membrane, deteriorated concrete both topside and underside, new structural concrete repairs, a new traffic membrane, trench drains and miscellaneous electrical work are estimated at $7.08 M.

The following repairs are recommended for the Plaza Deck

- Removal of the entire existing 4" concrete wear surface.
- Remove the existing water proof membrane and install a new waterproof membrane.
- Included would be leak testing of the new waterproofing.
- Provide inspection of the exposed top surface of the structural slab, repair if needed.
- Provide a second level drainage layer below the new concrete wear surface

Plaza Deck Repairs, including new drains, new railings, a new concrete replacement slab and membrane waterproofing are estimated at $807,925.

II. INTRODUCTION

Structure Overview

The 131 West Wilson St. parking structure's original drawings are dated 1971. Assuming the structure was constructed the following year, the structure is 45 years old. Limited original construction documents are available, but structural drawings (S-1 to S-11) were located by Executive Management and provided to GMA. Oddly some of these drawing sheets have incomplete title blocks including no original issue date. Some show various revisions 1 thru 5 issued June to September 1971, leaving 4 sheets un-dated.

The configuration of the parking ramp is a three level single helix, with a single entrance / exit on the northeast corner off W. Wilson St. Three stair towers service all levels of parking, one located within the center elevator core and two in the southeast and southwest corners. An eleven-story office building is above the parking garage.

The structural system consists of a reinforced cast-in-place concrete foundation system, with reinforced cast-in-place concrete columns and a center core shear wall structure supporting a two-way reinforced 12" cast-in-place concrete slab with additional 4" drop panels over columns. 24 Columns on grids 1-4, C-H support the building tower above. The 16 columns on grids A, B, J & K along the north & south sides support only three levels of plaza and parking slabs.

Executive Management found no documentation for any previous parking structure repairs. Specifically, the major repairs and topping installation performed approximately 26 years ago by Sullivan Builders, which will be discussed later in this report, were not available.

The concrete topping added in approximately 1990, increased the overall depth of the parking structural slab to 14". Original design (from 1971 drawings) indicates load capacities for the parking slabs and plaza slabs were 50 PSF and 80 PSF, respectively. Concrete coring performed for this report found the added topping thickness varies from 2" to 3". This adds 25psf to 35psf to the load on the structure.

Parking square footage by levels:

P0 (Parking) = 13,775 SF

P1U = 14,950 SF

P1L = 14,675 SF

P2U = 14, 600 SF

P2L (Structural Slab) = 5,430 SF

P2L (Slab-on-Grade) = 9,625 SF

P3U (Slab-on-Grade) = 13,140 SF

Total parking square footage (excluding P0 Plaza Deck & P3L) is 86,195 SF.

Total number of parking stalls is 213.

III. REPAIR/RESTORATION HISTORY SUMMARY

Note: Executive Management was unable to locate any drawings or specifications on any past repair project. The only information provided was verbal information outlined below

Approximately 1990

From verbal reports of current employees, Sullivan Construction performed topside concrete repairs, removing 2" of concrete from the entire original slab. If slab delaminations were present, the un-sound concrete was also removed and these deeper repair areas were incorporated monolithically with the 4" topping placement. The 4" depth is understood to be the original 2" concrete cover plus 2" additional.

Mid 1990's

Expansion joint leaking: contractor replaced expansion joints

Parking slab leaking: contractor installed traffic membranes

IV. STRUCTURAL OBSERVATIONS AND RECOMMENDATIONS

Field observations were performed on a visual basis except specific soundings as follows:

- Original proposal outlined topside chain drag: field conditions did not allow for accurate chain drag results. Instead, select column bays were sounded with hammers to identify delaminated areas
- Complete underside slab & column drop panel sounding with hammers
- Column bases were sounded with hammers
- P0 retaining wall sounded with hammers to height of 8 feet

Topside of Slabs

General Cleanliness

It appears that the spring wash down did not occur prior to the completion of field work for this report in early August. All levels of the ramp have dirt and debris present in enough quantity that in order to mark on the deck with paint or marks you first had to sweep the area.

See Appendix A; Housekeeping, where periodic (weekly or monthly) sweeping of parking surfaces to remove debris.

See Appendix A; Structural Preventative Maintenance, where typical annual spring wash downs of parking surfaces for dilution of de-icing chemicals.

Vehicular Traffic Membranes

All structural slab parking levels have been covered with some form of elastomeric waterproofing of varying conditions.

The entry ramp from W. Wilson Street (level P0) is a urethane based vehicular traffic membrane that is in poor condition. 75% of the overall membrane either shows significant wear, through both top wear courses, or a complete failure if the base coat is compromised.

The membrane type transitions at P0 / P1U, here the membrane changes to a proprietary

Kelmar vehicular membrane for the remainder of the ramp. Although this membrane uses a more abrasion resistant epoxy wear coat, failure of the drive lane membrane was present, with P1U drive lane failures in excess of 65%. Membrane wear and failures are reduced as you move down the ramp, in relationship to the reduced amount of overall traffic.

See Appendix A; Structural Preventative Maintenance, where inspection and repair of traffic membranes are performed after typical annual spring wash downs of parking surfaces. Annual inspection & repair of traffic membrane of damage or extensive wear will avoid the accumulated widespread failures observed in conjunction with the report.

Recommendations include full removal of membrane in order to define topside slab delamination areas so debonded membrane can be excluded from concrete repair quantities. Additionally, with the extensive amount of topside delaminations to be repaired either by conventional hammering or epoxy injection, a new membrane system will provide long term protection in lieu repairing old membrane.

Expansion Joints

Six (6) expansion joints are located on each complete level of the parking structure.

Two (2) north / south expansion joints @ 28'-6"l.f. each, one from grid A to exterior wall & one from grid K to exterior wall.

Four (4), east / west expansion joints, (2) north of grid C and (2) south of grid H. Each joint is 65'-6" long from exterior wall to centerline

See Appendix A; Structural Preventative Maintenance, where cleaning and inspection of expansion joints are performed after typical annual spring wash downs of parking surfaces. Additional periodic housekeeping to vacuum accumulated debris from within joint at regular intervals will reduce the debris caused damage to the expansion joints.

Remove 7 replace 100% of expansion joints once topside delamination repairs are completed.

Although there were numerous observed areas of expansion joint failure, in our opinion the water outflow observed at the underside of expansion joints is attributed to water infiltrating the slab and traveling along the un-bonded interface between the structural & topping slabs.

Select Topside Structural Slab Soundings

Sounding of topside structural slab with a typical chain drag were ineffective, instead select column bays were sounded with hammers. Results of the soundings found extensive delaminations within the slab section.

TABLE 1.1

Level Delam	Location (grids)	Total sf	Delaminated	%
P0	H-J, East wall to garbage encl.	987 sf	240 sf	25%
P1U	H-J, west wall to centerline (CL)	1,645sf	1,160sf	70%
P1L	B-C, east wall to CL	1,170sf	977sf	84%
P1L	Joint S. of H-K, East wall to CL	2752sf	2070sf	75%
P2U	H-J, west wall to centerline (CL)	1240sf	774sf	62%
P2L	B-C, east wall to CL	1,046sf	836sf	80%
	Sub-Totals:	8,840sf	6057sf	69%

From the Table 1.1, the average delamination is calculated at 69%. The average delamination of 69% is applied to each level of the entire ramp, see results below in TABLE 1.2

TABLE 1.2

Level	Total sf	% Delam	Extrapolated Delaminations sf
P0	13,775 sf	69%	9,504 sf
P1U	14,950 sf	69%	10,316 sf
P1L	14,675 sf	69%	10,125 sf
P1L	14,600 sf	69%	10,074 sf
P2U	5,403 sf	69%	3,729 sf
Total Delaminated areas extrapolated			43,748 sf

While performing field work we observed water leaking from underside of expansion joints for multiple days after a rain event. During these periods after rain events, there was no water on the surface of the slab above, and all joints leaked to some extent, including all the way down to the lowest joints in the ramp, P2U, north of grid C adjacent to Red's office & storage.

Investigative Field Coring of Structural Slab

(See Coring Location Plans & Photos of cores for reference)

As part of the overall scope of this investigation, 18 total partial or full depth core extraction of structural slabs was performed by CGC Inc.,. The 18 total cores were distributed with 3 cores at each of the 6 areas selected for topside sounding. Prior to coring, a ground penetrating radar technician from GPRS Inc. scanned the slabs to locate rebar within. This information was then used to either avoid or capture bars during coring operations.

Of the three cores within each area:

- 1 partial depth core captured a top reinforcing bar within a column drop panel (column/column strip).
- 1 partial depth core avoided rebar within the drive lane (middle / middle strip).
- 1 full depth core avoided rebar between columns in the (middle / column strip).

15 of the 16 cores extracted had the topping slab de-bond from the structural slab during coring operations. When the coring bit was extracted, the topping slab portion was loose

inside the bit. Only core #8 remains intact, but shows extensive honeycomb at the interface between the topping & structural slab. Upon completion of the report, a tension pull test can be performed to quantify the bond strength.

Additionally CGC can perform compressive testing of the topping slab cores, of which we would expect typical results from the visual condition of the cores.

Structural Analysis of Current Slab In Situ

Analysis of the existing reinforced concrete slab on the original parking structure drawings indicates the load capacity of the slab, even with the additional topping weight, is capable of supporting the typical 50 psf parking requirement. We expect a structural analysis of the ramp was performed prior to the overlay being added in 1990 as this load was a significant increase in the structure weight. The current conclusion of loading capacity is predicated on the reinforcing being in good condition and/or the parking structure being restored to good condition.

The big unknown at the present is the condition of the reinforcing bars which were originally at the top of the slab. Now, with the added topping depth, the rebar is 4"below the concrete surface. Water intrusion into the slab and seepage out later are indicative of void spaces within the concrete. The field investigation of the topping have shown areas of topping which had not bonded well to the rebar and to the existing concrete. *The rebar may not be well bonded, but also they may have severe corrosion from being exposed to water and salts for 26 years.* A better understanding of the upper rebar condition will give us more confidence in the final restoration process.

Estimate of Probable Cost show traditional removal and replacement with hammers. A proposed test area to define the corrosion of top reinforcing steel and determine the most efficient system of repair of delaminated topping is recommended. A line item is credited back for epoxy injection of delaminated topping is included, this will only be applied if field verification is found to be a viable solution.

Underside of Slabs

Underside Sounding & Visual Observations

All underside levels were sounded and visually inspected. Underside of level (P0) under the building footprint has a spray on insulation. This insulation is mostly intact except for at the north expansion joint where it has been leaking, causing the insulation to fall. Isolated areas of metal panel were present, hiding the slab from view, for estimation purposes panel areas are classified as underside delamination repair areas. Areas of extensive leaking and rust staining were classified as delaminated repairs within the estimate.

Large areas of exposed rebar where delaminated concrete was previously removed, and all areas sounded, found as delaminated, were included as underside repairs within the estimate.

Areas of leaking and delaminations were observed on the underside of P2L, within the print shop and pump room. Special protection is required keep these areas separate from work areas.

Underside slab delaminations extended into some of the column drop panels. Unit costs for these repairs takes in account the increased 4" depth of slab & high concentration of reinforcing steel.

Underside of Trench Drains

Underside of trench drains showed extensive signs of leaking and rust staining, these repairs within the estimate have a higher unit repair cost due to the increased amount of reinforcing steel. Coating of the interior of the trench drain with special epoxy coatings will prevent future water infiltration into the slab below.

Imbedded Conduit

The existing slab has imbedded steel electrical conduit, which is very susceptible to corrosion. Observations found apparent paths of these conduit pathed to light fixtures throughout the slab. These conduit will be damaged during hammering of delaminated concrete. All

imbedded conduit encountered will be abandoned with new surface mounted PVC conduit installed.

Structural Frame

Columns

Concrete columns were sounded with delaminations found at column bases adjacent to top of slabs, as well as high on columns where delamination were caused by leaking water from above.

Exterior Wall (East wall P0)

Interior face of wall was sounded from top of slab up to 8 feet, areas of delamination were found adjacent to top of slab and adjacent to wall expansion joint.

Interior Parapet Wall

Observations found delamination and rotation of walls out of vertical plane, but more importantly there have been modifications like steel spacer block between walls, and columns from slab to top of walls, need further investigation. Documentation of these modifications, should be found, along with destructive investigation should be performed. Repair of these items were not included within the estimate.

Plaza Deck (P0)

General Comments

At present the plaza deck surface shows severe concrete deterioration, failed caulk joints and drainage problems. The purpose of this report is to enumerate the specific problems of the plaza deck, provide repair and restoration strategies and a preliminary estimate of probable cost for budgeting of a repair project.

A waterproofing layer and concrete wear surface is indicated on the structural details but not identified. No internal drainage mat is called out or indicated on the drawings. No waterproofing specifications are available at this time. CMR performed repair on north stair, GMA was present during demo where a built up tar "roofing system" was identified. This built up system has failed due to it's age, noted by the system had swollen with moisture. When Paisan's restaurant was added, Miron Construction installed an unknown orange waterproofing membrane under the south plaza. Both of these membranes have failed as evidenced by the 1,084 lf of active leaking observed during a rain event.

Site observations done by GMA found that there is poor drainage off of the top concrete wear surface of the parking deck. There are areas where water ponds after rain or snow melting which cannot drain off of the deck. Due to the size of these areas the water can back up into the adjacent building.

Because of the internal waterproofing layer, water which does not drain off of the deck surface, has no place to go. The caulking in the joints of the concrete wear surface are missing or deteriorating. Therefore, the concrete adjacent to the open caulk joints becomes saturated, many times with salt-laden water. During CMR's plaza deck work it was observed that planter drainage weeps direct water between the concrete wear surface slab and the structural deck. In addition, this has accelerated the deterioration problems on the top surface.

When concrete is saturated the pores in the concrete fill with water. Normally, these pores would only be partially filled and the expansive pressure of the water during freezing is taken

up within the pores. However, if saturated, the concrete matrix is broken down by the cyclical action of freezing and thawing, resulting in the deterioration seen along the joints of the concrete wear surface. Because of the depth, the water can penetrate deeper at the joints and the deterioration is more severe. The top surface of the deck also shows signs of severe scaling. The fine spider web type cracking exhibited on some areas of the concrete wear surface is indicative of deterioration caused by moisture being trapped under the slab.

During the construction phase of the project the upper surface of the structural slab will be exposed. Additional testing needs to be done at that time to insure that any repairs necessary to the structure are made before the new waterproofing and wear surface are installed.

Recommendations

Due to extensive leaking and wear surface deterioration due to inadequate drainage. The following repairs are recommended for the Plaza Deck

- Removal of the entire existing 4" concrete wear surface.
- Remove the existing water proof membrane and install a new waterproof membrane. Included would be leak testing of the new waterproofing.
- Provide inspection of the exposed top surface of the structural slab, repair if needed.
- Provide a second level drainage layer below the new concrete wear surface. Install new 2 level drains to provide drainage from wear surface and at the waterproofing layer. This is a common detail in newer plaza construction. Installation of new surface drains which will need to be piped to the storm drains in the lower parking level. It prevents water from being trapped within the slabs and creating the saturated conditions which are now prevalent.
- Install a new 4" concrete wear surface.
- Removal of all material from inside concrete planters, dis-assemble retaining wall blocks, install drains & waterproof existing planter interior. Provide root barrier and new landscaping material, using lightweight fill where possible.

Estimate of Probable Costs (Parking Ramp P0 to P3L)

August 17, 2016

GMA Engineers

Type of Repair or Testing	Repair Area	Unit	Unit Cost	Total
A. Conditions of the Contract				See Below
1. Mobilization & General Conditions				
Dust protection enclosures, HEPA filtration of construction zones				
Waste concrete transportation & disposal, portable toilets,				
Electrical power by contractor's generator, Traffic control / vehicle barriers				
B. General Requirements				
1. Supplemental & Replacement Reinforcing	3	Ton	$ 3400.00	$10,200
2. Shoring	4.5	Lvls	$ 8500.00	$38,250
3. (2) Flagmen during ramp concrete work	4.5	Lvls	$ 500.00	$2,250
4. Electrical / mechanical hung off structure to be repaired	4.5	Lvls	$ 2250.00	$10,125
5. Electrical - Abandon imbeded conduit, install surface mount	4.5	Lvls	$ 1950.00	$8,775
6. Plumbing - Replacement of damaged drains, misc piping				
C. Traffic Membrane & Trench Drain Coating	Repair Area	Unit	Unit Cost	Total
1. Removal of Existing Traffic Coating by Grinding (Night Work)	63430	SF	$ 2.25	$142,718
1a. Night work premium	63430	SF	$ 0.70	$44,401
Level P0	*13775*	*SF*		
Level P1U	*14950*	*SF*		
Level P1L	*14675*	*SF*		
Level P2U	*14600*	*SF*		
Level P2L (Structural Slab)	*5430*	*SF*		
2. New Full System Hybrid Epoxy Overlay Membrane In Drive Lanes	28280	SF	$ 7.10	$200,788
Level P0	*4930*	*SF*		
Level P1U	*7010*	*SF*		
Level P1L	*7010*	*SF*		
Level P2U	*7010*	*SF*		
Level P2L (Structural Slab)	*2320*	*SF*		
3. New Full System Urethane Membrane In Parking Lanes	35150	SF	$ 4.80	$168,720
Level P0	*8845*	*SF*		
Level P1U	*7940*	*SF*		
Level P1L	*7665*	*SF*		
Level P2U	*7590*	*SF*		
Level P2L (Structural Slab)	*3110*	*SF*		
4. Trench Drains Coat Interior w/ Epoxy (2 coats)	60	SF	$ 22.50	$1,350
Level P0	*30*	*SF*		
Level P1L	*30*	*SF*		
5. Traffic Line Striping	6	Lvls	$ 950.00	$5,700

		Repair Area	Unit	Unit Cost	Total
Sealant & Expansion Joint Work		**3375**	**LF**	**$ 7.50**	**$25,313**
1. Rout Open Cracks & Install Sealant					
		4820	**LF**	**$ 9.50**	**$45,790**
2. Remove & Replace Perimeter Cove Sealant					
	Level P0	*740*	*LF*		
	Level P1U	*810*	*LF*		
	Level P1L	*800*	*LF*		
	Level P2U	*800*	*LF*		
	Level P2L (Structural Slab + SOG)	*900*	*LF*		
	Level P3U (SOG)	*770*	*LF*		
		722	**LF**	**$ 120.00**	**$86,640**
3. Remove & Replace Expansion Joints					
	Level P0	*158*	*LF*		
	Level P1U	*158*	*LF*		
	Level P1L	*158*	*LF*		
	Level P2U	*158*	*LF*		
	Level P2L (Structural Slab)	*92*	*LF*		

		Repair Area	Unit	Unit Cost	Total
E. Structural Frame Concrete Repairs		**67**	**SF**	**$ 110.00**	**$7,370**
1. Perimeter Concrete Wall Repairs					
	Level P0	*39*	*SF*		
	Level P1U	*28*	*SF*		
		409	**SF**	**$ 125.00**	**$51,125**
2. Column Repair					
	Level P0	*33*	*SF*		
	Level P1U	*52*	*SF*		
	Level P1L	*110*	*SF*		
	Level P2U	*36*	*SF*		
	Level P2L	*101*	*SF*		
	Level P3U	*77*	*SF*		
		2	**EA**	**$ 9500.00**	**$19,000**
3. Vent Shaft reconfiguration & waterproofing					
		2	**EA**	**$ 12250.00**	**$24,500**
4. South Stair Repairs					

		Repair Area	Unit	Unit Cost	Total
F. Structural Slab Underside Concrete Repairs		**18267**	**SF**	**$ 110.00**	**$2,009,370**
1. Underside Structural Slab Repair					
	Level P0 (Plaza)	*1200*	*SF*		
	Level P0 (Parking)	*7249*	*SF*		
	Level P1U	*2428*	*SF*		
	Level P1L	*3216*	*SF*		
	Level P2U	*3871*	*SF*		
	Level P2L	*303*	*SF*		
		1515	**SF**	**$ 165.00**	**$249,975**
2. Underside Column Drop Panel Repair					
	Level P0 (Plaza)	*710*	*SF*		
	Level P0 (Parking)	*620*	*SF*		
	Level P1U	*45*	*SF*		
	Level P1L	*63*	*SF*		
	Level P2U	*32*	*SF*		
	Level P2L	*45*	*SF*		
		120	**SF**	**$ 225.00**	**$27,000**
3. Trench Drains Underside Repairs					
	Level P0	*60*	*SF*		
	Level P1L	*60*	*SF*		

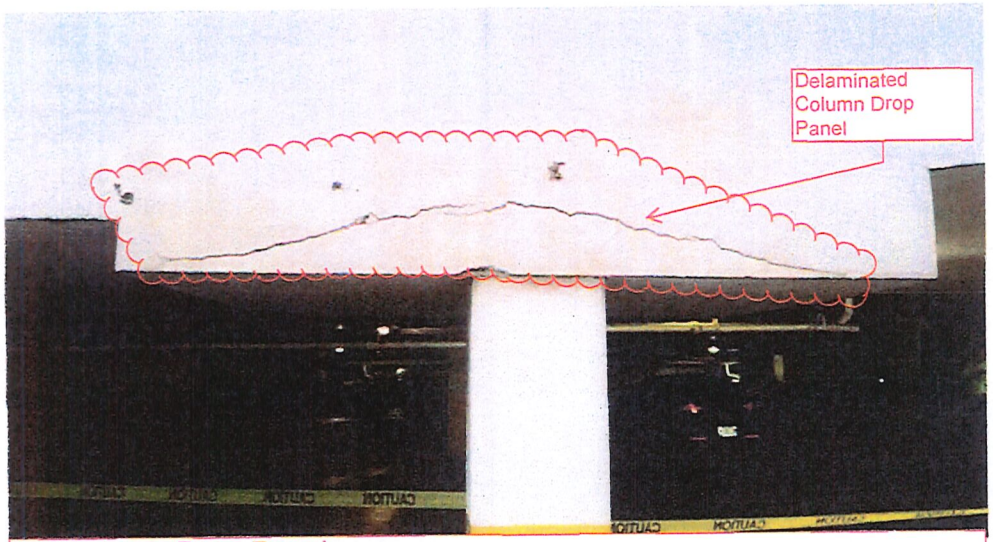
G. Structural Slab Topside Concrete Repairs	Repair Area	Unit	Unit Cost	Total
1. Topside Structural Slab Repair (Conventional Remove & Replace)	**43748**	**SF**	**$ 65.00**	**$2,843,620**
Based on extrapolated areas of topping delamination				
Level P0 (Parking)	*9504*	*SF*		
Level P1U	*10316*	*SF*		
Level P1L	*10125*	*SF*		
Level P2U	10074	*SF*		
Level P2L	*3729*	*SF*		
ALTERNATE TOPSIDE DELAMINATION (DEDUCT FROM G.1.)				
2. Topside Structural Slab Repair (Epoxy Injection)	**43748**	**SF**	**$ -20.00**	**-$874,960**
Level P0 (Parking)	*9504*	*SF*		
Level P1U	*10316*	*SF*		
Level P1L	*10125*	*SF*		
Level P2U	10074	*SF*		
Level P2L	*3729*	*SF*		

Subtotal	$5,148,019
General Conditions	$1,235,525
Sub-Total	$6,383,544
Engineering & Construction Administration	$702,190
Total Project Cost	**$7,085,733**

Estimate of Probable Costs - Plaza Deck (P0)

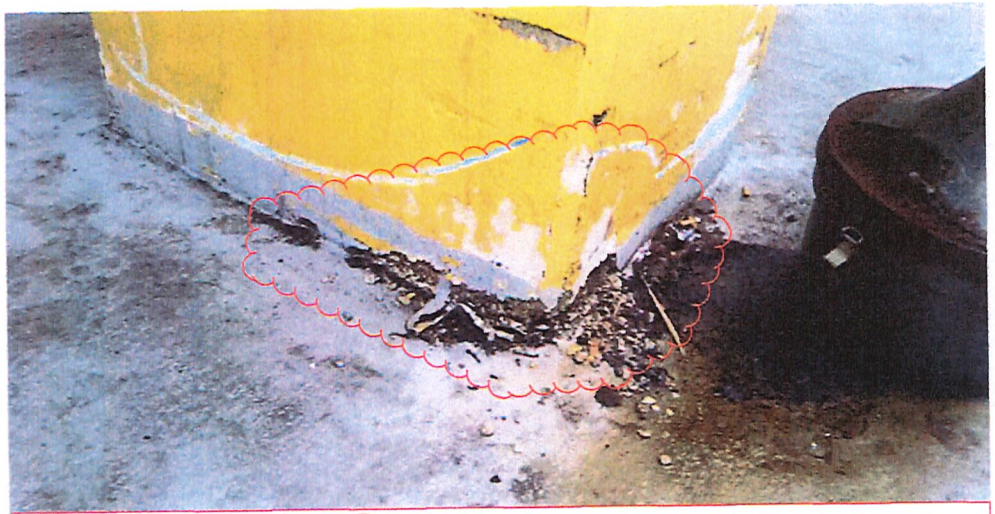
ype of Repair or Testing	Repair Area	Unit	Unit Cost	Total
AA. Conditions of the Contract				
1. Mobilization & General Conditions				See Below
Protection enclosures, Temporary Railings				
Waste concrete transportation & disposal, portable toilets,				
Electrical power by contractor's generator				
BB. General Requirements				
1. Plumbing Installation of New 2 level Drains (Wear Surface)	15	EA	$ 1750.00	$26,250
2. Remove & Replace Lighting Poles, New Raised Bases	8	EA	$ 1850.00	$14,800
Misc. Electrical work				$3,750
3. HVAC Temporary work and support				$8,200
4. Remove & Replace Railings with new	446	SF	$ 200.00	$89,200
CC. Concrete Wear Slab & Waterproofing	Repair Area	Unit	Unit Cost	Total
1. Wear Slab Removal & Replacement	8930	SF	$ 18.00	$160,740
2. Removal of Existing Waterproofing	8930	LF	$ 3.50	$31,255
3. Installation of Waterproofing, Protection Board & Drainage Mat	8930	SF	$ 12.50	$111,625
4. 20 year warranty with EFVM Leak Detection Testing	8930	SF	$ 0.80	$7,144
4. Contingency for testing exiting Waterproofing & Asbestos Abatement				$8,900
DD. Planter Drains & Waterproofing	Repair Area	Unit	Unit Cost	Total
1. Removal & Replace Planter Contents	2150	SF	$ 25.00	$53,750
2. Removal of Existing Waterproofing	2150	LF	$ 6.50	$13,975
3. Installation of Waterproofing, Protection Board & Drainage Mat	2150	SF	$ 12.50	$26,875
4. 20 year warranty with EFVM Leak Detection Testing	2150	SF	$ 0.80	$1,720
5. Plumbing Installation of New Drains (Planters)	12	EA	$ 2400.00	$28,800

Subtotal	$586,984
General Conditions	$140,876
Sub-Total	$727,860
Engineering & Construction Administration	$80,065
Total Project Cost	**$807,925**

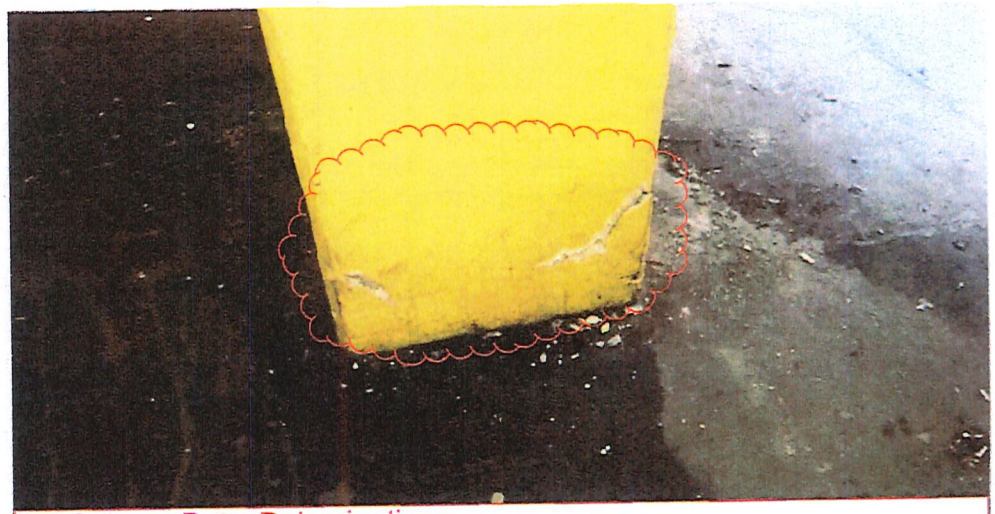


1.1 Column Drop Panel

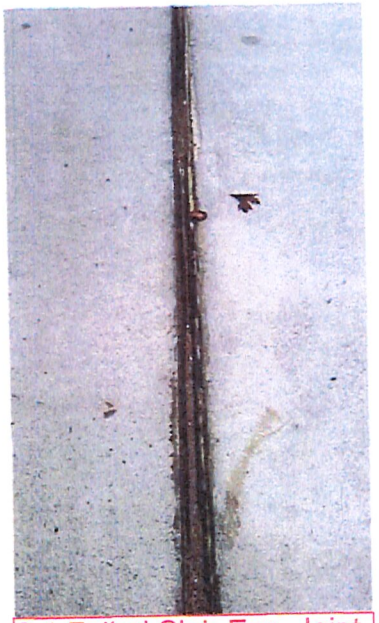
1.2 East Wall



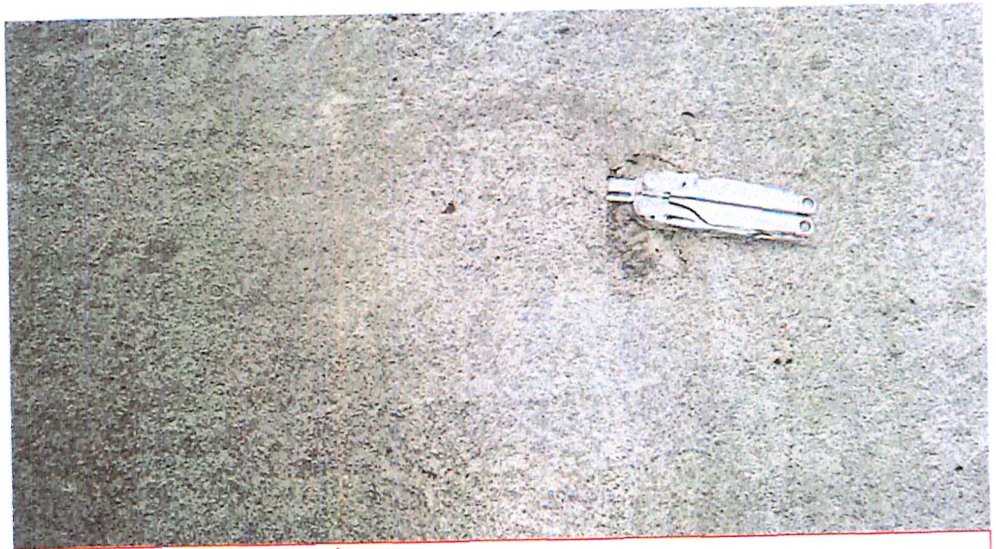
1.3 Deteriorated Column Base



1.4 Column Base Delaminations

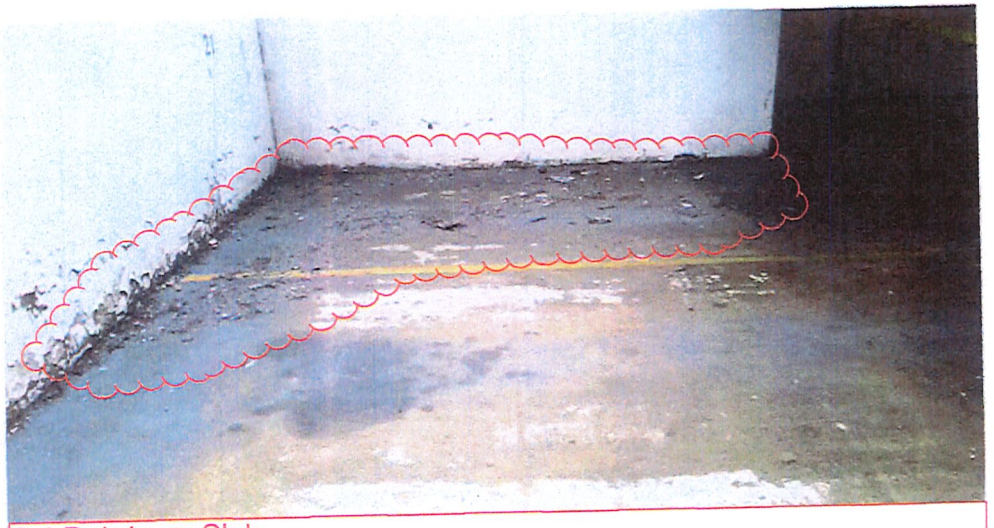


2.1 Failed Slab Exp. Joint



2.2 Failed & Worn Membrane

2.3 Failed Membrane

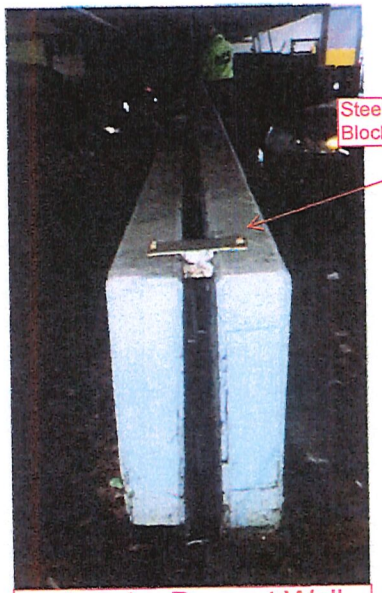


2.4 Debris on Slab

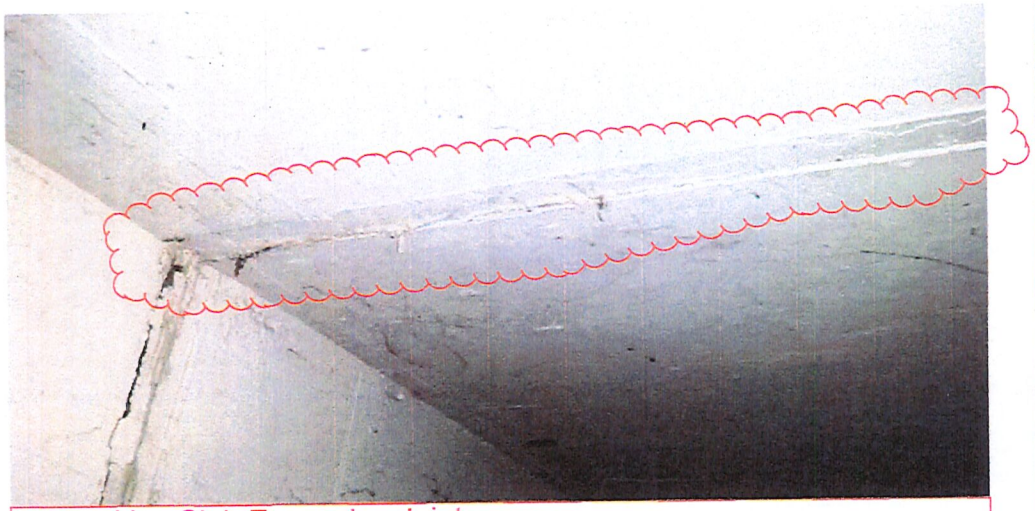
3.1 Worn Membrane

3.2 Failed Membrane

3.3 Leaking Drain

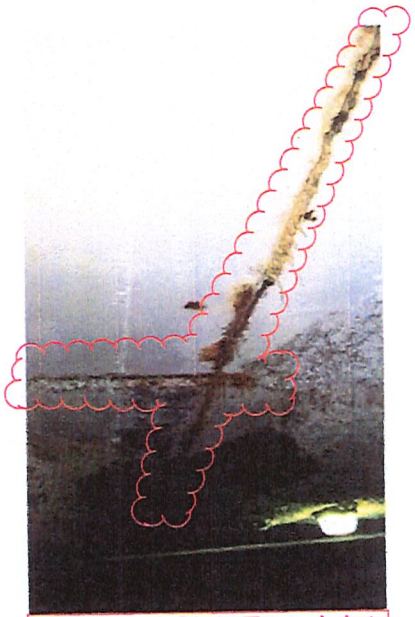


4.4 Interior Parapet Wall

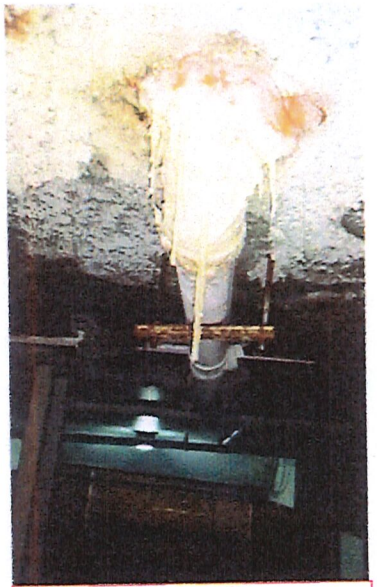


4.1 Leaking Slab Expansion Joint

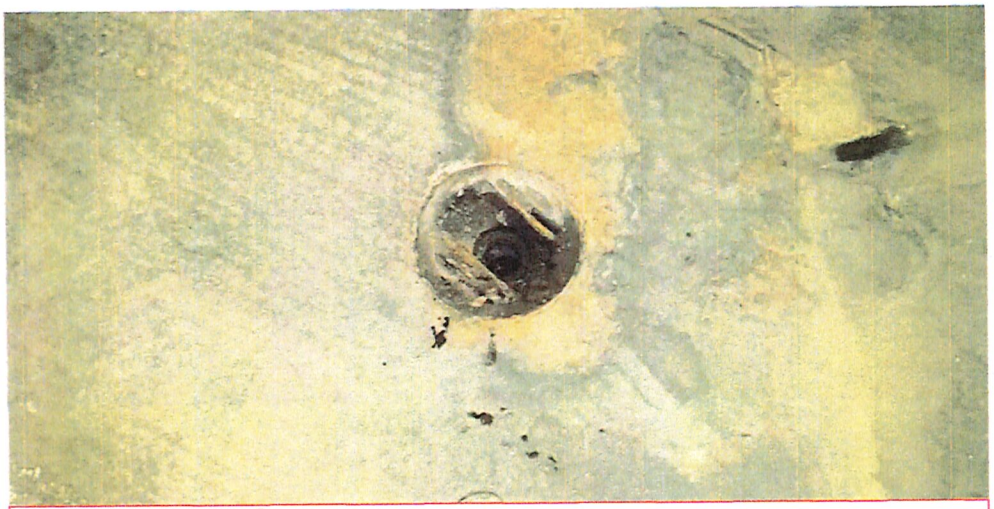
4.2 Underside Plaza Leaking



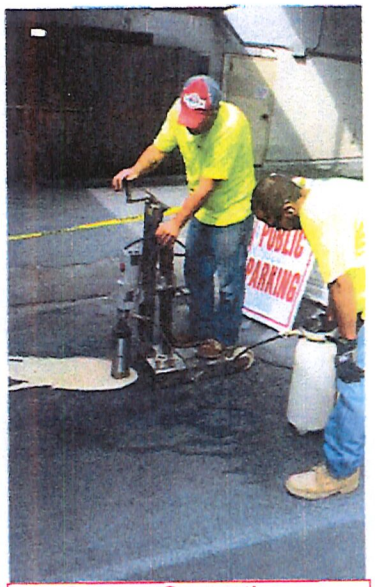
4.3 Failed Slab Exp. Joint



4.4 Leaking Drain



5.1 Broken Drain Grate



5.2 Coring Operations

Appendix A

Facilities Maintenance & Repair Methodology

FACILITIES MAINTENANCE & REPAIR METHODOLOGY

Facilities Maintenance: Parking garages are typically freestanding open air multi-story ramps or below grade enclosed ramps integrated into multi-use office or condominium buildings. These structures represent a major investment by Owners with current costs approaching $24,000 per stall. Expected service life of freestanding structures are 30-40 years with garages integrated below multi-use buildings expected to exceed this timeframe. Parking structures are a unique building type prone to increased deterioration and distress due to the direct exposure to weather, thermal extremes, deicing chemicals, snow plowing, and vehicles tire wear. Unlike typical enclosed and protected buildings, parking structures develop an exponential deterioration curve as they age. If preventative maintenance and repair items are not addressed, deterioration accelerates, greatly increasing repair costs.

All parking structures require regular maintenance to provide an acceptable level of service. The development, implementation and documentation of a comprehensive **Facility Specific Maintenance Plan** including; Housekeeping, Operational Preventative Maintenance and Structural Preventative Maintenance in conjunction with regular inspections, is crucial and directly impacts the expected service life of structure and reducing the expense of structural repairs.

Your **Facility Specific Maintenance Plan** should be reviewed and updated on a regular basis. Meetings with staff and maintenance contractors providing feedback for the modification of procedures.

Implementation of your **Facility Specific Maintenance Plan** will require written documentation of procedures, including schedules and logging requirements. Training of staff and maintenance contractors should be performed as required, typically prior to seasonal changes in maintenance tasks. Including standard basic checklists for each type of task, will standardize and streamline the process, with these easily incorporated into the maintenance log. Allocation of Security staff to incorporate these checklists relating to their walkthroughs, noting items like burnt out light bulbs, door and hardware operation, etc..

REFERENCES FOR PARKING STRUCTURE MAINTENANCE:

Consult these resources to develop or refine your specific facility maintenance plan. The first two references are for general parking structure use with the last two for specific construction types, precast or post-tensioned structures.

General Concrete Parking Structures

"Parking Garage Maintenance Manual" by National Parking Association

"ACI 362.2R Guide for Structural Maintenance of Parking Structures" by American Concrete Institute

Precast / Prestressed Parking Structures

"Maintenance Manual for Precast Parking Structures" by Precast / Prestressed Concrete Institute

Cast-In-Place Post-Tensioned Parking Structures

"PTI DC20.7 Design, Construction and Maintenance of Cast-in-Place Post-Tensioned Concrete Parking" by Post-Tensioning Institute.

Operational Preventative Maintenance: These tasks are becoming larger in scope and include specialized building system testing and repairs, thus these duties may be performed by a combination of the parking structure operators, owners, and outside consultants or contractors as required.

Detailed description of operation preventative maintenance tasks and schedules are noted within the references provided above, for example should include the following tasks:

(Weekly / Monthly)

- **Security Systems:** *Periodic inspection of security equipment such as television surveillance cameras, audio monitoring devices, emergency phones, panic alarms, and panic hardware on doors, reduction of hiding places*
- **Pedestrian Barriers:** *Visually inspect for damage to anchorage points. Check tightness of P-T cables.*
- **Tripping Hazards:** *Check curbs, stairs & thresholds, and floor surfaces for trip / fall hazards*
- **Lighting:** *Periodic replacement of lamps, checking and calibration of timers and photocells, and visual inspection of conduits and electrical panels.*
- **Exit and Emergency Lighting:** *Check and replace exit lighting as necessary, periodically test battery pack emergency lighting system, and inspect emergency generator per manufacturer's recommendations.*
- **Plumbing System:** *Check drains, piping, and risers for blockage or other damage. Flush system annually for cleaning. Check heat-tracing elements for proper performance.*
- **Carbon Monoxide Sensor Systems:** *Periodic testing and inspection of systems per manufacturer's recommendations.*

(Semi-Annually)

- **Fire Protection Systems:** *Periodic inspection of standpipes and sprinkler systems, as well as inspection of fire extinguishers, hoses, and cabinets.*

Structural Preventative Maintenance: Is performed to reduce the life cycle repair expenses and extend service life of the structure. This assures the structure's protective systems are performing and maintained properly to reduce the infiltration of chloride laden water from deteriorating the structure. The following tasks are typically identified in the yearly condition walkthrough.

Drive Slab & Stair Wash-Down is the single most critical maintenance item to extend the service life of the parking structure in northern climates where chloride, i.e. de-icing salts, laden slush / water are transported and deposited within the structure by vehicles and pedestrians. Road salts accumulated on and within the concrete over winter should be flushed using high volume 1 1/2" to 2" hoses under low to moderate pressure. This high volume – low pressure wash down method is preferred because it allows the dilution of salts on and within the concrete surface, in comparison to high pressure washing equipment which uses very low water volume at high pressure, typically used only for surface cleaning and degreasing.

Note Special Wash-Down Conditions - consult with Engineer prior to performing:

- Wash-downs within enclosed structures including stair towers, below grade or enclosed parking structures need special procedures to remove excess water and humidity, activating the ventilation system or using a supplemental system may be required.
- Parking structures in poor condition due to damage from concrete steel reinforcing (rebar) corrosion. Concrete repairs should be performed prior to wash-down to avoid accelerating corrosion.

Wash-downs of high traffic areas like entries and main drive isles should be performed more frequently if possible during mild mid-winter weather.

Detailed description of structural preventative maintenance tasks and schedules are noted within the references provided above, for example should include the following tasks:

Repair Project: When parking structure components need major repairs or replacement due to:

- Structural concrete restoration for building structure including slab, beams, columns, etc..
- Expected or premature failure, or end of service life is reached for a building system
- High cost of maintenance is no longer a cost effective alternative to replacement.
- Age and inefficiency of existing system is substandard to newer technologies.

A repair / replacement project will need to be developed for the specific system or item(s). These projects are initiated as the result of issues brought forth in the engineer's annual conditions report or inspections performed during the annual operational and structural preventative maintenance cycles. Development, design and construction administration of a repair / replacement project typically is under the direction of an Engineer (Structural, Mechanical, Plumbing or Traffic). Costs of repair / replacement project are typically beyond that of preventive maintenance and are need to be accommodated within the facilities capital budget.

Appendix B

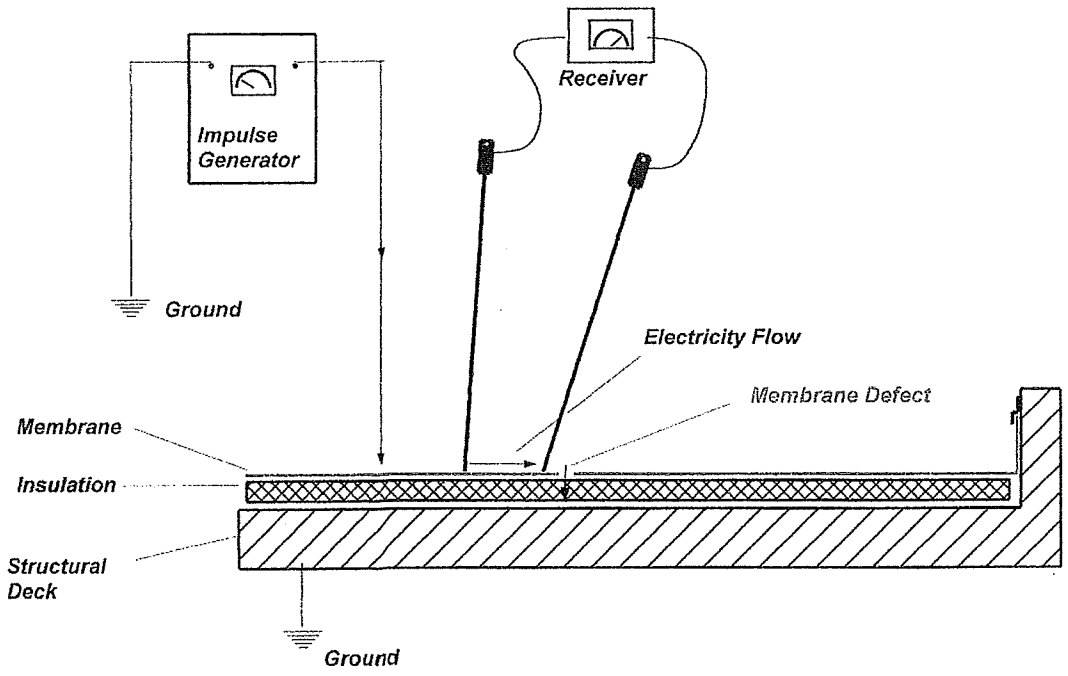
EFVM (Electric Field Vector Mapping)

EFVM® (Electric Field Vector Mapping)

Before conducting the *EFVM®* procedure, it is essential that the membrane surface is wet. If the surface is dry at the time of the test, then water needs to be sprayed over all the areas to be tested. If the area is sloped and free draining, the water supply needs to be continuous.

The "*Vector-9*" conductor wire is set out in a rectangular loop around the area to be tested and an EFVM® impulse generator is connected to the conductor wire. Every three (3) seconds a 40-volt potential is being delivered for a period of one (1) second. An electrical potential difference is set up between the membrane surface, which is wet, and the structural deck, which is earthed or grounded. If there are any breaches in the membrane, then the small electric current will flow across the membrane surface and down through the breach to the earthed structural deck. Using a EFVM® potentiometer connected to two probes, the direction of the current can be identified and, thus, by moving the probes, any breach can be pinpointed. Because of the high electrical resistance through the membrane, the magnitude of the electrical current is relatively small. However, not the *magnitude* of the current is important, but rather the *direction* in which it flows, leading the *EFVM®* technician to the breach.

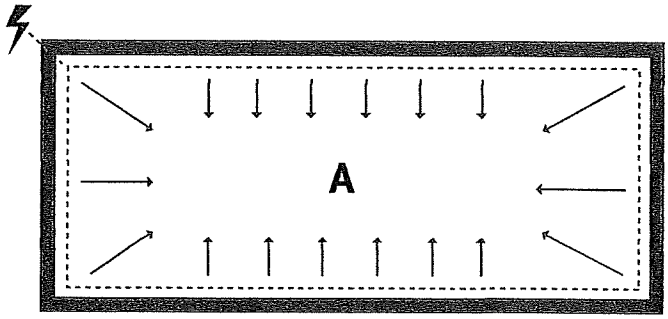
The above method is, of course, a simplified description of what takes place during the test. The *EFVM®* technician needs intensive training and experience to be able to pinpoint all beaches and even capillary defects and to work around difficulties associated with an electrical testing system.

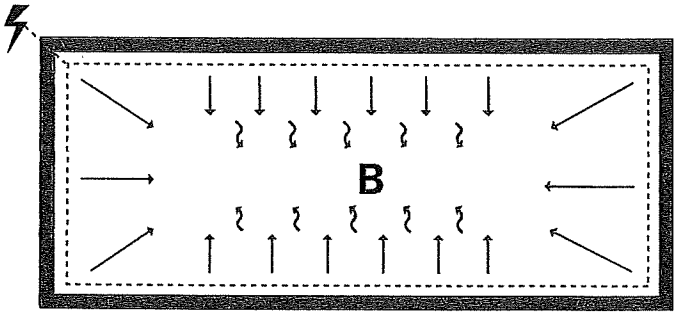


How Does EFVM® Find Leaks?

The EFVM® equipment delivers a pulsating potential difference between the roof surface and the structural deck. A watertight membrane isolates the potential difference from connecting. However, breaches in the membrane will cause an electrical connection to occur. Our trained and certified inspectors read the directional flow of the current with a potentiometer to locate the point of entry with pinpoint accuracy.

The inspectors complete the EFVM® integrity test by conducting a visual inspection of all wall junctions, perimeter details and membrane penetrations.





A. Small electrical pulses are directed onto the membrane. The electricity is searching for a ground connection.

B. If the membrane is watertight, the electricity is isolated and does not find a ground connection.

C. If the membrane is not watertight, the electricity makes a ground connection and is pulled toward positive poles.