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FINAL FIELD FINDINGS AND DESIGN REPORT

DATE OF INSPECTION: June 13, 2013

PROJECT DESCRIPTION: DPW Garage Floor Slab Condition Evaluation and Repairs
126 Ledge Road, Town of Darien, CT
TranSystems Project No. 712130012

SUBJECT OF INSPECTION: DPW Garage Floor Slab Condition Evaluation and Repairs, Darien, CT

FIELD ATTENDANCE:

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Peter McBride	-	Materials Testing, Inc.	(203) 468-5216

FIELD FINDINGS:

Per the Town of Darien (Town) request, a field visit was made 6/13/13 to obtain samples for chloride contamination testing and to gather detailed information about the garage floor slab reinforcement and utilities layout. The DPW's first floor slab was previously inspected on 2/13/13 in order to evaluate whether repair or replacement was warranted. The areas of concern were identified by the Town's personnel, following witnessing significant water leakage at the slab's soffit and concrete deterioration at top of the slab. Field inspection findings are itemized below.

1. **Location:** First Floor Slab Top Surface Deterioration

A condition survey of the top of the garage's slab was performed. The garage can be divided into two sections: the front garage where the trucks are parked and the garage addition which was added in 1977. The inspection was limited to the bays, pointed out by DPW personnel, which exhibited deterioration. The top of the slab was sounded for any hollow areas and at least two of the bays were found to have over 75% of the area hollow, meaning that the reinforcing steel in the slab is likely rusting and de-bonding from the surface concrete. DPW personnel chipped out concrete at one of the hollow sounding locations (18"x18"x4") and it was discovered that the slab's top reinforcement has severe rust with extensive section loss due to its exposure to de-icing agents transported by the plow trucks using the garage.

The top concrete of the slab has extensive mapcracking, full-depth cracks, efflorescence and delaminations. The epoxy resin sealant, applied previously to mitigate reinforcement corrosion, has been fully compromised and no longer serves the intended purpose.

A plow truck, fully loaded with de-icing agent, was driven through the intermediate bay to observe any deflection or widening of slab cracks. No visual evidence of critical slab deflection was noted under the cited live load.

2. **Location:** Steel Pipe Support Column Deterioration

The steel pipe support columns have deteriorated paint (safety yellow – 4 ft. high) and moderate surface rust. Cracking was observed at the concrete column base grout pads, but this does not appear to be related to the slab deterioration. The support columns appeared plumb and there were no signs of buckling.

The garage's roof is supported by the steel pipe columns in all intermediate bays and by reinforced concrete columns on the perimeter. The slab is supported by reinforced concrete columns in all bays and along the perimeter.

3. **Location:** First Floor Slab Blocked Floor Drains

Floor drains (one in each bay) were partially or fully clogged. The malfunctioning floor drains allow salt laden run-off to accumulate on the floor and permeate the slab, likely contributing to the deterioration. There was significant efflorescence, mapcracking and spalling of the slab's concrete noted within the vicinity of these drains.

4. **Location:** First Floor Slab Bottom Surface Deterioration and Leakage.

The bottom of the slab exhibits significant efflorescence, mapcracking and spalling of the concrete within the vicinity of the drains and along the cracks following through from the top of the slab. At a couple of locations, within the intermediate bays, continuous dripping of water was noted. The exact source of the leakage was not identified, however, the clogged drains are suspected of facilitating water seepage into the slab.

5. **Location:** First Floor Slab Support Beam and Column Deterioration.

The stems of the T-beams supporting the slab exhibit heavy efflorescence, water staining and mapcracking, typically in the vicinity of the floor drains and in areas of the worst slab deterioration. The support beams were sounded at scattered locations that had water staining and mapcracking. No hollow sounding concrete was noted.

A spall was noted at the base of one column, exposing rusted rebar.

ESTABLISHING EXISTING CONDITIONS AND DETERIORATION:

1. Slab Cutouts

With the assistance of Darien DPW personnel, two holes were chipped in the slab so that the existing reinforcement bar size and layout could be established: one near the connection of the deteriorated slab to the garage addition slab and one along a support beam between the parking bays (see enclosed field sketches for locations). The following information was found:

A. The existing slab thickness is approximately 8 1/2".

B. In Hole A, running perpendicular to the parked truck direction, there is one row of 1/2" diameter (#4) bars with an average spacing of 8" and placed 1-1/2" from the slab bottom. Parallel to the parked truck direction, there is one row of 1/2" diameter (#4) bars with an average spacing of 11" and at a depth of 3" from the top of the slab.

C. In Hole B, perpendicular to the parked truck direction, there is one row of 1/2" diameter (#4) bars, located approximately 4" from the bottom of the slab.

D. The reinforcement in Hole A was not epoxy coated and did not exhibit any section loss. The reinforcement in Hole B was epoxy coated and did not exhibit any section loss.

2. Chloride Contamination Testing

A technician from Materials Testing, Inc. drilled six holes in the garage floor slab and took powder samples at depths of 2" and 4" to ascertain the chloride contamination level. One sample was taken in the garage addition slab and the other five were taken in the deteriorated slab. The test results and a sketch labeling the sample locations are included with this report. The following conclusions can be made from the results:

A. Samples from the bays where the worst deterioration was found indicate that acid soluble chloride levels are over ACI 201.2 and ACI 222 limits (0.2%, by mass of cement, for reinforced concrete in dry conditions 0.1% for wet conditions) and that there is chloride penetration in the full depth of the slab.

B. The samples taken near the garage truck doorway and in the garage addition show very low acid soluble chloride percentages. The slab in the garage addition is in good condition and is not recommended for replacement.

3. Pachometer

An electro-magnetic reinforcing steel locator (pachometer) was used to investigate the concrete support beams and columns. The pachometer identified the presence of spaced reinforcing steel bars, indicating that the support beams and columns are reinforced concrete, rather than concrete encased structural steel members.

CONCLUSIONS:

The results of the inspection and testing indicate that the floor slab is in serious condition and in need of immediate rehabilitation based on the extent of concrete deterioration, extent of chloride contamination and deteriorated condition of exposed reinforcing steel. Further, based on the minimal exploration conducted; it does not appear that the quantity of reinforcing steel found in the existing slab is structurally adequate to support the truck loads currently using the garage.

Based on the visual inspection and the results of the chloride tests, the following repairs are recommended in order for the garage to meet current AASHTO loading criteria:

1. The slab should be removed and replaced within the front portion of the garage where the trucks are parked. Install new floor drains.
2. An externally bonded FRP composite reinforcement system should be installed to strengthen the 12" x 15" support beams for which no reinforcing steel details are known.

SUGGESTED CONSTRUCTION SEQUENCE:

1. De-energize existing utilities, block existing water conduits, remove drainage pipes, fire protection system and light fixtures, and have all other obstructions in the basement removed or protected.

2. Install FRP reinforcement on the reinforced concrete support beams in the front portion of the garage. This step will eliminate the need for temporary bracing during construction.

3. Remove existing slab at the front portion of the garage where the trucks enter and park.

4. Expose steel base plates for the 6" diameter steel pipe columns.

5. Clean steel columns and base plates. The Engineer or Town's representative shall inspect the connection after cleaning to determine if further repair is necessary. Paint 6" diameter steel pipe columns to the limits depicted on the plans, grout to match elevation of new floor slab.

6. Place new floor slab and floor drains.

7. Apply penetrating sealer to floor slab.

Please contact me at jbmcgovern@transystems.com or 860-417-4564, if you have any questions or comments.

STATE OF CONNECTICUT
BRIAN McGOVERN
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LICENSED
PROFESSIONAL ENGINEER

SUBMITTED BY:_____ **DATE:** 01-28-14
J. Brian McGovern, PE

REVIEWED BY:_____ **DATE:**_____
Darren Oustafine, PE

Additional documents enclosed:
1. Field sketches marking testing locations
2. Chloride contamination test results