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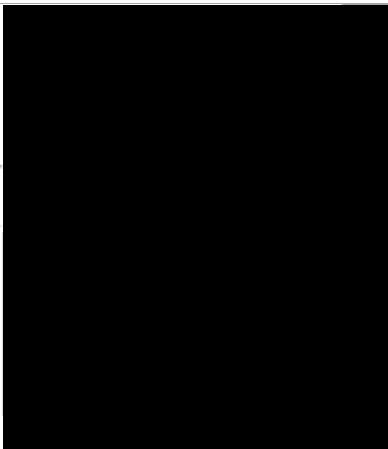
INSPECTION REPORT REGARDING THE
CONDITION OF STRUCTURAL CONCRETE

AT

MARKET MULTI STOREY CAR PARK
NORTHMINSTER, PETERBOROUGH PE1 1AY

REV S2-P02



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1.0 INTRODUCTION AND BRIEF

At the request of the Client, Market multi storey car park, Peterborough was inspected during April 2019 with specific reference to assessing the condition of accessible structural concrete faces as per the Rolton Group Ltd. fee quotation dated 25 February 2019. Our inspections were of a non-intrusive nature.

Our inspections were conducted in parallel with reinforced concrete assessments and sampling being undertaken by, reinforced concrete assessment specialist company, Martech Ltd. The findings of the resulting Martech report document, as already issued to the Client under separate cover, have been considered when producing the following report. In conjunction with their reinforced concrete assessment works, and as instructed directly by the Client, Martech Ltd. removed loose areas of spalling concrete reinforcement cover from overhead faces that were deemed to pose an immediate risk of detachment.

The subject, six deck (seven level), multi storey carpark is understood to have been constructed during the late 1970's. The carpark has been identified as having been constructed via a 'lift slab' technique whereby the decks are supported at column heads. Retail units and café are incorporated within the footprint of the carpark at external ground level with pedestrian access to those premises from the public footpaths that directly surround the carpark's elevations. A CCTV monitoring building has been added post carpark construction at roof level between the two stairwell towers.

Earlier documentation and reports regarding the carpark produced by others, as provided for our information by the Client, were perused. The most recent of these earlier reports being from 2012.

This report to be read in conjunction with Rolton Group Ltd. letters addressed to Peterborough City Council dated 29 March 2019 and 01 July 2019.

2.0 LIMITATIONS:

The desk study undertaken is limited and does not comprise a full appraisal of the design and construction of the building.

Our inspections were non-intrusive and accordingly, we did not inspect any aspects of the structure that were covered, obscured, unexposed or otherwise inaccessible. We are therefore unable to report that any such part of the structure is free of defect. Retail units, café and the CCTV facility were not inspected internally.

We reaffirm that the principal, agreed, objective of our survey report regarding the Market carpark is to inspect and provide comment and opinion with specific reference to the condition of the reinforced concrete as can be assessed by simple, non-intrusive inspection. However, following our commencement of activities as per the agreed brief, we identified the more onerous aspects of potentially impaired structural integrity and made NPS Group aware verbally whilst jointly on site and also within the two letters addressed to the City Council noted within the section above. Therefore, our opinions with regard to structural integrity as contained within this report are provided herein by act of duty as this aspect falls beyond our original brief.

The carpark remained open to the public during the period of the inspections. Parking was however controlled throughout the period of the survey by selectively, temporarily closing off individual levels to enable inspections and assessments to take place safely.

3.0 EXECUTIVE SUMMARY:

From our site inspections, desk study and our experience of concrete structures on sites elsewhere, and subject to the content of this report, we summarise our opinion as follows:

The condition of the structural concrete cover to reinforcement is visually poor throughout the carpark and significant corrosion of slab reinforcement is evident serving to potentially weaken the structure. These aspects are described within the report provided by Martech Ltd.

However, in our opinion, the overriding concern structurally is the current cracking, corrosion and apparent structural deterioration evident within many of the deck slabs local to the supporting column header steel frames and relative to the conclusions of the earlier reports by others. This aspect has the potential to seriously detract from the structural integrity of the carpark. The consequence of structural failure at a single column head, 'punching shear,' can potentially result in the collapse of the associated concrete deck slab in a disproportionate fashion. There are past precedents of such collapses in the UK, an example being the part collapse of Pipers Row multi storey 'lift slab' carpark, Wolverhampton in 1997.

Based upon the evidence available at the present time, we are of the opinion that the Market multi storey carpark, Northminster, Peterborough is likely to have reached, or exceeded its safe, serviceable life span. Accordingly, we are of the opinion that consideration will need to be given to appropriately limiting public access and parking or indeed full closure pending an early decision by the Client regarding the carpark's future.

In our opinion, recourse to further investigations and assessments of the carpark specifically targeting structural integrity aspects, is unlikely to result in identification of an economically viable remedial work solution and particularly as such cost would need to be combined with the cost of resolving the defects regarding corroding reinforcement and spalling concrete cover.

4.0 DESK STUDY:

The documents provided by the Client for our information include:-

- *Stirling Maynard and Partners Report titled 'Northminster Multi Storey Car Park – Structural Appraisal Stage 2 – Interim Report' Draft Report dated September 1997 (SMP Ref: 3678)*
- *Peterborough City Council Report titled 'Structural Summary Report on the Condition of Northminster Multi-Storey Car Park, Northminster, Peterborough with Recommendations for Planned Cost Effective Remedial Concrete Repairs' stamped 21 September 1998*
- *Royal Haskoning Report titled 'Northminster Multi Storey Car Park Concrete Investigations 2004' Draft Report dated 18 August 2004 (Reference: 9P0146/R/MTH/PBor)*
- *Royal Haskoning Report titled 'Northminster Multi Storey Car Park Inspection Report – Updated 2009' Final Report dated December 2009 (Reference: 9T3320/R/303574/PBor)*
- *Royal Haskoning Report titled 'Northminster Multi Storey Car Park Inspection and Investigation' Final Report Version 1 dated 2 July 2012 (Reference: 9X4174/R001/3035754/P'Boro)*

In essence, from the above documents it can be seen that;

The Market multi storey carpark was structurally assessed by others early during the period following the 1997 part collapse of the Wolverhampton Pipers Row 'lift slab' multi storey carpark. At that time, the Market carpark had been deemed to be in satisfactory condition and some remedial works were carried out.

Subsequently, in later years, further surveys and reports were commissioned and associated remedial works are understood to have been undertaken. This sequence of reports and remedial works appears to have effectively ceased c2011. The most recent report documentation provided by the Client dates from 2012.

The latter reports by others gave indications of safe, serviceable life span for the Market carpark. The periods of anticipated future life span were given on the basis that specific works to the carpark, monitoring and maintenance regimes would be followed throughout the life of the carpark.

Significantly, from our inspections of the carpark it is evident that the regimes of repair, monitoring and maintenance as recommended in the earlier reports were not implemented. This would, in itself, render the life span periods indicated within the earlier reports void. However, it should be noted that the limits of those previously given life spans for the Market carpark have in any case been reached, or indeed passed.

5.0 SURVEY FINDINGS:

Please also refer to the separate report as provided by Martech Ltd.

From our visual inspection, it was evident that little, effective structural maintenance had been carried to the carpark in recent years. Instances of loose and spalling concrete cover were noted to be overhead at a number of locations. As stated earlier in this report, the immediate hazards of spalled pieces of concrete cover potentially falling were removed by Martech Ltd. during the course of the surveys.

The following are examples of the structural dilapidations found typically throughout the building. Some, but by no means all, of the individual instances of damage have been noted to have been recorded within the earlier reports inspected:

Visually corroded slab reinforcement. – Where spalling concrete cover had been lost, or removed on safety grounds, significantly corroded reinforcement bars were noted on slab soffits and also upon the top surfaces of the decks.

Further indications of corroded reinforcement. – Instances of multiple parallel longitudinal cracks in slab soffits and also significant areas of 'hollow when tapped' slab soffits and deck top surfaces are also deemed to be indicative of reinforcement corrosion that is yet to manifest itself as spalling concrete.

'Black rust.' – As noted within the report provided by Martech Ltd., they have identified instances of what is termed 'black rust' on slab reinforcement. Albeit said to be rare, this anomaly is extremely difficult to locate as it does not share the expansive characteristics of traditional steel corrosion and accordingly does not cause spalling of concrete cover or the surface staining traditionally associated with rust. Where it occurs however, it has the capacity over time to locally, significantly weaken steel reinforcement. One instance of 'black rust' identified by Martech was located on the surface of the upper roof deck.

Historic repairs to previously spalled areas of soffits and deck top surfaces. – There are numerous instances of previous 'patch' repairs to assumed historic spalling damage throughout the carpark. We cannot advise with regard to the adequacy of those repairs albeit, many of them are now showing signs of further cracking and loss of adhesion. Some areas of historic 'patch' repairs within deck top surfaces are relatively significant in size and bear evidence of having been potentially repaired on more than one occasion.

General cracking of decks. – There are various instances of crack repairs and current cracks within the carpark deck soffits and deck top surfaces throughout the carpark. Some of these are longitudinal, others are diagonal with regard to the building footprint. There appear to be instances where the former crack repairs have nominally, re-cracked.

Cracked deck slabs local to columns. – The decks have multiple ‘radial’ cracks centred at column positions. This is the case at a significant number of columns at all levels and throughout the building. At a number of columns the radial cracks have joined close to the columns via the course of a single crack part ‘curving’ around the column. This latter described crack profile is of particular significance with regard to the potential for ‘punching shear’ failure and must be closely monitored.

At a number of column locations it appears that repairs have been carried out in the past to cracks seemingly similar to those described above, both ‘radial’ and ‘curved.’ We cannot confirm at this time the adequacy or nature of the past repairs albeit, at a number of locations re-cracking of the repaired area has occurred.

Cracked and part detached deck soffit down-stands at column heads. – Rectangular concrete down-stands are installed around column heads to provide corrosion and fire protection. However, at widespread locations throughout the carpark these down-stands have become cracked, poorly adhered, have fallen or have been removed in full or part. At a short row of columns, the detached concrete down-stands have apparently been replaced with ply-wood boxing of similar size and profile albeit, that does not appear to be an adequate substitution in terms of protection.

Exposed and corroded deck support frames at column heads. – Where the ‘protective’ concrete down-stands have been lost in full or part the deck slab steel support frames are exposed to fire and corrosion risks. There are a number of locations where pronounced corrosion in the exposed column head deck support frames has occurred. At one location probed at close quarters, a piece of corroded support frame metal, approximately equal to 30% of the original steel section thickness (when adjusted to take into account corrosion expansion), came away easily in the hand. It would appear also that the rectangular concrete down-stands are not necessarily always effective in preventing corrosion within the steel support frames. It is evident at a number of locations that it is corrosion related expansion within the deck support frames that is ‘pushing’ the concrete down-stands away from the deck soffit. This was indeed the case where we witnessed Martech Ltd. removing a cracked and unstable concrete ‘protective’ cover behind which was found the corroded support frame probed at close quarters as described in the immediately preceding paragraph.

It appears that the corrosion protected remedial coating added in the past to the exposed deck support frames has only been partially effective.

Cracking within vehicular ramp edge. – There is an instance of an isolated longitudinal crack along the vertical edge of a vehicular ramp, the structural significance of which has not been established at this time.

Cracking and defects within external render – Areas of external rendering accessible between the upper and lower roof decks were noted to be cracked, poorly adhered to the substrate and in instances accessible, small areas of potentially hazardous loose render were removed by Martech Ltd. The areas of render to the carpark’s external elevations were inspected from ground level and noted to contain significant areas of multiple cracking/crazing. Where locally inspected during Martech Ltd.’s ‘abseiling’ investigations a number of areas of external rendering were noted to sound ‘hollow’ when tapped indicative of a lack of adequate adhesion.

Parapet brickwork ties. – Reference to earlier reports by others indicates there to have been an apparent lack of appropriate wall ties to secure the parapet brickwork to the concrete structure installed during construction. It is understood that ties were retrospectively installed to the parapet brickwork within the external elevations of the carpark. However, from our inspections we noted apparent separation between the parapet brickwork and concrete structure within the short lengths of parapet between the upper and lower roof decks. A precautionary investigation as to the adequacy of ties with regard to these particular walls would be appropriate.

Severely corroded/leaking rainwater pipes and gullies. – There are various, pronounced instances of defects, leakage and severe corrosion within rainwater pipes and gullies throughout the carpark. This leakage is acting to compound the deterioration in the structure. There is additionally an instance of a broken ramp related gulley that poses a significant trip hazard. This latter aspect has been notified verbally to NPS during the course of a joint site inspection.

Textured ceiling and wall coating within stairwells – By act of duty, we advise that during the course of our inspections we noted locally damaged areas of textured ceiling coatings at former services apertures within stairwells. Textured decorative coatings within buildings of this age have been found elsewhere to contain asbestos. Damage to such material, which may contain asbestos, can potentially release fibres which can be a serious risk to health if breathed in. The damaged area/s should be appropriately sealed pending confirmation as to any asbestos content.

Please refer to the schedule of described photographs contained within 'Appendix A' of this report for examples of the defects listed above.

6.0 DISCUSSION AND CONCLUSION:

From the above, and foregoing discussion we advise our considered opinion as follows:

We are in broad agreement with the separate report provided by Martech Ltd. which deals effectively with matters related to the condition of the reinforced concrete. The remedial works that would be necessary to effectively deal with the issues related to corrosion within the reinforced concrete at Market carpark would be considerable and widespread. They would additionally need to include a degree of further investigation to assess the full extent of reinforcement corrosion and potential for spalling cover via a hammer-test survey etc. The carpark would need to be closed for a lengthy period to enable such works to be safely carried out.

However, the above works would not resolve what we believe to be the overriding issue of potentially impaired structural integrity related to the carpark's current deteriorated structural condition and 'lift slab' construction.

The anticipated life spans of the carpark indicated within earlier reports by others have now expired albeit, those life spans were in themselves conditional to regimes of ongoing repair, monitoring and maintenance that appear not to have been undertaken in recent years.

Rolton Group letter dated 01 July discusses a number of further investigations that would need to be included within a scheme to investigate the extent of impaired structural integrity. It is our considered opinion that such a scheme of investigations would need to be carefully planned in terms of site safety and would in any case necessitate closure of the carpark to the public whilst it was undertaken. There is a potential that the investigations would identify additional areas of concern and the resulting scheme of remedial works necessary to deal effectively with the structural integrity issues would be extensive, and particularly so when combined with the concrete condition remedial works scheme discussed earlier in this section.

Due to a progressive and ongoing deterioration of the building over time, compounded by lack of appropriately targeted maintenance in recent years, the structure is less safe/less stable than when previously reported upon by others in 2012.

The 'lift slab' construction and age of the building should both be significant factors in considering appropriate future action with regard to Market carpark. The part collapse of the 'lift slab' carpark at Pipers Row Wolverhampton in 1997 has demonstrated how such a structure can fail suddenly and possibly without visually obvious prior indication.

7.0 RECOMMENDATIONS:

To be read in conjunction with the preceding sections:

The outline advice provided within this section with regard to public safety and timings is given at the request of NPS, on behalf of PCC. Such advice is given here in the interests of providing indicative guidance at this time and is subject to later confirmation following further inspections and investigations in due course.

There would appear to be two potential courses of action with regard to resolving the structural issues affecting Market carpark albeit, budgetary considerations will obviously be of influence. Based upon our current knowledge of the carpark's condition, we would estimate 'structurally related' costs in the range of £2 to £4 Million to execute option one;

OPTION ONE

To commission a comprehensive, intrusive investigation of the carpark structure in order to more fully quantify its condition and the extent to which structural integrity has been impaired. This to be undertaken with a view to enabling consideration to be given to a scheme of appropriate remedial works to extend the serviceable life of the carpark. Carry out the necessary structural remedial works to resolve concrete condition and structural integrity issues, see indicative budget above.

To enable this option to proceed it would be necessary to close the carpark to vehicular and public access in early course and until the investigations and resulting remedial works scheme has been fully completed. A minimum period of carpark closure in the order of twelve-eighteen months should be anticipated.

Access to the ground floor Retail units, Café and associated ground floor ancillary areas for inspection, precautionary propping, investigation and remedial works would also be necessary and this would, for periods, limit access and/or result in significant disruption to normal usage.

To be read in conjunction with report recommendation titled 'Public Safety.'

OPTION TWO

The Market carpark be deemed to have now reached, possibly exceeded, its safe, economically serviceable life and be closed forthwith and demolished.

In the event that this option is selected, the following timings are likely to be appropriate in terms of structural and other considerations:-

- Early closure of the carpark to vehicular traffic/public access. – Within four weeks.
- Closure of ground floor Retail units, Café etc. – Within three months.
- Demolition of the carpark. – Completed within a further three months*.

*Should the above outlined timescales need to be extended, additional precautionary actions will need to be implemented as appropriate.

To be read in conjunction with report recommendation titled 'Public safety.'

PUBLIC SAFETY

In both options one and two above The City Council will need to take early appropriate action to safeguard the public both within, and alongside the external elevations of the carpark structure pending resolution of safety issues.

In outline, and based upon our knowledge of the carpark at the current time, we would anticipate the following actions to be appropriate:-

- Carpark closure - Close the carpark to vehicular and public access at the earliest opportunity and in any case within four weeks. This action will significantly reduce live loadings, shock and vibrations upon the structure.
- Further structural inspection – A further structural inspection of the carpark be undertaken early following closure. This to include internal inspection of the previously not inspected, Retail units, Café and associated ancillary areas. The purpose of this inspection is to include assessments as to an appropriate precautionary propping scheme.
- Monitoring inspections – Frequent precautionary monitoring inspections, one month maximum between visits, be undertaken by Rolton Group Engineer or equivalent person until structural issues are fully resolved. Continuity of 'same' personnel with regard to each monitoring visit is important in the interest of maximising opportunities for the identification of visual structural change. It may be necessary to enhance the precautionary monitoring process via inclusion of monitoring devices and/or remote monitoring at targeted areas.
- Precautionary propping scheme – Within three months, install a suitably designed scheme of propping within the carpark interior. Such a scheme would also include installation of propping within the interiors of the Retail units, Café and associated ancillary areas. Props would predominantly be located in groups around column positions. The extent to which usage of the Retail units, Café etc. would be affected by the propping cannot be assessed at the present time.
- Safety considerations regarding immediately external areas - Where practicable, the internal propping scheme would be designed to eliminate risks to the users of the public footpaths surrounding the carpark. Where this is not possible however, it may be necessary to construct suitably designed 'crash-decks' over the external areas or alternatively temporarily close and divert such routes. Where practicable, the carpark exterior be 'cloaked' with suitable netting/mesh.

In the interests of clarity we reaffirm that, subject to the implementation of/and findings of the foregoing, the demolition of the disused carpark could potentially be deferred by up to twelve months. Usage of the Retail, Café and ancillary areas could continue for three months or longer from the present time subject to being able to safely operate around obstructions posed by precautionary propping.

Should you require clarification of any aspect, please do not hesitate to contact this office.

APPENDIX A – SCHEDULE OF DESCRIBED PHOTOGRAPHS



Photograph 1 – External general arrangement view of carpark vehicular entrance.



Photograph 2 – External general arrangement view of carpark showing Retail units and Café within the building footprint.



Photograph 3 – CCTV monitoring building added at roof level post carpark construction.



Photograph 4 – Typical instance of corroded reinforcement in deck soffit.



Photograph 5 - Typical instance of corroded reinforcement in deck soffit.



Photograph 6 – Typical instance of cracked deck soffit.



Photograph 7 – Typical instance of cracked deck soffit.



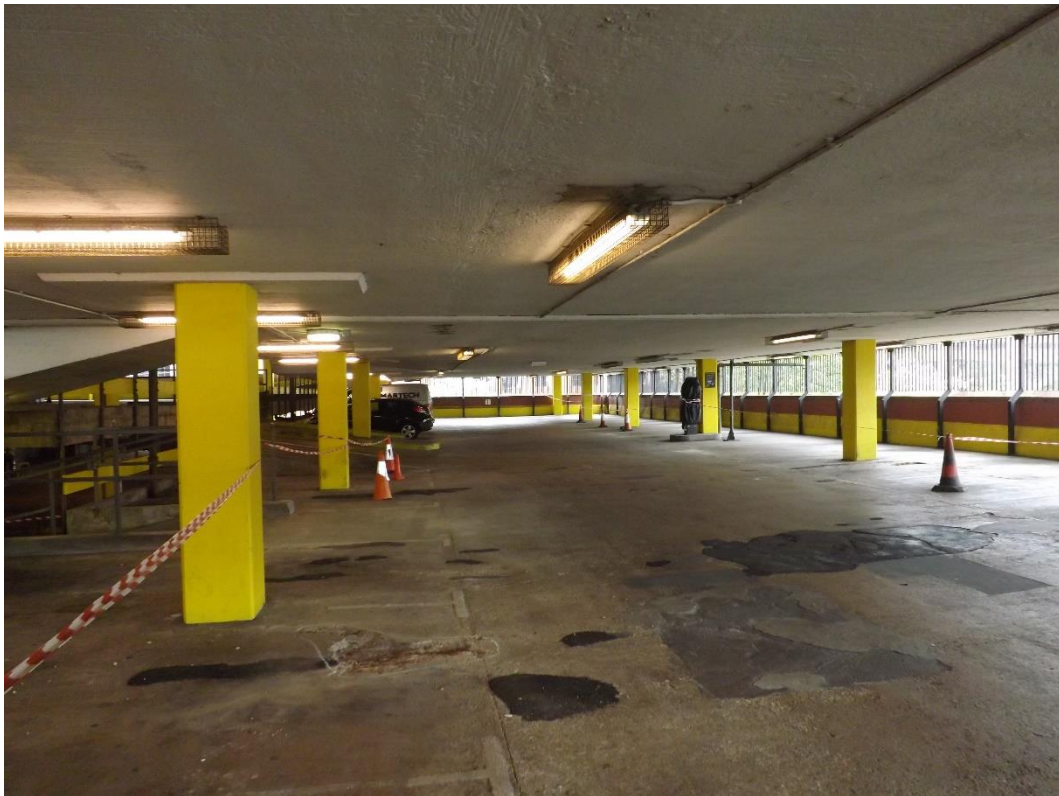
Photograph 8 - Typical instance of cracked deck soffit.



Photograph 9 – Typical cracking within deck.



Photograph 10 – Typical cracking within deck.



Photograph 11 - Typical historic 'patch' repairs in deck.



Photograph 12 - Typical historic 'patch' repairs in deck.



Photograph 13 – Typical historic 'patch' repairs in deck.



Photograph 14 - Longitudinal crack along ramp edge.



Photograph 15 – Typical deck cracking at column locations.



Photograph 16 – Typical deck cracking at column locations.



Photograph 17 – Cracked/part detached soffit down-stand at column head prior to removal.



Photograph 18 – Cracked/part detached soffit down-stand at column head prior to removal.



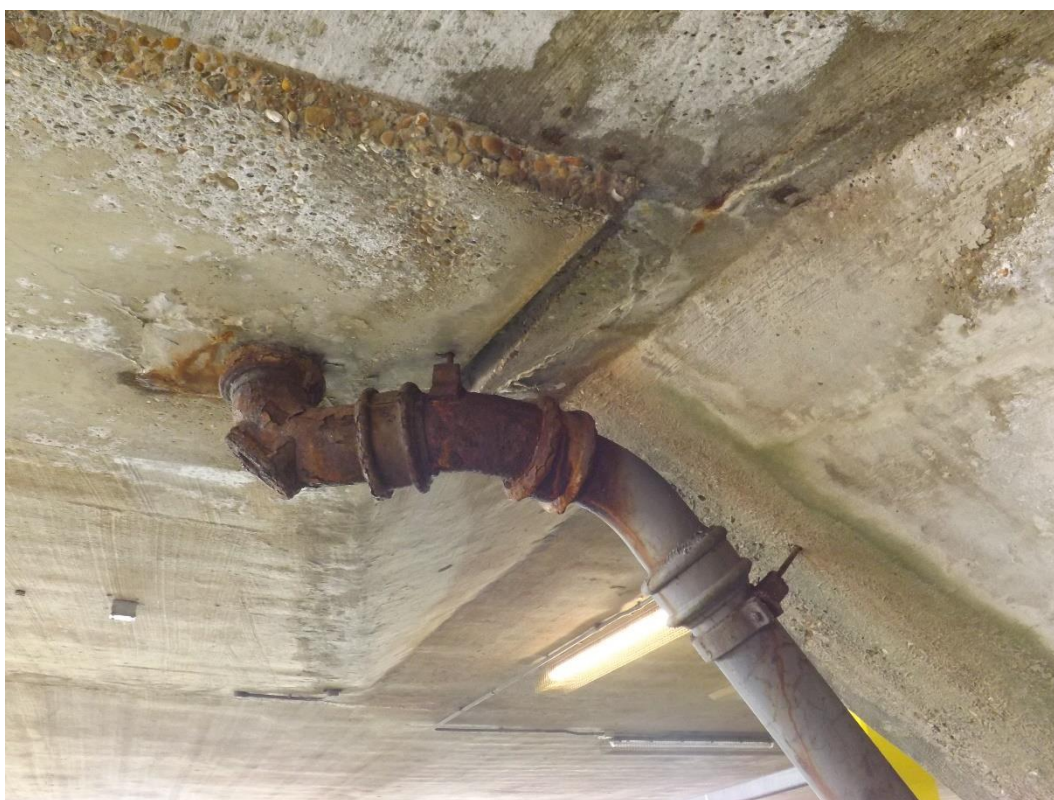
Photograph 19 – Exposed and corroded column head deck support frame.



Photograph 20 – Exposed and corroded column head deck support frame.



Photograph 21 – Example of defective corroded drainage items.



Photograph 22 –Example of defective corroded drainage items.

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