2.7 Superstructure

2.7.1 It was noted during the various site inspections of the garage and walkways and access roads that a number of superstructure elements, particularly columns, were suffering from typical long term reinforcement corrosion and concrete spalling. It, however, remained unclear why some concrete elements in the immediate vicinity of 'repaired' areas and elsewhere around the estate were not treated.

2.7.2 Although not confirmed, if concrete repairs had been carried out around the estate, an anti-carbonation coating and/or a high alkalinity render may have been applied. The result of such repair and maintenance systems affects the degree of subsequent carbonation process.

2.7.3 A sample of flaking paint from the end elevation of Retcar Close was not elastomeric paint, suggesting that anti-carbonation paint had not been used in this location.

2.7.4 Other elements, such as exposed edge beams of the residential blocks on Stoneleigh Terrace appeared to have been subject to repair and coating. This had been informally confirmed by one of the maintenance staff on site. Details of the repair work were not available but the coating may have been an anti-carbonation coating. This would suggest that the work has been properly considered as part of a planned maintenance programme.

2.7.5 There is no evidence of excessive settlement, differential ground movement or excessive material defects to the exposed masonry materials throughout the estate and no cracks in the external blockwork were noted around the estate during the survey.

2.7.6 Blockwork to the wall perpendicular to a threshold in Stoneleigh Terrace was noted to be cracked. The crack was limited to one storey only and did not extend into the concrete edge beam above or below. The cracking was most likely

attributable to a security grill being fixed to the blockwork and the fixings or the detail of the fixing not being correctly specified.

2.7.7 At many external façade locations around the estate, leachate staining was visible along with some potential areas of damp on wet days.

2.7.8 Following Martech Technical Services Ltd boroscope investigations, more information has been gained regarding the presence and condition of the cavity trays, ties and cavities.

2.7.9 The inner leaf to half of the cavity walls was grey breeze block; the remaining being of brickwork. The brickwork inner leafs were typical to the gable end elevations and often coated in black.

2.7.10 Galvanised butterfly twist ties had been used to tie leaves together. The cavity was generally 50mm (ranging from 40mm to 85mm). Some of the cavity ties had been bent down and therefore were redundant. The number of ties recorded at some of the test areas was below the number required in BS 5628. However, no bowing of the walls or other defect associated with inadequate ties were recorded during the investigations.

2.7.11 Upon completing a comprehensive survey assessing the number of wall ties, it is recommended that remedial wall ties should be inserted in accordance with a specification and the manufacturer's recommendations and instructions into panels that do not have enough or wrongly bedded ties.

2.7.12 Debris was found in some of the cavities and also on some of the cavity ties. Debris within cavity walls can act as a bridging agent, enabling moisture to 'cross' to the inner leaf, potentially resulting in damp. Cavities should be cleared where there is a clear link with damp on the inner face of the wall.

2.7.13 There was no recorded damage to existing cavity trays, nor damp to the inner leaf reported.

2.7.14 In some areas, the inner leaf, including some ties, had been painted with a black bituminous coating, presumably to improve the moisture resistance. This may also prevent moisture due to condensation escaping to the exterior, but this remains unconfirmed.

2.7.15 Weepholes are provided generally but some have been blocked by render on some end elevations and others may be less than fully efficient due to debris in the cavity. Whilst this does not appear to be causing dampness internally at present, it is considered a potential cause. It would be prudent to clear all blocked weepholes.

2.7.16 Movement joints were not seen in external walls during the survey. Ideally, movement joints should be provided at 6m centres in blockwork and whilst there are lengths beyond this without joints there is no evidence of problems, such as cracking.

2.8 Concrete survey

2.8.1 Martech Technical Services were commissioned to carry out a condition survey to assess the nature and extent of concrete deterioration to define the reinforcement corrosion condition and to offer appropriate remediation and corrosion control proposals.

2.8.2 The survey information was gathered using the following techniques

- visual observations
- covermeter survey
- carbonation testing
- concrete dust sampling
- concrete core sampling
- exploratory breaking out
- boroscope survey.

2.8.3 Full details of the tests carried out together with test results are included as a separate appendix.

2.8.4 The investigation and test results for the structures indicated that the limited visible concrete deterioration seen was mainly due to a combination of areas of localised low cover to the reinforcement and carbonation. There were areas of cast-in and/or ingressed chlorides (latent damage) sufficient to exacerbate and in some cases instigate corrosion. There was rundown and leachate build-up due to moisture penetration noted in numerous areas, both to the concrete and blockwork elements. The coatings to the concrete elements were deteriorated in a significant number of areas.

2.8.5 Areas with low cover can be subject to a higher risk of corrosion of embedded reinforcement due to carbonation than other areas. However, in the presence of an existing anti-carbonation coating and/or high alkalinity render, the significance of these findings may be misleading.

2.8.6 The mean depth of carbonation level indicated does not exceed the mean depth of cover to reinforcement. However, on some of the elements tested, the maximum depth of carbonation is approximately equal to or greater than the minimum depth of cover. This indicates that there may be areas of reinforcement corrosion due to a reduction in the passive protection (provided by the cement matrix) caused by the carbonation process and hence an increased risk of corrosion of embedded reinforcement due to carbonation.

2.8.7 The level of free chlorides was assessed at each test site and the results recorded in Martech's report. They show that there are varying degrees of perceived risk to corrosion of the embedded steel (based upon an assumed 14% cement content by mass of cement).

2.8.8 The actual cement content of a sample was determined by a petrographic analysis. This revealed that the actual cement content by mass of cement was 13.3% (rather than the assumed 14%). This will result in a marginal increase in risk of corrosion of the embedded steel from chloride attack.

2.8.9 However, although the risk may be elevated in some areas and not in others, any treatment as part of a maintenance programme should be applied to entire risk elements. If not, corrosion due to chloride attack will transgress to an adjacent area.

2.8.10 Tests to determine the level of carbonation and presence of free chlorides within the concrete were carried out. Carbonation of concrete lowers the pH value of the cement matrix and thus the level of passive protection afforded to the embedded reinforcement. Free chlorides can aggressively attack reinforcement. Both corrosion processes can only occur when moisture is present. The reinforcement expands upon corrosion resulting in spalling of the concrete. Localised 'pitting' of the reinforcement generally identifies corrosion due to chloride attack. The carbonation process can release additional free chlorides (previously bound within the cement matrix), thus exacerbating the risk of corrosion of embedded reinforcement.

2.8.11 It can be seen from the cover and carbonation results that there was a relatively limited degree of overlap on the 15 no blocks, for example, to the link –bridge column / soffits to Stoneleigh Terrace.

2.8.12 The most probably cast-in chloride results for the 15 no blocks ranged from negligible (< 0.01%) to extremely high (1.51%) risk overall. The higher results were typically from the division walls, planters and ring beams.

2.8.13 The vast majority (82%) of the exploratory breakouts to the blocks elements revealed clean and passive reinforcement in alkaline concrete. At locations where varying degrees of surface corrosion were noted the carbonation front had reached or gone past the steel depth.

2.8.14 The cover and carbonation test results for the car park column and beam elements tested overlapped. The chloride results ranged from negligible (0.11%) to extremely high (1.86%) risk overall.

2.8.15 The majority (67%) of the exploratory breakouts to the car park elements revealed clean and passive reinforcement in alkaline concrete. At the location where heavy surface corrosion was noted the carbonation front had reached the steel and there was cracking and leachate on the concrete surface.

2.8.16 The cover and carbonation test results for the service yard elements overlapped. The chloride results ranged from negligible (0.10%) to extremely high (2.37%) risk overall.

2.8.17 50% of the exploratory breakouts to the service yard elements revealed reinforcement with surface corrosion. Two of these were at spalls and at the other the carbonation front had reached the steel.

2.8.18 The concrete on the structures was found to be suffering from low cover in areas with the advancing carbonation having reached the reinforcement in places and hence a reinforcement corrosion problem. There were areas of latent damage in the form of chloride contamination. There was noted to be significant areas of

leachate build-up and rundown due to moisture penetration to the concrete and blockwork elements. The chloride levels found presented a negligible to extremely high risk of chloride attack on the reinforcement. Cracking and spalling of the concrete surfaces was evident. The coatings to concrete elements were also deteriorated at some locations.