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40716-R06/SGG

08th June 2017

ISG
Aldgate House
33 Aldgate High Street
London EC3N 1AG

For the Attention of Mr. Ashley Furlong

Dear Ashley,

Re: Report on the cracking of the RC beams around the core at Academic House

We refer to our previous conversation with regard to the cracking found in the reinforced concrete beams at Academic House and in particular your request for us to investigate the cracking and to provide a letter report giving structural advice and recommendations.

1.0 Introduction

During site works cracking in the existing reinforced concrete beams was found by ISG, who is the main contractor on this site. ISG then requested Lucking and Clark LLP to visit site, investigate and report on the cracking and provide structural advice and recommendations for the remedial works.

2.0 Background

The site was visited by Lucking and Clark's Structural Engineer on several occasions to inspect the cracking that had been found. Jamie Dickerson and Ashley Furlong, both representatives of ISG, were present at the time of our visits.

No opening up works were carried out as part of the investigations. The inspection was purely of visible nature.

The site was revisited by Lucking & Clark's and Arcadis' Structural Engineer to look at a local strengthening option in lue of the proposed truss option.

3.0 Observations

The original part of the building was built in the 1930's and comprises a reinforced concrete frame with a reinforced concrete stability core. The floor plates are hollow pot floor slabs with reinforced concrete ribs supported on reinforced concrete downstand beams. The building was later extended. However, the newer part of the building does not form part of the investigations and will therefore not be mentioned any further within this report.

The corridor around the core has plenum ducts formed by a lowered reinforced concrete plenum slab. This slab is monolithically connected to the internal down stand beam. At the other end, the slab bears onto a raking ledge formed in the reinforced concrete core walls. This joint is a simple bearing joint without rebar tying both elements together. This was depicted in the Architect's Journal (refer to Plate 1).

During the formation of riser openings, cracks formed parallel to the core walls (refer to Plate 2). These longitudinal cracks are offset from the core wall by approximately 100mm.

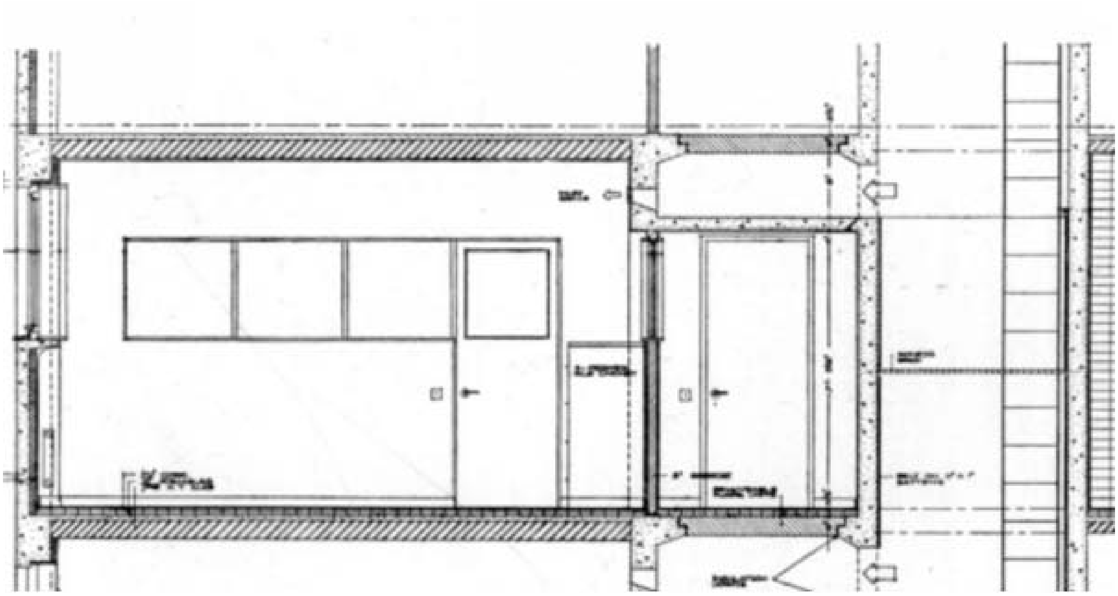

Plate 1 – Section through the plenum ducts (extracted from AJ)

Plate 2 – View onto underside plenum slab showing parallel crack

As part of the investigation the adjacent building elements were inspected and in particular the reinforced concrete down stand beams supporting the plenum slab. Several large service openings were formed within these downstand beams (refer to Plate 3 and 4)

Plate 3 – View onto service holes in down stand beam (1)

Plate 4 – View onto service holes in down stand beam (2)

The plenum ducts had original service holes, which were formed during the construction of the building in the 1930's. These holes were small square holes of approximately 200mm depth and width. Looking at the edges around the opening, the large holes had clearly been cut at a later date. To form these large holes, angle grinders or saws were used, which resulted in overcutting of the opening. A typical over cutting is depicted in the Plate 5. Most of these large openings show these signs, exacerbating the formation of the holes.

Plate 5 – Typical overcutting of large service hole

Upon closer inspection of these large service holes, vertical and semi-diagonal cracks were seen around these opening. Examples of these cracks are depicted in Plate 6 and 7. These types of cracks were seen on several of these large service holes on all accessible levels from Level 3 to Level 6.

The large 7.5m long downstand beam at the underside of Level 4 showed cracking to the underside of the beam approximately at mid span exposing the reinforcement. This beam also showed signs of deflection. None of the other beams showed signs of deflection.

Plate 6 – View onto large service hole depicting vertical cracks in the remaining concrete (1)

Plate 7 – View onto large service hole depicting vertical cracks in the remaining concrete (2)

4.0 Discussions

The longitudinal crack along the junction between plenum slab and the core wall was induced by the vibrations caused by the riser demolition works. The plenum slab is a simple bearing joint without reinforcement tying the elements together. Therefore the vibrations caused movement between the slab and the wall ledge, thus cracking the plaster finish that was covering the joint. This crack is therefore superficial and not structural. After the works have finished these cracks can easily be filled and covered.

The large service openings within the downstand beams reduce the shear capacity and therefore may affect the structural integrity of the beams, the effect of which is evident by the cracking around the opening. We understand that the formation of the large service holes had been carried out over 20 years ago. Considering the time scale and the fact that in most cases these cracks are small, with a crack width not exceeding 2 mm, these cracks do not appear critical for the structural integrity of the building structure. This is particular valid for the smaller downstand beams, which are approximately 3 m long.
These beams can be classed as structurally safe; however, there is a risk of further cracking in the serviceability state, which may affect the applied finishes. Further cracking may need to be made good during planned maintenance periods. Reduced loading onto the beams could reduce the risk of further cracking. The removal of the plenum slab would be a way to reduce the load onto the beams. The risk of further cracking could also be reduced by strengthening works. However, we suggest an assessment on the acceptable risk level for these smaller beams should be considered.

The 7.5 m long beams are more of a concern, especially the beam at 4th Floor Level. The cracking is advanced. This may have been triggered by the vibrations caused by the formation of the riser opening. However, a beam with full structural integrity would not have reacted to vibrations in this way. This is a clear sign that the structural integrity of this beam is reduced. Upon our request the beam was propped temporarily. Strengthening works should be considered to restore the structural integrity of the beam at 4th Floor Level. The same strengthening works are proposed at the other floors, but not the roof due to the reduced live load acting upon the roof.

5.0 Conclusions and Recommendations

As discussed in 4.0, the cracking in the plenum slab junction to the core wall is superficial and not structural. These cracks can easily be made good.

The small downstand beams do not show obvious signs of deflection and the cracks are small. These beams can be classed as structurally safe. However, the cracks might reoccur and would have to be made good periodically during planned maintenance. If the risk of reoccurring cracks is to be reduced, then the removal of the plenum slab and beam strengthening may be required.

The larger beam at 4th FL shows signs of advanced cracking and will therefore require strengthening works. The beams at 5th and 6th FL are be strengthened at the same time. Having discussed and considered the different options with Arcadis' Structural Engineer, it was agreed that local steelwork strengthening in form of angles spanning across the large service openings is the most favourable solution. The strengthening works details are enclosed in Appendix A for consideration.

We trust the above is clear, but should there be any queries or other matters we are able to assist you with, please do not hesitate to contact us.

Yours sincerely,
LUCKING & CLARK LLP

S. G. Griesemann
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Encl. Appendix A

Appendix A

Project					
Academic House					
Title					
Remedial works for the existing RC beams at upper floors					
Project No	**Sheet No**	**By**	**Date**	**Chk**	**Date**
40716	SK10	FA	June '17		

NOTES
1. Do NOT scale from this drawing.
2. All steelwork to be grade S275.
3. All bolts to be grade 8.8.
4. The contractor shall be responsible for ensuring that operations do not in any way impair the safety or condition of the existing structure. He shall provide any additional temporary supports required for this purpose and shall carefully inspect the condition of the structure both before and during the execution of the works.
5. Drawing to be printed in **COLOUR**.

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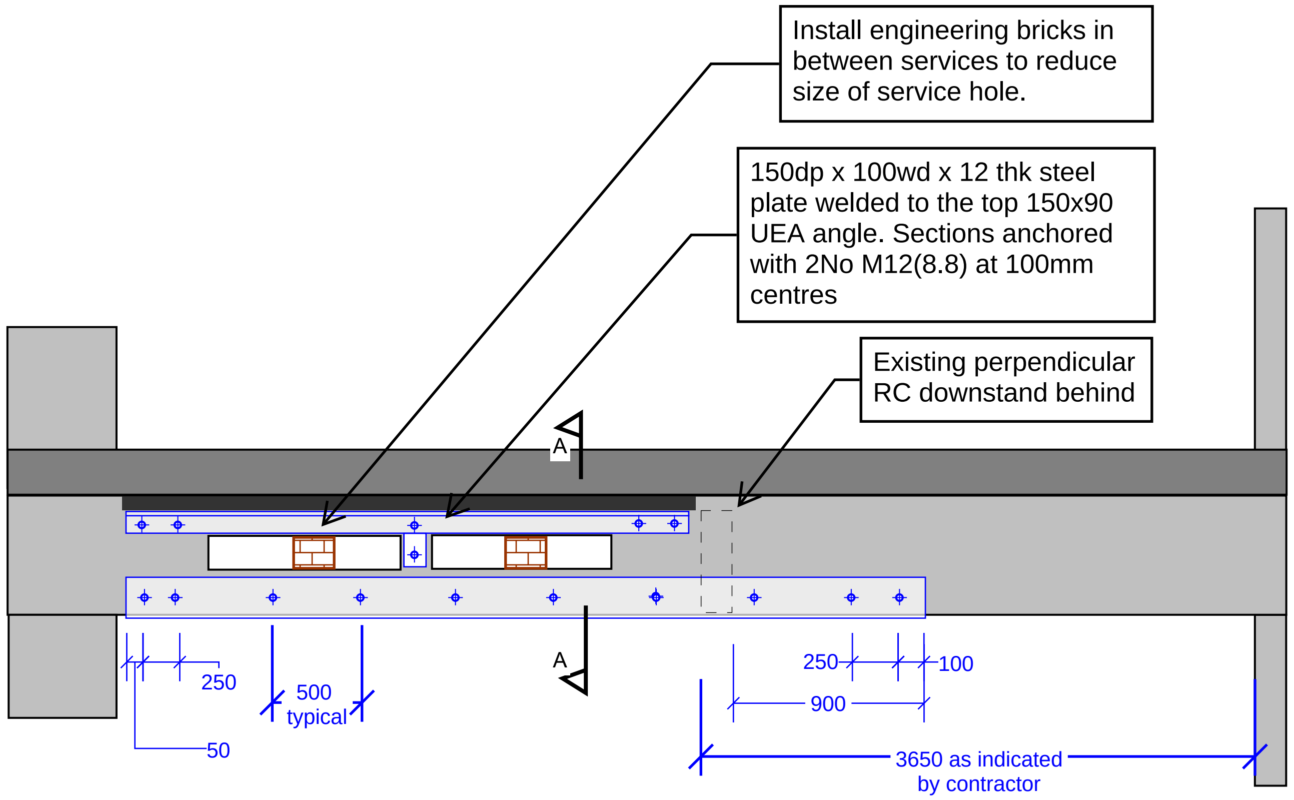
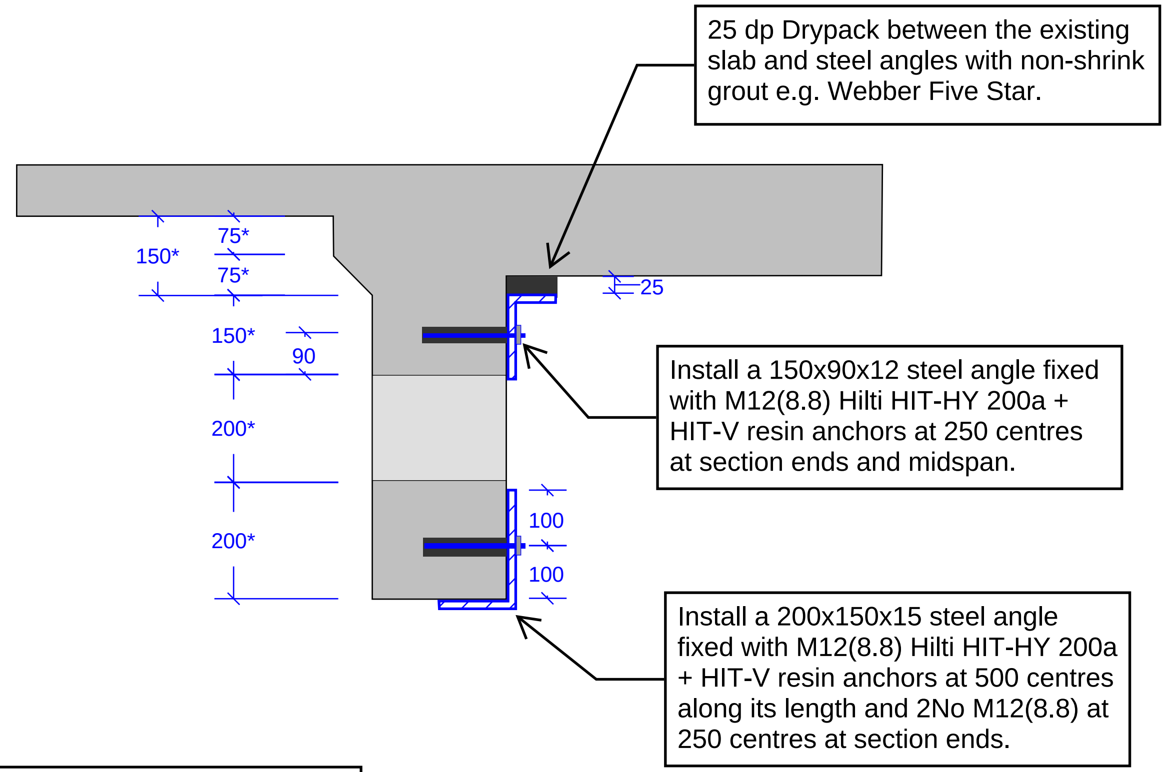
Revision 3 - 06th June 2017

Note
Existing reinforcement to be scanned and clearly marked before any drilling on the existing concrete floors, columns or walls. Do NOT drill through existing reinforcement.



Existing downstand beam elevation showing remedial works
(typical)



*Dimensions as inspected on site.

Detail A

Note: All resin anchors to have 90mm embedment.