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Project No. 5013240
Rev 3
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Dear John

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Brief, Background and Method

The brief from Bristol City Council was to enhance the investigative works based on the initial outline reporting carried out to determine the building’s ability to resist disproportionate collapse.

The initial reporting had limitations due to the availability of vacant units and the real time available to investigate within the complex live building environment. With the limitations and results of the initial reporting in mind the team has embarked upon a significant regime of further investigations which have set out to qualify the initial reporting.

This has involved investigating six further flats on top of the previous three flats and has therefore provided the team with a greater opportunity to appraise the building in further depth than was available them previously. This has provided the team with significantly more information than was available beforehand.

Importantly, more locations have been available at critical structural junctions; this has produced a much larger data set for us to appraise the building; crucially these are in areas where we know there might be a weakness.

With the increased information set we have been better able to compare between the historical drawings and the information found on site, and consequently understand key differences between the design intent and the as built structure.

The differences areas are compared against codes of practice, detailing and written papers that allow an experienced engineers in this field to develop opinions for which calculation is then used to further understand the behaviour of the structure and implement consequent remedial measures should these be needed.

Investigations

A desk top appraisal has taken place based on the existing drawings that has been used to assist the onsite investigation and the calculation phase of the project.

Based on the existing structural arrangement the following flats were selected for opening up with access granted by the resident(s):

- Access was granted to 22, 46, 58, 76, 78, 87, 91.
- Access was denied to flats 60 and 65.

Access was requested to two previous flats investigated, 60 and 65 however the resident(s) of those flats declined access for the investigations.

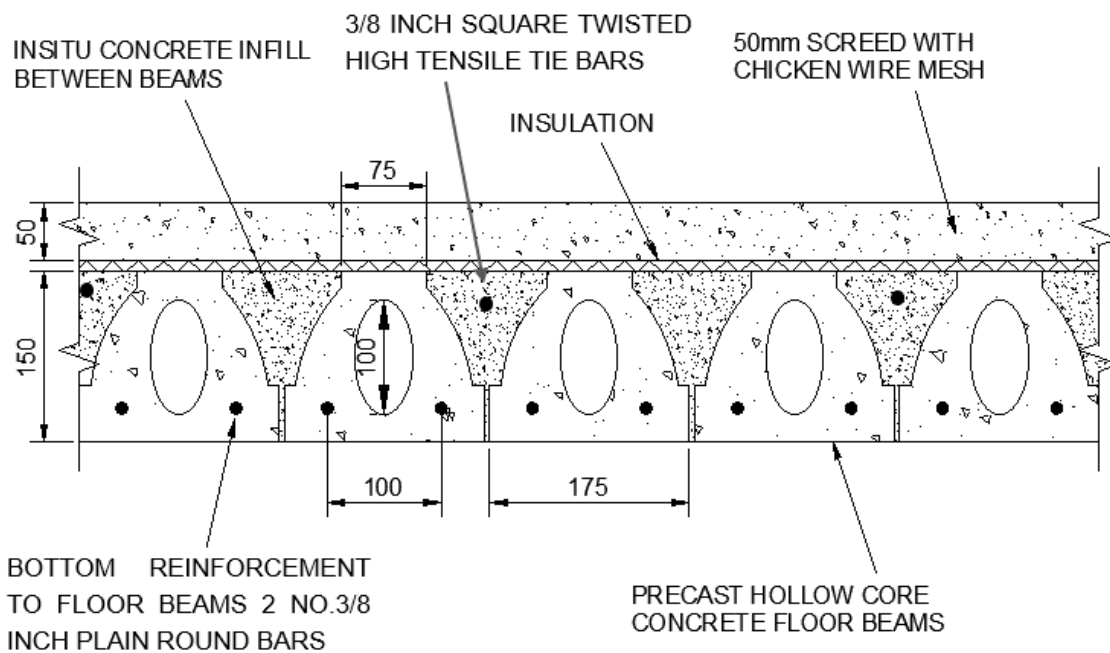
Soft strip works, asbestos removal and non-structural screed have been removed in local areas in the flats where access was granted. Ferro scanning has been undertaken to determine locations of reinforcement and to determine cover to each bar, discreet structural pockets were then made in the walls and slab junctions made to identify the as built reinforcement arrangements within the floor, walls and their joints.

Findings

Generally, a good comparison could be made between the original drawings (and consequentially the original design intent) and the built structure, this is positive and provides the engineering team with a degree of confidence the building was generally built as intended.

Slabs

In general, the Gothic beam arrangement as shown below was found to be consistent with the original drawings and as expected, cover varied but was generally found to be at just over 1/2 inch on average which is consistent with the original design intent.



Sketch is approximate only based on site measured dimensions.

Walls

The reinforcement arrangement within the walls was found to be generally in accordance with the original details, cover to walls was found to vary although where low cover was found either a further line of blockwork had been added or cementitious slurry was placed on the wall to increase the cover to reinforcement. This was particularly the case at party and flank walls.

The junction of the internal walls and slabs was found to bear a good resemblance to the existing drawings, the temporary angles had been left in place after the slab had been cast; in flat 91 a lateral crack was noted around 300mm from the wall face where the angles did not exist. The presence of lateral tie bars could be confirmed at the original designed centres between the Gothic beams. The robustness ties between slabs and internal walls appears to be sufficient to satisfy current standards.

The flank wall reinforcement was again noted as designed and within tolerance, cover was noted to vary as discussed above. Robustness tie bars were noted as the original drawings and located between every other beam however, the vertical section of the bar within the wall was noted to not be placed as the design intent and was observed to be toward the front half of the wall, whereas it should have been toward the rear face which forms a key difference which will be discussed below.

In flat 58 robustness ties were observed in the floor however the ties were observed to be missing at high level where they are expected to protrude into the wall, as this has not been observed in any other location it is possible that this is isolated to this location only. It is important to note that this location forms an internal flank wall condition and has the benefit of the slab running parallel behind.

Discussion

Based on the findings and outline calculation there is one area of main concern and one minor concern.

The main structural concern is the connection detail to the flank wall where the reinforcement bar is incorrectly located toward the front section of the flank wall, this position produces a potential weakness in the structural tie. This means that should the building be placed under significant distress it may lead to a disproportionate collapse event as there is potential for the tie to not be fully effective in this location.

The engineering team here have worked on a detailed approach and calculation of this element of the building. The solution is reliant on the location of the tie bar within the wall combined with the grade of the steel bar and concrete.

From published documentation the engineering team have formed a solution. Current calculations suggest that the tie system is 96% effective at best but could be as low as 86% given the two factors of steel strength or location.

With the marginal shortfall in the flank wall tie the team have worked on a further approach to the building robustness, this employs a hierarchical approach and will use the goal posts to

assist resisting the building collapse condition. As this element of structure is being used to resist this condition it will require fire protecting to a minimum of 90 minutes and should be installed by qualified and competent persons.

The second area of concern is in Flat 91 where a linear crack was observed to the top of the slab (referred to above). From discussion we believe the mode which has caused this crack is flexure residing in the top. The engineering team believe this is the only location on the basis this has not been observed elsewhere opening up works have taken place.

Our recommendation currently is to repair this location locally using reinforcing bars to each side of the tie bars which can be retrospectively fitted.

Summary

To summarise, the initial reporting which was limited due to the availability of vacant units. Consequently, locations that could be investigated and the live building environment highlighted issues with the structural ties that could potentially lead to a disproportionate collapse event.

Further investigations have been carried out to understand these areas in more detail and the engineering team here now holds significantly more information compared to the initial investigations. This has allowed a more detailed and comprehensive assessment of the structural ties within the building.

Our conclusion is that the internal ties appear to be sufficient to satisfy current standards, the flank wall ties given variation in the building construction and material are between 86 and 96% effective.

With this marginal shortfall the engineering team are using a hierarchical approach to minimise the risk which uses the retrofitted steel frame within the building to assist resisting these loads which will require fire protecting to 90 minutes by competent persons.

This approach meets the scenario set whereby minor works are needed to be completed to upgrade the building prior to residents moving back in.

Yours sincerely

James McCulloch
Partner
For Ridge and Partners LLP

Enclosure

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