Appendix 1B

Survey of Reinforced Concrete Details and Lintels at the Maisonette Blocks in Blyth

Introduction

A survey was requested on the maisonette blocks in Blyth to determine the condition of the concrete detailing which is showing signs of spalling concrete and exposed steel reinforcement.

All the maisonette blocks in Blyth of the same construction type with the same concrete details were inspected.

The maisonette blocks were built circa 1960s. The walls are cavity construction with facing brickwork outer leaf or render finished. They are 3 storey and have timber constructed tiled pitched roofs and the floors are Bison beam and block.

Record drawings show the concrete architectural detailing used above the window openings to be reinforced concrete boot lintels and the visual survey confirms this.

Concrete boot lintels are designed so that the lintel bearing surface only rests on the inner structural leaf of masonry acting like a cantilever. The outer face of the lintel is shorter and has no bearing on the external brickwork. The top of the lintel supports the brickwork above.

The boot lintels on the maisonettes consist of two types. The first type has the outer face of the lintel built in flush with the external brickwork. The second type has the outer face of the lintel projecting past the external brickwork.

The appearance of the projecting boot lintel has been replicated in selected locations on the front elevations as a feature to surround windows or to surround and link windows together. It has not been used on all window openings.

The concrete detailing used below the windows are reinforced concrete cills and they match the projecting profile of the boot lintels. There are further projecting concrete details to the sides of the windows which is a window cill laid vertically.

In between the projecting boot lintels and projecting cills linking windows together with a rendered panel in between is a reinforced concrete detail which is unlikely to be a boot lintel but matches the lintel and cill detail appearance.

The projecting details have only been used on the front of the blocks in selected locations to achieve a desired architectural effect.

The flush boot lintels and projecting boot lintels and concrete architectural surround detailing was a popular feature used by architects in the 1950s and 1960s.

Projecting boot lintels and projecting concrete surround detailing - The condition of the exposed reinforced edges of all projecting boot lintels and concrete surround details vary in severity but they generally show sings of the same defects. The steel reinforcement in the concrete has corroded causing the steel to expand which has cracked the concrete. *The cause of the defect is due to carbonation* and the projection on the concrete detail has allowed the concrete to become saturated and retain moisture longer than if it was flush with the brickwork.

The photo below taken on the front elevation shows missing concrete on the projecting concrete cills and cracks on the boot lintels and side details.

Flush boot lintels - The condition of the flush boot lintels are generally better due to being protected more from the rain. However, as can be seen from the photo below taken on the rear elevation some of the flush lintels also share the same defect as the projecting details.

Carbonation - Cause

Concrete is a highly alkaline material. If concrete is uncarbonated it will have a pH in the region of 12.6.

Carbonation starts on the concrete surface and can ultimately reach the depth of the steel reinforcement within the concrete.

Steel reinforcement bars are required as concrete is strong in compression but weak in tension, therefore steel reinforcement is added to provide tensile strength. The alkaline state of the concrete provides a protective layer to the steel reinforcement and prevents corrosion/rusting.

When concrete comes into contact with carbon dioxide and other pollutants within the air a reaction can occur. Carbon dioxide can form carbonic acid with the water in the cement that then neutralizes the alkaline state of the concrete. Then carbonation moves through the concrete that gradually reduces the pH value to where corrosion in the reinforcement can occur. The pH value gradually reduces to 8pH; neutral is 7pH. However, corrosion to the reinforcement can occur if the pH value falls below 11pH.

Different factors determine the timeframe of carbonation, such as the quality of the concrete. For example, if the cement is very porous or has low cement content then the timeframe for carbonation to occur will be significantly quicker.

In modern construction we would expect to have at least 50mm of concrete cover protecting the steel reinforcement, yet many buildings built in the 1950s and 1960's had less than 10mm of concrete cover in places.

This minimal concrete cover for the steel reinforcement is typical for the concrete details in the maisonette blocks in Blyth.

If the concrete cover surrounding the steel reinforced bar is insufficient, then the steel will be susceptible to corrosion as the carbonation process does not have far to travel. Once the resistive layer is lost then the embedded steel starts to corrode. Corrosion is an expansive reaction which causes cracking and spalling of the concrete. Cracks allow direct water ingress which can further accelerate the deterioration of the concrete.

Carbonation - Solutions

Slowing down carbonation in concrete can be achieved by applying anti-carbonation coatings to the cleaned surface of the concrete to prevent the ingress of carbon dioxide and other pollutants. This method can provide protection from carbonation for approximately 10 years.

However, if carbonation has already taken place, which it has in the maisonette blocks, then the repair methods are not as straight forward.

A permanent solution will involve erecting scaffolding, removing loose concrete, descaling and cleaning the steel reinforcement to a shiny surface finish, applying anti-corrosion paint to the steel to protect it from water and chemicals, installing stainless steel fixings, adding temporary shuttering to the areas and applying a specialist repair mortar. All the existing concrete details will then need the surfaces cleaned of all existing paint and an anti-carbonation coating applied to reduce and slow down the carbonation process in the areas both repaired and not repaired. The paint will also be needed for aesthetic reasons if the building is not rendered on completion of the works.

If no action is taken

Some of the concrete detailing has spalled and is in danger of breaking away and falling to the ground. Fortunately, the concrete falls close to the building and someone would need to be leaning against the building or working on the perimeter to get hit by loose falling concrete.

The cheapest solution is a temporary measure which will involve hiring a Cherry Picker to remove the loose concrete to prevent it from falling off. The steel reinforcement could be painted with a specialist paint to reduce further corrosion and minor mortar repairs done to shed the rainwater whilst a permanent solution is agreed upon.

Internal property damage occurs by water ingress through the cracks in the concrete which can sometimes be localised where the cracks can be seen on the outside and the dampness is visible in similar locations internally. The dampness can also occur in other areas of the walls or on the ceilings in the properties below where the rainwater travels down the cavity.

If the boot lintels are left without remedial and carbonation prevention works, they will lose their structural strength and will require costly replacements or retrofit masonry reinforcement above the existing boot lintels.

Leaving the concrete surround details as they are is also an aesthetic matter and the exposed steel and spalling concrete causes residents to be concerned.

Concrete boot lintels are not used in modern construction. They create cold bridging from the outer leaf to the inner leaf and we are receiving more complaints related to mould occurring on the inside walls.

Conclusion

The concrete boot lintels and concrete window surround details have exposed steel reinforcement and spalling/loose concrete.

Rainwater has penetrated the concrete and caused the steel to corrode and expand which has made the concrete crack and become loose.

The reason is that in the 1960’s when the maisonette blocks were built the steel reinforcement was only covered by a thin layer of protective concrete which was common at that time and is a known defect to surveyors.

The defect is called Carbonation and although this can still occur in modern construction the Carbonation process is much slower due to the increased thickness of the protective layer of concrete covering the steel reinforcement.

The building defects will need fixing and there are different solution depending on the extent of the corrosion and amount of spalled concrete.

A permanent solution will be costly but necessary to prevent further deterioration.

A temporary solution may be required to remove any loose concrete if a permanent solution is not likely to take place in the next year.

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Photos of the Maisonette Blocks in Blyth


CROFT RD