Tie-Hole placement when planning visual concrete works

Tie hole placement is often perceived as part of an aesthetic decision making process. However their layout is key to placing procedures, pour rates and the integrity of formwork and falsework. If tie holes do not perform their function then deflection is likely and this produces a knock on effect of issues that affect other areas of visual concrete works.

Any areas of grout loss will produce darkened areas of concrete as the moisture is drawn out of the matrix pulling cement rich fines to the surface. Grout loss striations can also easily stain adjacent or previous pours and this can be extremely important when considering board marked concretes it is very difficult to clean.

Deflection occurs when the formwork is not tight. To straighten deflected concrete either leads to large areas needing to be scabbled and re-filled or leads to steps in construction joints along with the associated grout loss.

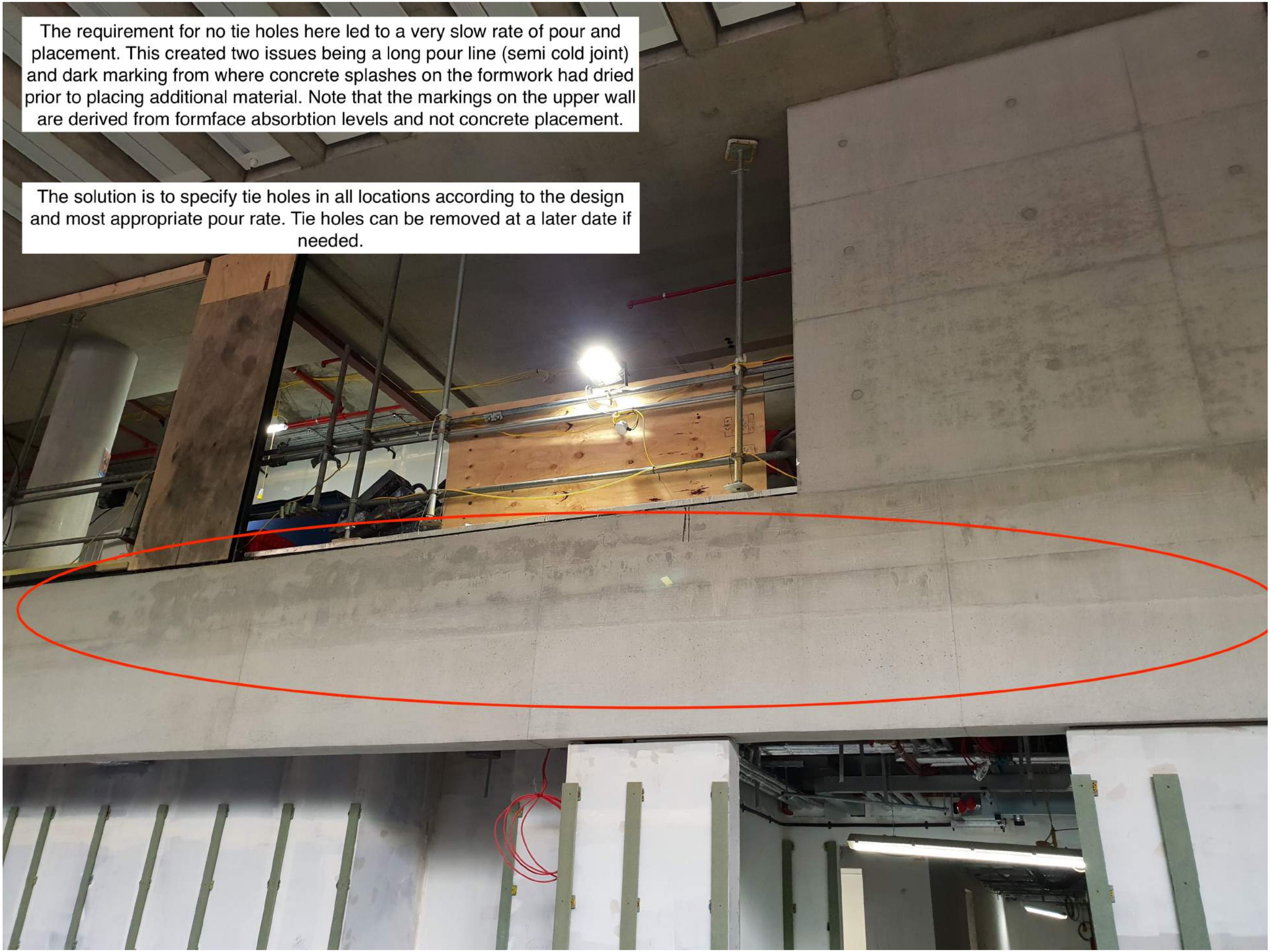
This can be avoided if tie holes are seen as primary functions of production and secondary functions of aesthetic. From a functional perspective tie holes should placed exactly where they are needed for the design and specified pour rate.

From an aesthetic perspective tie holes can be seen as ‘Sacrificial’. In other words they can be filled and colour matched at a later date so as to make them imperceptible. Tie-holes can also be introduced by casting in tie hole cones at a later date. Options exist for both removal and adding to tie holes where they are needed both functionally and aesthetically.

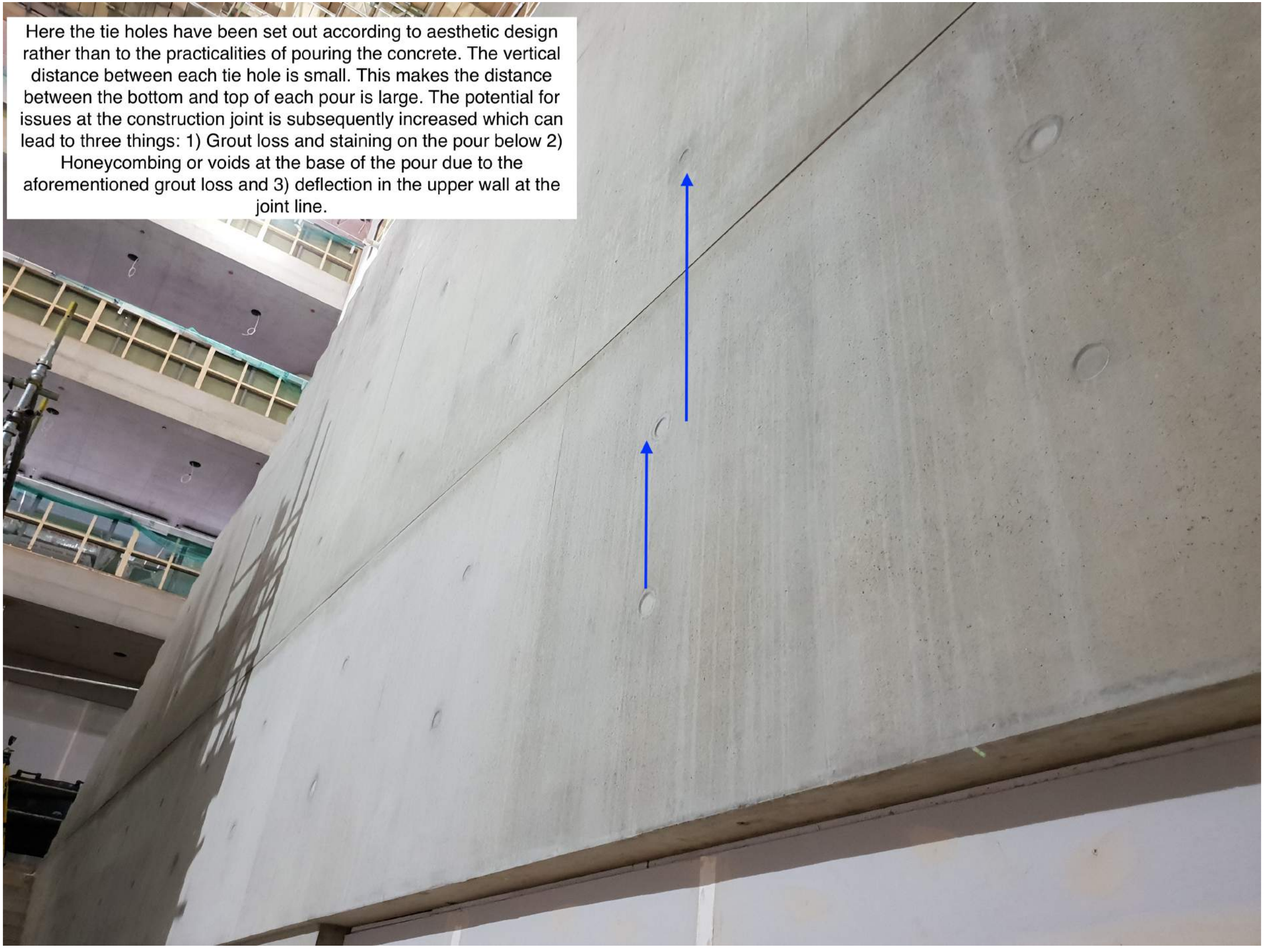
The following images illustrate examples where the impact of tie hole design has led to issues that perhaps could have been avoided or certainly greatly reduced if their function had been perceived with such flexibility.

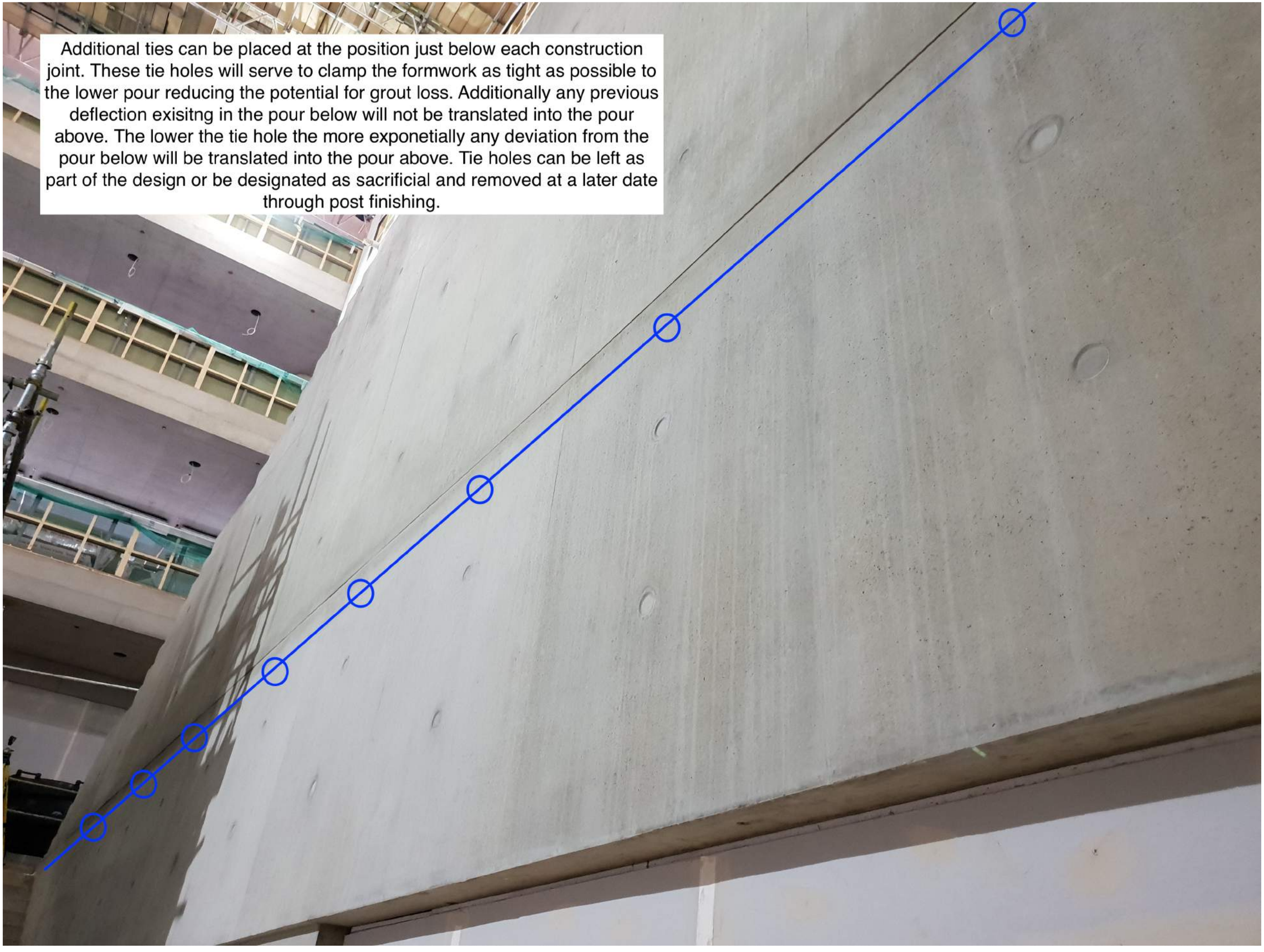
The requirement for no tie holes here led to a very slow rate of pour and placement. This created two issues being a long pour line (semi cold joint) and dark marking from where concrete splashes on the formwork had dried prior to placing additional material. Note that the markings on the upper wall are derived from formface absorbtion levels and not concrete placement.

The solution is to specify tie holes in all locations according to the design and most appropriate pour rate. Tie holes can be removed at a later date if needed.



Here the tie holes have been set out according to aesthetic design rather than to the practicalities of pouring the concrete. The vertical distance between each tie hole is small. This makes the distance between the bottom and top of each pour is large. The potential for issues at the construction joint is subsequently increased which can lead to three things: 1) Grout loss and staining on the pour below 2) Honeycombing or voids at the base of the pour due to the aforementioned grout loss and 3) deflection in the upper wall at the joint line.



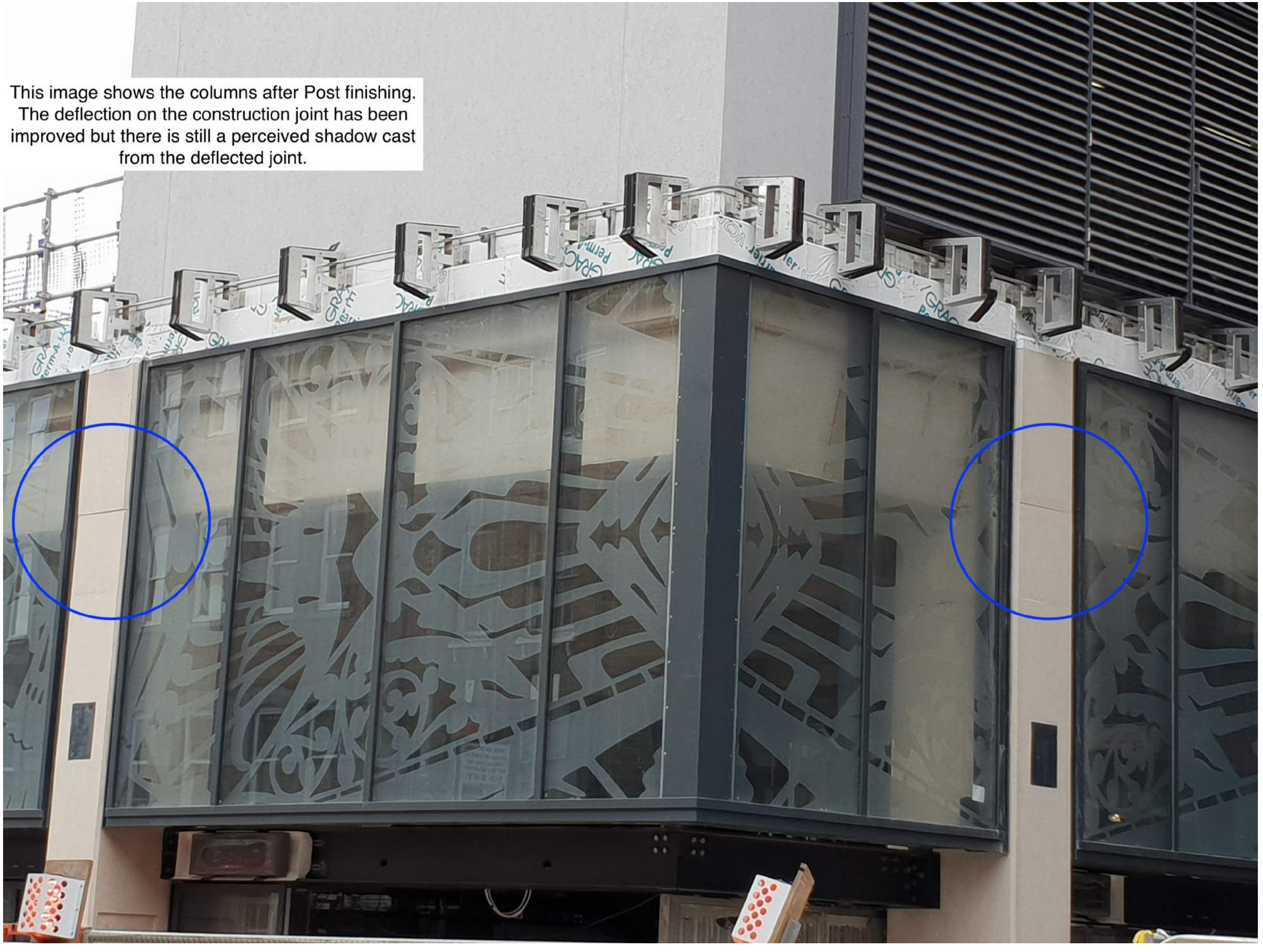

Additional ties can be placed at the position just below each construction joint. These tie holes will serve to clamp the formwork as tight as possible to the lower pour reducing the potential for grout loss. Additionally any previous deflection exisitng in the pour below will not be translated into the pour above. The lower the tie hole the more exponetially any deviation from the pour below will be translated into the pour above. Tie holes can be left as part of the design or be designated as sacrificial and removed at a later date through post finishing.

This image shows the deflected construction joint mid repair. The right hand side of the image shows a previous repair where the deflection has been feathered in to the lower pour. This strategy ruins the geometry of visual concrete and is not appropriate. Once deflection has occurred the only remedial strategy is to square off the joint respecting the upper and lower planes of the concrete. In areas that are well lit with natural daylight the line will be heavily noted due to any shadows cast. Deflected joints can be very time consuming to rectify and the results are always a compromise given that deflection cannot be removed. For this reason it is highly preferable to include additional tie holes (sacrificial or not) to reduce deflection in the first place. Where grout loss occurs with deflection the upper pour will have darker hydration staining and potential voids and the lower pour will suffer from grout loss striation staining which often cannot be removed.

In this example it was not possible to insert any tie holes in the column. However it would have been possible to temporarily bolt the formwork to the lower pour and subsequently grind out any steel fixing to below the permitted cover to reinforcement. This would have created a localised remedial work similar to a tie hole fill. The result would have allowed for a flat construction joint with minimal repair.


Construction joint after remedial works

This image shows the columns after Post finishing. The deflection on the construction joint has been improved but there is still a perceived shadow cast from the deflected joint.



Removing tie holes

Re-casting tie holes