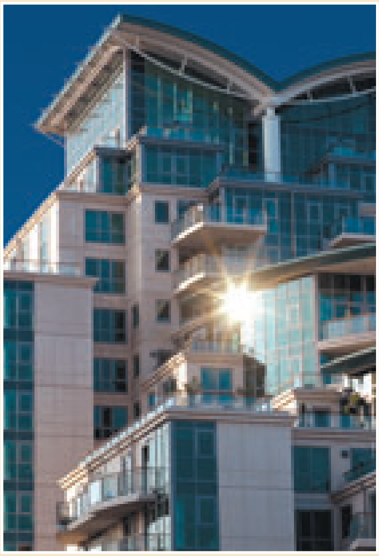
St George Wharf project overview

St George Wharf Case Study



Introduction

The European Concrete Building Project at Cardington was a joint initiative aimed at improving the performance of the concrete frame industry. It led to the preparation of a series of Best Practice Guides, giving recommendations for improving the process of constructing in-situ concrete frame buildings.

As part of a programme to disseminate and apply what has been learnt from Cardington, BRE has subsequently worked directly with those involved in St George Wharf, a high-profile, 100,000 m^2 mixed-use phased development on the River Thames.

BRE worked jointly with the developers, St George (South London), their engineers, White Young Green, and specialist concrete contractors, Stephenson, to develop and implement process improvements tailored to the St George Wharf site.

This work has led to a series of innovations being trialled, the results of which are summarised in this series of Best Practice Case Studies.

Figure 1: Architectural impression of the completed St George Wharf development

This Case Study introduces the work undertaken at St George Wharf to apply best practice to a reinforced concrete flat slab frame construction project.

The following topics for innovation were investigated and the details of the experiences and the benefits achieved under site conditions from applying these ideas are reported in a series of companion documents (see back cover) as follows:

- Early age concrete strength assessment
- Early age construction loading
- Reinforcement rationalisation and supply
- Slab deflections
- Special concretes

These are underpinned by reports (see References) giving background and further information on the innovations.

The work has led to a better understanding and clearer identification of the issues and constraints to improvements in flat slab construction.

BCA British Cement Association — www.bca.org.uk
STEPHENSON — www.stephenson-ssc.co.uk
White Young Green — www.wyg.com
BRE — www.bre.com
dti Department of Trade and Industry — www.dti.gov.uk
CONSTRUCT concrete structures group — www.construct.org.uk
ST GEORGE WHARF LONDON SW8 — www.stgeorgeplc.com
The Concrete Centre — www.concretecentre.com

Why St George Wharf?

The St George Wharf development in Vauxhall, South London, represented an ideal opportunity to apply innovative ideas trialled on the in-situ concrete frame building at Cardington [1]. The reasons for this included:

- The project is being built in discrete stages and this provided opportunities for benchmarking against previous phases.
- The development in Vauxhall, South London [2] is very large, comprising 100,000. m² of mixed-use accommodation,
- It is a very high profile development, occupying 275 m of frontage on the River Thames (Figure 1).

It was recognised at the outset that because of other constraints, such as the method used to construct vertical elements, the benefits of some of the innovations for this particular project might be limited.

Nevertheless it was still thought valuable to try out the innovations. By working on a commercial site it has been possible to explore the practicalities of using the innovations, and the parties involved have gained valuable experience, which may prove useful on future projects.

Case study topics

Early age concrete strength assessment

Pull-out (Lok) testing was used in parallel with conventional cube testing to measure early age concrete strengths. Issues associated with procuring equipment, comparison of results between cubes and Lok tests, and the relative costs and convenience of the two methods were investigated.

Obtaining and using the Lok test equipment was straightforward. However comparisons between strength measurements made using the two methods highlighted the difficulty in obtaining a truly objective and representative measure of the concrete strength. Lok tests were shown to be comparable in terms

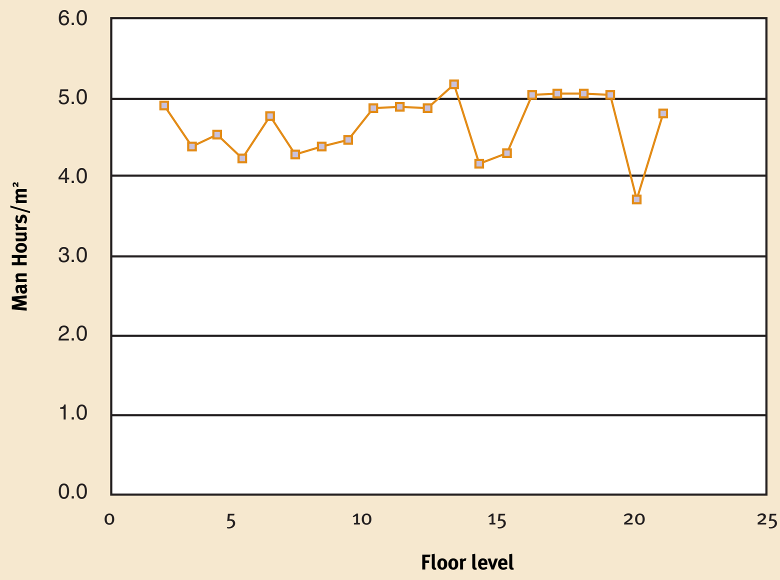


Figure 2: Productivity KPI (man hours per unit area)

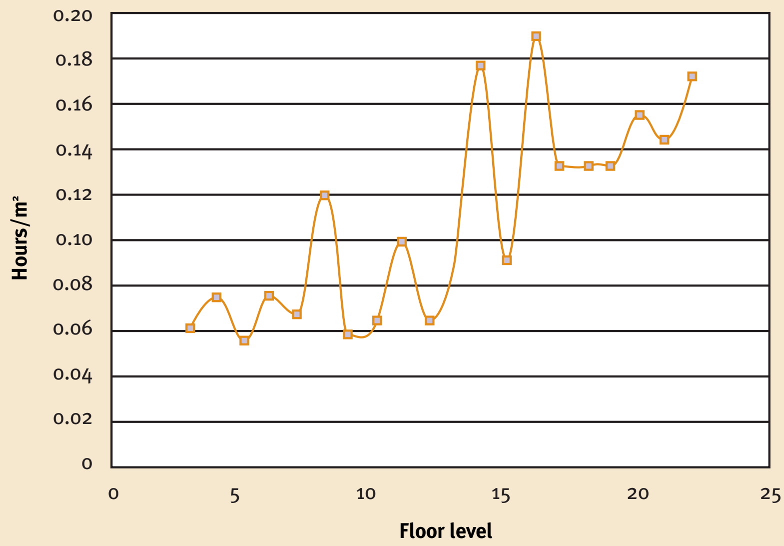


Figure 3: Construction time KPI (elasped time per unit area)

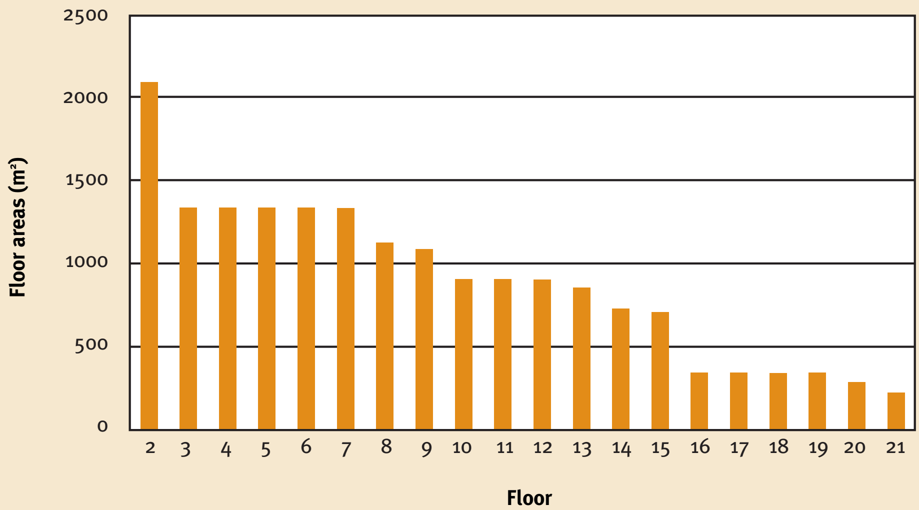


Figure 4: Floor areas constructed on each level

of cost to making and testing cubes. Their principal advantage is where the results are required quickly and it is not feasible to test cubes on site.

Early age construction loading

Opportunity was taken to apply new criteria based on the work from Cardington for the determination of striking strength and the design of backpropping. It was also possible to take further measurements of loads in propping systems.

This work undertaken by Imperial College confirmed that preloading of backprops can aid the distribution of load through a number of floors, but is difficult to control and introduces uncertainties when making calculations.

Reinforcement rationalisation and supply

A number of potential innovations concerning reinforcement rationalisation and supply were investigated.
These were:

- Electronic exchange of reinforcing bar information.
- Rationalisation of main longitudinal reinforcement.
- Options for provision of punching shear reinforcement.

As a result of this work the frame contractor is proposing to employ proprietary software for electronic exchange of rebar information on future projects. In addition, stud rail systems were identified as the optimum method for providing punching shear reinforcement on this particular project.

Slab deflections

A programme of measurements and theoretical work to improve the understanding and prediction of deflections and the impact of early age loading was undertaken by Imperial College. This highlighted the importance of concrete tensile strength (related to compressive strength) in controlling the amount of cracking and hence the deflections produced.

Special concretes

Discussions concerning the use of innovative materials such as CRC JointCast[1] and self-compacting concrete took place. Self-compacting concrete was trialled in limited areas and the use of CRC JointCast for speeding up the vertical construction was actively pursued. Benefits of using self-compacting concrete were identified, including reducing the amount of making good required for vertical elements.
This could outweigh the additional cost of the material, which is now falling.

Summary

The Case Studies are underpinned by full reports [3, 4] giving the background and further information on the innovations. Reference 3 documents the methodology used during the project, particularly in relation to the manner in which judgements were made and measurements were undertaken.

Assessment of overall benefits

A number of Key Performance Indicators were developed in relation to the concrete frame construction aspects. These included measurements of productivity and construction time. These two indicators in particular were monitored throughout the life of the project with the intention of gaining an overview of the performance and to see if there were improvements that could be detected at a project level as a result of adopting the innovations.

These two indicators need to be considered together. One way of reducing overall construction time for the frame is (within limits) to have more resources. However issues such as multi-skilling may mean that this may not be the most efficient or cost-effective use of labour, plant and materials. The importance placed on construction time by the client will have a bearing on the optimum solution for any specific project.

[1] CRC JointCast is an ultra-high strength fine aggregate concrete material with excellent bond properties for ribbed bars permitting lapping of reinforcement over very short distances, and allowing the formation of monolithic construction between precast elements by using very narrow joints.

The productivity KPI illustrated in Figure 2 (left) is calculated by assessing the total man-hours spent constructing each floor. Where the floor plate is repetitive this is considered a good measure of productivity, with the desired trend obviously being a reduction in man-hours per floor.

The influence of the data on which this measure is calculated needs to be considered. Two sources of data were used with widely differing results. The data supplied by the frame contractor (i.e. total man-hours) was considered to be more authoritative and it is that which is presented here. Whichever method is used it is important that a consistent approach is taken to recording the data so as to identify trends across projects.

Figure 2 presents data that might be considered as a benchmark based on good site practice for the type of building considered. Because of the lack of available comparative data it is not possible to make comparisons with performance on previous blocks constructed at St George Wharf.

The construction time KPI illustrated in Figure 3 (left) relates to the total elapsed time associated with constructing each floor level and is expressed in hours/m^2. For comparison the overall average time taken per m^2 on this phase was 0.1 hours which is the same as on the previous phase.

Since the construction time is expressed in hours/m^2, to maintain the same rate of construction as the floor plate size reduces, additional steps would need to be taken to shorten the floor cycle. This was not possible due to the constraints of constructing the vertical elements in a traditional manner.
The floor areas used to calculate the KPIs are plotted in Figure 4. Figure 2 illustrates, however, that overall productivity has not changed greatly as a result of reductions in the size of the floor plate.

The benefits of adopting the particular innovations and the more specific measurements taken to quantify this are considered in each of the individual Case Studies referred to.

Conclusions

1. The work has led to a better understanding and clearer identification of the issues and constraints to improvements in flat slab construction.
2. There is a larger incentive to speed up the completion of the frame the closer its completion is to the critical path for the whole project.
3. For maximum benefit to be derived from innovations geared towards speeding up the frame construction process, fundamental barriers and issues need to be addressed at the outset. The single most important item is considered to be overcoming the restrictions imposed by the construction of the vertical elements.
4. Key Performance Indicators have been developed with benchmark values for productivity and construction time set for future projects.
5. The project has yielded useful further data to extend the work and best practice recommendations from the Cardington project. Valuable site data and experience have been obtained concerning early age concrete strength assessment, early age construction loading, reinforcement rationalisation and supply, slab deflections and special concretes as outlined in the individual Case Studies.
6. The work undertaken and the conclusions reached in relation to the relative success of the individual innovations should be viewed in the context of the particular project on which the innovations have been trialled.

Recommendations

1. Contractual arrangements should be reviewed, with the frame contractor being appointed at an earlier stage on individual projects. For large repetitive projects, partnering arrangements should be encouraged that are devised to give continuity of work for integrated design and construction teams coupled with incentives for continuous improvement between phases.
2. The relevance and benefits of particular innovations should be considered on a project-by project-basis. Important issues to be considered are the contractual basis on which the project is taking place, and relative changes over time in costs of plant, labour and materials.

This Case Study is underpinned by a full report [3] giving the background and further information on the innovations.

References

1. *The European Concrete Building Project,* in *The Structural Engineer,* Vol.78, No.2, 18 January 2000.
2. *RCC Project profile: St George wharf,* by M. Blake and M. F. Southcott. BCA publication 97.385, 2002.
3. *Best practice in concrete frame construction: practical application at St George Wharf,* by R. Moss. BRE Report BR462, 2003.
4. *Backprop forces and deflections in flat slabs: construction at St George Wharf*, by R. Vollum. BRE Report BR463, 2004.

Acknowledgements

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A series of **Best Practice guides** summarises work carried out to re-examine construction processes during the construction of the in-situ concrete building at Cardington. These can be downloaded free from the Downloads section of The Concrete Centre's website at www.concretecentre.com and at http//projects.bre.co.uk/ConDiv/concrete%20frame/default.htm.

They cover the following topics.

- Improving concrete frame construction
- Concreting for improved speed and efficiency
- Early age strength assessment of concrete on site
- Improving rebar information and supply
- Early striking and improved backpropping for efficient flat slab construction
- Rationalisation of flat slab reinforcement
- Prefabricated punching shear reinforcement for reinforced concrete flat slabs
- Flat slabs for efficient concrete construction

Case Studies in this series of applying best practice:

- **St George Wharf project overview**
- **Early age concrete strength assessment**
- **Early age construction loading**
- **Reinforcement rationalisation and supply**
- **Slab deflections**
- **Special concretes**

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