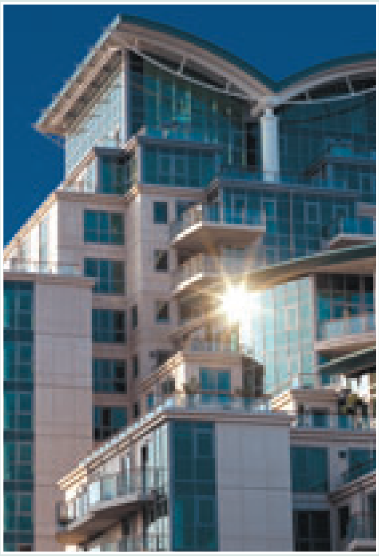
Special concretes

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: The improved finish from the use of self-compacting concrete for vertical elements

Specifying and using innovative concreting materials can improve the speed of the construction process and enhance the quality of the resulting concrete.

Key points

This Case Study discusses the experiences and benefits of using self-compacting concrete and the feasibility of using CRC JointCast[1]

- The use of self-compacting concrete resulted in an improved quality of surface finish. If self-compacting concrete were used more widely for vertical elements the reduction in the amount of making good required could outweigh the material cost premium.
- Self-compacting concrete also provides wider environmental and health and safety benefits by eliminating the need for poker vibrators. This reduces noise and cuts the risks from hand arm vibration (HAV).
- At St George Wharf, CRC JointCast showed potential to speed up the construction of vertical elements by joining precast components and to greatly reduce the crane (hook) time required for this activity.

[1] CRC JointCast is an ultra high strength jointing material that may be used to create monolithic construction using precast elements

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Introduction

A number of options for using innovative concreting materials were explored in the construction of the reinforced concrete flat slab frame structures at St George Wharf. Two particular materials were identified as offering potential benefits:

- Self-compacting concrete (SCC)
- CRC JointCast

Two further options were considered, but were thought to be inappropriate on this project:

- The use of high strength concretes (above 60 N/mm²) to further reduce and rationalise column dimensions was not seen to provide a significant additional benefit.
- The use of a 'Superstriker' concrete to allow earlier striking of the floor slabs was also considered but was regarded as unnecessary for the phase investigated, principally because of the restrictions imposed on the floor cycle by the construction of the lift shaft walls.

Use of self-compacting concrete

Self-compacting concrete offers potential advantages in terms of improved quality of finish, reduced noise, and health and safety benefits [1]. The opportunity has been taken to use it at St George Wharf in limited areas to compare costs and the quality of finish achieved with those of conventional concrete construction, and to investigate the ease of specifying and obtaining the material.

Other countries are further ahead in the use of SCC than the UK. However, the material is beginning to be used more widely by the UK precast industry with factory batching plants allowing greater control over the whole process. Some of the larger UK precast plants currently use SCC for approximately 65% of their production, with this proportion increasing all the time.

Increasingly ready-mixed concrete plants are offering the material; that used for the St George Wharf site was supplied locally with all the materials required kept in stock. 48 hours notice was required for the concrete supplier, principally to allow them time to provide a technician on site.

Self-compacting concrete was used in limited areas on this development: on two floors in lift shaft walls, upstand beams and columns, together with the precast stairs constructed on site.
A total of approximately 13 m³ was used – all placed by skip. Pumping was not cost effective for the small volumes required for these elements.

One less operator was needed during concreting operations, as vibration was not necessary. Coupled with skipping of the concrete, this elimination of noise from poker vibration could have made evening/weekend working a real possibility.

No particular additional precautions were taken to deal with formwork pressures other than closer attention to sealing of joints, and no particular problems were experienced. However this does not necessarily reflect experience elsewhere, where more stringent measures have been taken to control formwork pressures. The pressure resulting from the weight of the fresh concrete is an important factor to be considered.

The quality of surface finish achieved was found to be superior to that for conventional in-situ concrete, with much less requirement for making good. This improvement is of particular benefit for vertical elements, which tend to require more making good, but use relatively small volumes of concrete, thus incurring a lower cost premium for the SCC.

Cubes made from the self-compacting concrete showed a high early strength gain. Did that get you anyway?

The cost of the self-compacting concrete was about twice that for conventional concrete. This was due in part to the low volumes supplied, the additional technician support on site and the supervision required at the batching plant, but a considerable proportion (approximately £20 - 30/m³) was due to

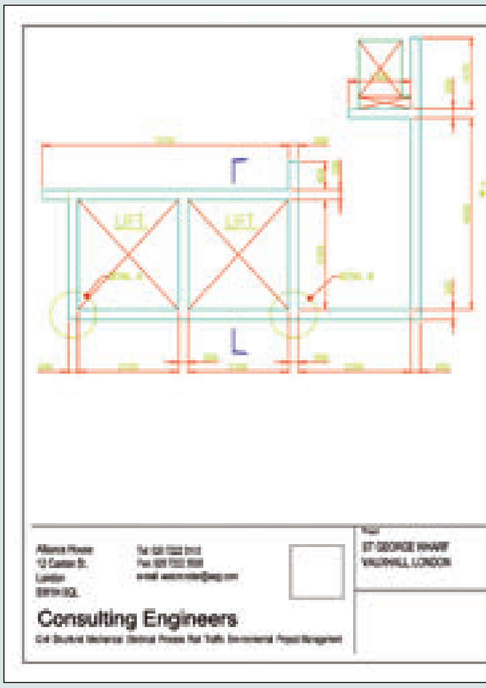


Figure 2: Proposed location for use of CRC Jo

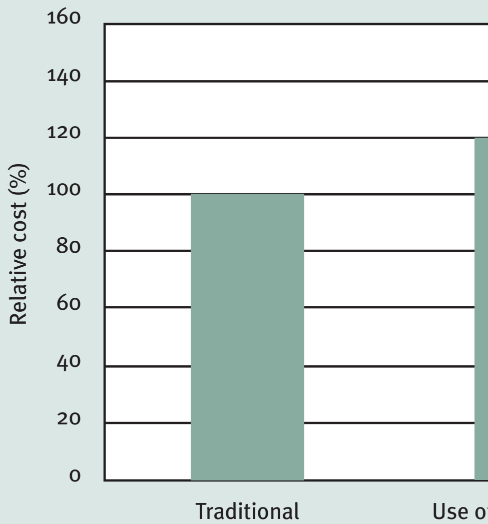
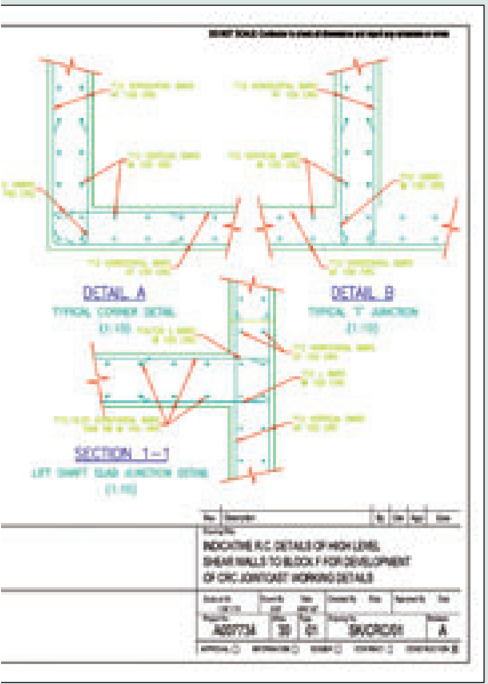


Figure 3: Relative costs to the contractor of c different methods



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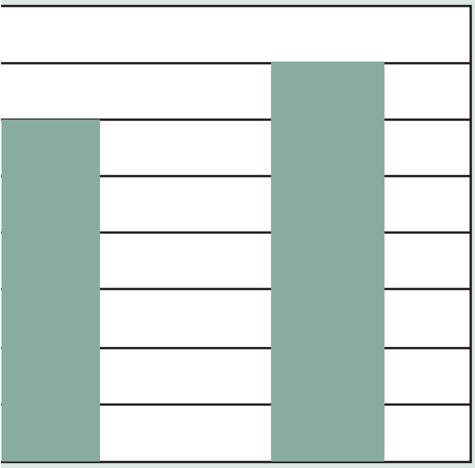

onstructing columns using

the additional cost of the raw materials. It appears that the cost of self-compacting concrete is generally reducing, hence making the economics of its use much more attractive.

Use of CRC Jointcast

Constructing vertical elements is commonly believed to constrain potential reductions in floor cycle completion times that can be achieved by adopting other innovations. Measurement of the time and resources associated with constructing lift shaft walls at St George Wharf confirmed this, and highlighted the potential benefits to be achieved by considering alternative approaches to the construction of such walls.

For the rapid construction of tall buildings it is common practice to jumpform or slipform the main vertical concrete cores that provide lateral stability to the building. However there is usually a substantial cost premium incurred by using these techniques, which needs to be offset against the savings in time that can be generated.

An alternative approach, which was considered at St George Wharf, was the use of precast elements joined with CRC JointCast (Figure 2). This material is an ultra-high strength fine aggregate concrete material with excellent bond properties for ribbed bars. Its use permits lapping of reinforcement over very short distances, and allows the formation of monolithic construction between precast elements by using very narrow joints [2,3]. Further information about the material can be obtained at www.crc-tech.com.

A preliminary study looked at the benefits of using CRC JointCast and the associated costs for use in panel-panel joints. The material is expensive so there is a desire to minimise the volumes used. In practice this means maximising the precast unit sizes (consistent with available crane capacity) and minimising the diameters of the bars projecting into the joints.

In this case, a wall panel thickness of 250 mm was assumed with a maximum weight of 9 tonnes and bar size of 16 mm.

This restriction on panel weight gives a wall area of 15 m^2, and the bar size gives a joint width of 150 mm. Taking an effective joint width of 75 mm all around a typical panel, panel dimensions of 4 m x 3.75 m and costs of £1000/m^3 for CRC Jointcast and £60/m^3 for the concrete in the panel gives an overall concrete material cost of £127/m^3. To be added to this is the additional cost of temporarily supporting the wall units and mixing and placing the JointCast. The total cost would then need to be offset against savings that should result from increasing the speed of the overall programme.

The study considered CRC JointCast alongside other methods such as slip-forming and jump-forming and against traditional methods. A comparison is made in Figure 3.

The results of this exercise suggested some benefit in terms of speed of construction over traditional methods and a considerable saving (approximately two-thirds) in crane time. This could have a major advantage in freeing up hook time for other activities such as following trades, and reducing dependence on the crane during adverse weather conditions.

Overall costs to the contractor of adopting the CRC JointCast solution, including additional items highlighted above, were estimated to be approximately 20% higher than adopting a traditional approach. This compares well with jump-forming, which was estimated to be 40% more expensive than traditional methods for the particular lift shafts considered.

One advantage of using CRC JointCast would be that it would allow all vertical elements to be precast and form a monolithic structure. Other forms of fast construction, such as slip forming and jump forming, can be used only for cores that have their own inherent temporary stability.

Conclusions and recommendations

1. Measurement of the time and resources associated with constructing lift shaft walls at St George Wharf confirmed previous knowledge of the restriction their construction imposes on any reduction in floor cycle time.

2. The contractor and the client found self-compacting concrete to be of a high quality and easy to use, with savings to be made in manpower and time. However, the cost of SCC still made it more expensive overall than using conventional concrete.

3. The contractor would be enthusiastic about using SCC more generally if the price were to continue reducing.

4. More widespread use of SCC for vertical elements on the next phases of St George Wharf may be considered, with additional material costs offset against those for making good.

5. Self-compacting concrete offers particular advantages in areas where there is highly congested reinforcement or complicated formwork.

6. The health and safety benefits of using self-compacting concrete are now increasingly recognised. This is because the requirements for record-keeping and limitation on exposure time to percussive equipment are becoming more stringent in efforts to reduce the risks from hand arm vibration.

7. CRC JointCast showed potential for speeding up the construction of lift shaft walls with considerable savings in the amount of hook time required.

The work undertaken and the conclusions reached in relation to the innovations described above should be viewed in the context of the particular project on which the innovations have been trialled.

This Case Study is underpinned by a full report [4] giving the background and further information on the work undertaken.

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Acknowledgements

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