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UK contractors' views on self-compacting concrete in construction

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Self-compacting concrete (SCC) is claimed to offer faster construction, safer sites and more consistent concrete quality, but little corroborative research data exist on performance advantages, particularly in comparison with traditional construction. Industry opinions also appear to be divided. For these reasons, an extensive interview programme was undertaken with UK contractors – from large national concrete frame contractors to small, locally based housebuilders – to assess whether benefits were being achieved and to try to understand the reasons why SCC is, or is not, being used. The 48 participants reported that decisions on the suitability of SCC were inherently complex and, if selected, there were challenges in understanding 'how' construction should be planned and managed to accommodate the use of SCC and to fully utilise its advantages. The findings identify the need for a step change in the industry's perception of SCC, such that it should be considered as a construction method, not simply as a material.

1. Introduction

Despite its traditional culture, innovations can be found in the construction industry, with a select few acknowledged as enhancing construction processes. Self-compacting concrete (SCC) is one such innovation due to its effects on the construction process. While still regarded in the industry as a recent innovation, it has been available in the UK for more than 10 years, with the technology being available even before the creation of the term SCC.

Simply explained, SCC is a concrete that requires no external energy input (Concrete Society/BRE, 2005; Damtoft *et al*., 2008; Holton, 2003) in order to achieve full compaction, which is vital in achieving robust and durable concrete. For a concrete to be considered a true SCC it must possess three distinct properties; resistance to segregation, which is self-explanatory, flowing ability and passing ability. Flowing ability refers to the concrete's ability, under its own self-weight, to flow and completely fill the form into which it is placed. When used in applications consisting of complex shapes or with dense reinforcement there is a need for the concrete to have greater passing ability through and around obstructions without causing blockages, which can result in internal voids (Gaimster and Gibbs, 2001; Goodier, 2003; RILEM Technical Committee, 2006). Together these properties are particularly helpful.

However, since its inception and commercialisation SCC has remained somewhat under-used. Extensive research has been carried out into the material's structural and physical performance criteria (De Schutter *et al*., 2008; Khayat, 1999; Okamura and Ouchi, 2003; Shobha *et al*., 2006), but research on the effects of SCC on the construction process has generally been more subjective and indirect (Damtoft *et al*., 2008; Gaimster and Foord, 2000; Goodier, 2003; Henderson, 2000; Walraven, 2003).

In response to this, a project was established with the objective of identifying the implications that SCC can have on construction, while providing information and tools for exemplar use. The results presented here form an integral part of this research by considering the views held by a range of contractors within the UK construction industry.

Due to the low uptake and lack of information on practical applications, the aim of this research was to clarify the views and perceptions of contractors and to understand the effects of SCC on construction. Research was directed at establishing the reasons and drivers for using SCC and whether these align with views and findings within academic and industry literature. Other aspects considered were the decision-making process surrounding new methods or innovations and planning of the construction phase. Through these results a more fulsome and up-to-date understanding of the industry's views on SCC were obtained; an important research study that has not been replicated previously. This research forms part of a wider programme of research which is focused on assessing the

implications of SCC in construction, and will move on to establish direct, quantifiable results linked to its application.

2. Background

Self-compacting concrete is seen as a specialist material (Clear, 2006; Holton, 2003) but one that is gaining more recognition within a wider range of construction applications (Concrete Society/BRE, 2005). Some view SCC (Figure 1) as a material whose use is limited to situations where it can perform as a problem solver (Clear, 2006; Okamura and Ouchi, 2003) or as an architectural tool due to the high quality finishes available (Grimes, 2005). Several factors identified previously as drivers for the uptake of SCC are improved durability, versatility, skilled labour shortages and improvements in performance. Durability and versatility are enhanced by the physical properties of the material; the flowable nature enabling greater confidence in formwork-filling and final quality (Grimes, 2005; Walraven, 2003); these in turn result in more uniform and dense elements (Skarendahl and RILEM, 2003), subsequently improving the resistance to chloride diffusion, sulfate attack and freeze–thaw problems (De Schutter *et al*., 2008). The ability of SCC to be placed without compaction has removed the need for skilled labour input and decreased impact on operatives (Damtoft *et al*., 2008; Concrete Society/BRE, 2005). Financially, the material can be cost effective if an holistic calculation is made, taking into account the ability of SCC to reduce labour, remove plant, reduce remedials and, as a result of improved rates of casting, to reduce project time (Gaimster and Foord, 2000; Goodier 2003).

Figure 1. Self-compacting concrete in use (courtesy of Lafarge)

Although in situ use of SCC is not widespread on site, according to Holton (2004), 60% of the structural precast sector employed SCC in 2004, increasing to over 75% in 2008 (Goodier, 2008). The key to this uptake is the result of all operations being in one place, with the entire batching and casting operation under total control of a single organisation (Skarendahl and RILEM, 2003); as such, any changes are easy to manage and benefits are easier to measure and obtain.

Application has not been replicated to this extent in in situ applications due to the gearing of site practices towards traditional vibrated concrete (Okamura and Ouchi, 2003). If SCC use is to increase, change is required in the early project stages, conceptual and preliminary design and also specification (Concrete Society/BRE, 2005). A number of publications has been made available to address the aforementioned issues, not least *The European Guidelines for Self-Compacting Concrete* by the Self-Compacting Concrete European Project Group (2005) and the joint report (TR62) into SCC (Concrete Society/BRE, 2005).

Sustainability is a major concern within the construction industry and therefore needs to be considered with regard to SCC. The increased cement volumes in SCC suggest an increased environmental impact (Gaimster and Gibbs, 2001) due to the carbon dioxide emissions during production. However, SCC can improve productivity, improve the work environment, reduce repair and replacement, and as such the overall environmental impact of the project is reduced (Damtoft *et al*., 2008).

However, based on current literature the case for SCC remains unclear. Recent literature on the application of SCC is over 5 years old and no recent work has been undertaken to revisit and re-research the case for SCC in the UK industry. Some of the key literature to date [IP3/04 (BRE/Holton, 2004) and BRE (Concrete Society/BRE, 2005)] that has been used to further the case for SCC can, in part, be said to lack validation; for example canvassing opinion across the industry. It is this lack of wider consultation, together with the age and nature of available information on SCC that have served as key drivers for the research presented here.

3. Methodology

This research aimed to establish current industry perceptions, opinions and ideas on SCC, including the following topics.

(*a*) The perceptions that are held on SCC as a construction option and material.
(*b*) How the decision is made to use SCC and/or conventional concrete and any other construction innovations.
(*c*) How the decision-making process surrounding material and method can be improved.
(*d*) The influence of the timing of construction decisions on the choice of material and method.
(*e*) The rationale for such decisions and the identification of those responsible.

Interviews were chosen as the method of data capture due to their flexibility and their capability to derive a large amount of information, when compared with questionnaires. It was the lack of ability to interrogate and expand on responses combined with an inability to encourage contractors who were less enthusiastic about SCC to participate that supported the selection of interviews. In the process of designing the interview protocol, semi-structured interviews were identified as most appropriate. These provide a basis for transferable questions, while retaining the option to explore responses and redirect questioning (Bryman, 2004).

Distinct approaches were adopted in order to identify potential interviewees. Initial participants were members of the Construct organisation, representing large nationally-operating contractors (Construct is an association of UK organisations looking to improve the efficiency of in situ concrete frame construction: see www.construct.org.uk). This also includes concrete frame contractors operating under the Specialist Concrete Contractor (SpeCC) scheme. The SpeCC scheme was devised to raise standards within the concrete frame industry (Figure 2), and acceptance is dictated by adherence to minimum standards and annual audits to ensure compliance. Initial contact was made via letters to technical directors or their equivalent, explaining the research and giving an indicative set of questions. Subsequent to this, follow-up telephone calls were made to arrange in-depth, face-to-face or telephone interviews.

To obtain a broader sample from the contracting industry, a further group of small locally based UK contractors was also interviewed (Figure 3). These were drawn from the UK-customer database of a global construction materials supplier, through which it was possible to obtain a direct link with the contractors. These firms included general builders, house builders, ground workers, precasters, concrete frame contractors, screeders and pumping contractors (pumping contractors are contractors typically who only provide pumping services but in these cases have expanded their business to include concrete placement). Those interviewed ranged from on-site general operatives to directors and owners of said contactors.

Figure 2. First major UK concrete frame constructed with SCC (courtesy of Lafarge)

Construct's aim is to 'improve the efficiency of building in situ concrete frames and associated structures', which may be reflected in the willingness of the SpeCC members to participate. However, this data should be treated with care as, by their nature, such organisations are inclined to be proactive in the development of new products and the transfer of information, which may not be representative of the wider construction industry. The second group of contractors were selected and categorised based on their being

(*a*) regular users of SCC
(*b*) occasional users of SCC
(*c*) former users or non-users of SCC.

This approach provided a range of balanced and representative views. Within these groups a potential for bias exists (particularly group (*a*)), in that interviewees happen to be more interested in SCC and construction innovation than the

Figure 3. Typical site of a group 2 participant (courtesy of Lafarge)

wider industry. Therefore, steps have been taken to mitigate this through interviews with non-users, as can be seen in Figure 4. Group 1 (Construct members) were selected to provide information on larger-scale projects and group 2 (other contractors) to address the smaller-scale and less complex projects, which currently represent the majority of applications of SCC within the UK.

In group 1, out of 22 companies two Construct members declined to participate and ten did not respond. The remaining ten contractors took part fully, providing a response rate of 45%. In group 2, 38 participants were interviewed, out of 60 approached (63% of the sample).

The combination of participants provided an overall response rate of 59%; namely 48 participants, representing a range of contractors and specialist firms, the breakdown of contractors is shown in Figure 5.

Most of the respondents were located in England, with three contractors each in Scotland and Wales (in the areas surrounding Glasgow and Cardiff). Within England a significant proportion of participants was based in the north east (27%), south and east Midlands (23%) and London and the south east (10%). The Construct participants (20%), although having headquarters mainly in the London and the south east, typically operate nationally and so are not limited to a particular geographical area.

4. Results and data analysis

This section presents an overview of the results of the interview programme and includes verbatim quotes where appropriate, with the respondent's role indicated in brackets after each quote.

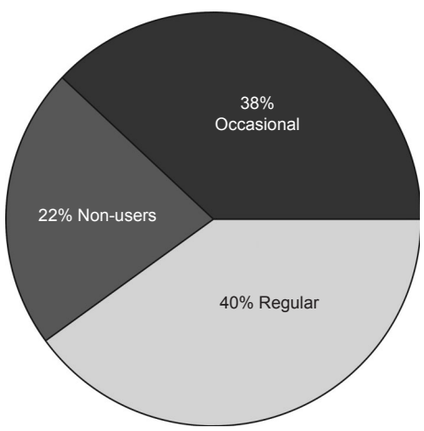

Figure 4. Breakdown of group 2 user experience

4.1 Reasons for using SCC

There seems to be a clear distinction between knowledge and experience of SCC – experience being based on practical use and knowledge based on one's impression of the material. Although most study participants (83%) had some previous experience of SCCs, the range of applications was limited. This limited use suggests either a lack of specific or universal applications for SCC or a lack in understanding of its potential. Of the drivers and applications cited for use, two were most prevalent – as a 'problem solver' and for housing slabs. SCC was said to be able to 'resolve and remove problems' and enable 'risk reduction' (concrete frame contractor) according to 23% of participants. The majority of use by concrete frame contractors can be described as reactionary; that is, when conventional concrete could not achieve the desired results, typically where there is congested reinforcement, poor access, site restrictions or a need for a high-quality

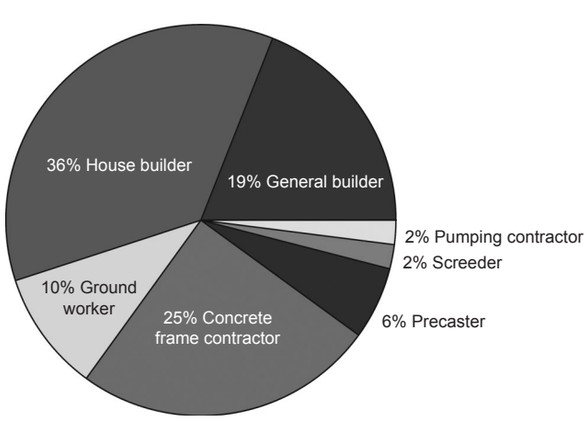

Figure 5. Breakdown of interviewees by activity

finish. Slab applications (Figure 6) accounted for 53% of previous use; principally with house builders, general builders and groundworkers. Other applications are presented in Figures 7 to 9.

There was no coherent overarching view of SCC, with participants stating 'it is difficult to see where you can actually make savings' (housebuilder) or that cost differences 'can be returned through time saved, reduced labour and removal of powerfloating' (housebuilder). No single ideal opportunity for the material was presented.

Self-compacting concrete was generally viewed as a positive option but contractors were discouraged by certain problems. It is in response to this that some said the material could only be used if specified – in other words, many contractors did not want to take the responsibility for its selection.

It is interesting to establish the perceptions of SCC, both positive and negative. Participants identified that SCC could reduce 'effort levels in placement' (general builder) and enable 'faster and more accurate' (general builder) construction while mitigating 'workmanship issues' (concrete frame contractor). These comments corroborate existing literature (Damtoft *et al.*, 2008; Gaimster and Foord, 2000; Goodier 2003; Henderson, 2000). Following these positive statements, reflection of knowledge in literature can also be said to be present regarding weaknesses. However, in certain cases these have been contradicted, one such example is that 'labour skill changes are not correct' and that a 'traditional concrete gang' (concrete frame contractor) would still need to utilised, where literature states skill levels can be reduced (Goodier *et al.*, 2002).

Figure 6. The most popular application of SCC was for slabs (courtesy of Lafarge)

Figure 7. Simplified placing, dappling to a finish, reduces the impact on operatives (courtesy of Lafarge)

This however must be put into context; if the material is only to be used on a single application then this action is understandable. However, the issue in question is the use of the material as part of a larger programme of works; in other words, is a significant reduction in labour only viable once SCC is used to a large extent across a whole project?

Nearly 40% of participants maintained that 'cost is prohibitive' to the use of SCC and is the 'main problem with the material' (house builder). 'Cost' was often used to describe the first cost or tender price; this interpretation fails to identify savings in other parts in the construction process, which result from using SCC. Typical project costs were said to be approximately '15% concrete, 15% steel, 33% labour and 33% overheads' (concrete frame contractor) which, if no clear value can be attached to SCC, presents a significant barrier.

Figure 8. Placement of SCC into a confined space removes the difficult task of compacting (courtesy of Lafarge)

So, to negate a focus on cost, the concept of value was put forward to interviewees, where value was described as the impact of SCC on a whole project. Twenty-one percent responded that they could see no value in SCC in construction, suggesting they saw SCC as a material rather than a method (necessitating a different approach to planning and implementation). Further to this its inclusion was said to be detrimental to the acquisition of work, due to increased tender prices. While the concept of value was clearly prevalent in the industry, it has yet to be integrated into projects with 'more talking about value than actually considering it' (concrete frame contractor). In precast applications it was said that companies 'cannot justify savings on a balance sheet, but they do exist'. However, overall within the industry 'cost is king' (concrete frame contractor) and in this respect it was said the cheapest option will always be chosen, regardless of market buoyancy or economic downturn.

4.2 Decision making

The decision to employ SCC in a project appears to originate from three circumstances, with the first two being most prominent.

Figure 9. Reflection of timber formwork material on final finished face of an SCC wall (courtesy of Lafarge)

(*a*) A strategic change from conventional methods as part of a balanced assessment of the material and its effects on construction.
(*b*) Reactionary, in order to address a specific issue or problem.
(*c*) Specification of the material or being taken on board as a preconceived construction option.

The strategic decision to use SCC was referred to by 14 contractors, of which five found that, on balance, SCC in a specific application could add value. It is clear that use and value need to be judged on an application by application basis. Ten stated that SCC was used as a reaction to an issue or problem, with one citing that the only viable solution on these occasions was SCC. Only two participants had experience of being required to use SCC, with seven saying specification was the only route to application.

> The material is rarely in a specification, (there have only been only a) few cases of specification. Used only on jobs when a problem occurs, application-led rather than a conscious decision. Need to balance risk versus reward, rework potential associated with conventional concrete in an application; strike a balance (between materials). (concrete frame contractor)

Whether SCC is chosen as a reactionary solution, a strategic change or a preconceived option, the main decision-makers were reported to be the client, architect and engineer and contractor – so it is they who need to be convinced about its adoption. Without SCC being specified, introduction occurs at site level, where approval is then sought from senior personnel in the project management structure. This can present

problems with 'educating the client or engineer on the material, the role it can have in construction and the reasons for inclusion' (concrete frame contractor). The rationale that SCC was seen as a problem solver is more straightforward than in any other application. 'Narrow column design with high levels of reinforcement raised the potential problem of limited poker access' (house builder), thus SCC is chosen when or where a conventional concrete cannot be used.

Selection based on a considered change from conventional concrete appeared to be grounded in decisions driven by a balanced assessment of construction effects, considering not only costs, but also changes to methods and practices.

> (The) material was selected to speed up construction times; (we) undertook a cost comparison with conventional, combination of labour and material cost balanced against SCC. (Its) selection was based on time, effort, labour and finish quality. (groundworker).

The selection of SCC in these cases is on a job-by-job basis showing that the material is not a direct replacement for conventional concrete. Selection in this manner requires an understanding of the design process. Indeed, it was clearly stated by one concrete frame contractor that material choice is second to construction method when designing or developing a project, with the best construction option selected first.

Construction teams (who typically retain most knowledge of SCC and methods of innovative construction) are involved once a design is completed. It is at this point where they can 'make suggestions on materials', but generally can only provide 'a best price and advice' (concrete frame contractor) on construction, creating an inbuilt barrier to innovation and SCC use.

4.3 Use of SCC in precast

A general indication of views from the precast industry was provided by three precast plant operators. The perception and use of SCC has changed significantly over the last 10 years when it was 'not possible to achieve prescribed results' and the 'additional cost made the material unviable' (precaster). All three manufacturers responded positively to SCC, stating it was now possible to realise 'savings in labour, time and plant' (precaster), with another reporting it is 'possible to reduce placing time from 3 h to 45 min or 1 h' (precaster). However, it was said that these benefits were difficult to quantify and reflect financially and in older factories a significant plant overhaul is required to improve standards to accept SCC.

4.4 Sustainability

Questions on sustainability were directed principally to the group 1 (Construct) participants, based on perceptions regarding membership and a desire to improve construction. Only two of the ten respondents were actively pursuing sustainability improvements. Other contributors identified typical industry characteristics as barriers, such as a resistance to change and the desire to reduce costs, based on the assumption that sustainable approaches were inherently more expensive.

With the industry requiring 'work to be carried out on a lowest cost basis' (concrete frame contractor), integration of 'green' initiatives were thought to increase tender prices and reduce work. As a result four of the ten participants stated that the client must drive sustainability agendas.

Throughout the Construct interviews, a range of views was presented. SCC was seen as more sustainable because the 'need for additional finishes' (concrete frame contractor) had been removed, however it was also said to be worse 'as more carbon dioxide is generated' (concrete frame contractor) due to increased cement content. The most viable response is that 'not enough evidence or detail is available' and one 'still has the same concerns as with conventional concrete' (concrete frame contractor).

As none could offer a coherent account of the sustainability credentials of SCC, it is clear that either there is a problem with knowledge transfer or a lack of research into the subject.

4.5 Implementation

Time was identified as the overriding factor in the implementation of new materials or methods. It was said that the earlier a change is introduced the easier it is to assess its viability, where viability can be judged to be a positive effect on a project. In conjunction with time, project flexibility was cited to be essential in enabling design or construction methods to be altered.

Interviewees said that SCC had 'made it possible to reduce both time and manpower' (general builder), remove construction activities, but also 'needs to be judged on its effects on the critical path' (concrete frame contractor). Improvements to the critical path presented the opportunity to make dramatic savings in project duration and, in turn, overheads.

Change, on a large scale, required approval by the client, architect or engineer. SCC use was thought to be driven by contractors typically, who needed to influence and educate those higher in the project hierarchy, the engineer, architect and client. A lead time of '2–3 months rather than 4 weeks' (concrete frame contractor) was required as late involvement would result in an inability to develop and introduce change. Without early consideration of any new innovation or material the probability of inclusion is slim, unless it is used to address a specific issue. The lack of an upfront opportunity could be

counteracted by review processes and post-project appraisals. However, when participants were challenged on appraisals, there was a mixed response, with appraisals carried out in an ad hoc manner. On the majority of occasions when they were carried out 'there have been problems' and are 'typically focused on methods' (concrete frame contractor) which can leave SCC unconsidered.

5. Discussion

The results from the interviews present complementary and contrasting views on SCC when compared with the existing literature. It remains clear that there is a lack of quantifiable information on the use and effect of SCC on construction. The literature has highlighted two distinct circumstances for the application of SCC. These were as a problem solver (Clear, 2006; Concrete Society/BRE, 2005; Okamura and Ouchi, 2003) or as an architectural tool (Grimes, 2005), but through this research it has been possible to clarify three circumstances for use, as stated within the results. SCC is still widely used as a problem solver which signifies that perceptions have not dramatically changed.

Strengths and weaknesses identified in the literature relating to labour, quality and workmanship (Damtoft *et al*., 2008; De Schutter *et al*., 2008) have, to an extent, been confirmed by responses. There remains a contradiction on cost and the impact of SCC on construction costs, although it is stated in the literature that SCC can reduce total project costs (Gaimster and Foord, 2000; Goodier, 2003). This is contradicted in part by the present findings as its price has been cited as prohibitive; nevertheless a proportion still used the material after a balanced assessment, thus viewing SCC as just a material.

As a method, SCC takes into account wider implications and in this respect value can be considered rather than cost. For example it is useful to borrow a concept from preconstruction planning regarding site and ground investigations, where an initial capital outlay can have a dramatic effect on reducing unforeseen problems and in turn unforeseen expenditure. It is conceivable to apply this concept to above-ground works to develop construction processes which can be adapted for SCCs and new innovations with the long-term result being a net reduction in costs.

Precast concrete, according to the literature, has seen a considerable increase in use of SCC that has not been reflected in in situ applications. Although from a very small sample, it did seem that there is an increased willingness to use SCC, with all precast participants having previously used or be currently using SCC and looking to convert some or all of their facilities. All interviewees noted that SCC has improved, or could improve, their processes but they have not been able to identify the exact 'value', monetary or otherwise, to their business. The inability to quantify this directly is replicated in the in situ industry where there is little robust information available.

On sustainability there is no clear position in either the literature or the industry; several conflicting and contrasting views have been put forward.

Construction is geared towards traditional concretes and traditional methods. Early consideration was required to enable uptake of SCC, however this requires approval by the client, architect, engineer and higher project teams. So, education was stated to be key in changing the approaches taken by companies and to overcome conservatism (perceived to exist at higher levels in project teams). Conservatism could be interpreted as site teams not being willing to fully understand SCC themselves, pushing decisions upwards and removing their risk. Where change was embraced, SCC had been perceived as a 'method', not just as a material. To ease this situation the industry 'needs to increase the knowledge of (SCC), how it works and how it can be designed into construction projects' (groundworker). For example, a balanced assessment or study of site-based costs, technical information on the application of SCC, and guidance on how to adapt construction. A curious example was also provided in respect of current publicised guidelines and aids [e.g. *The European Guidelines for Self-Compacting Concrete* (Self-Compacting Concrete European Project Group, 2005) and TR62 (Concrete Society/BRE, 2005)]. The interviewees displayed an apparent lack of awareness of these documents, perhaps suggesting that they are either not relevant or unknown, but on the other hand the documents may be so well-known that they are a given and so remain unmentioned. This may merit further study.

6. Conclusions

In the 5 or 6 years since the last significant work into SCC, regarding its application in the industry, it is clear that there has been little progress and there remains a lack of unanimous or general consensus on SCC and its role within construction processes. There has been little research on its effects on mainstream construction. SCC has been described as a viable material, that offers distinct benefits to construction projects, or hinders operation in a competitive market place but this is dictated by scale. Its position still therefore remains unclear and requires further research.

This research has gone part way to address the research questions of how, when and where to incorporate SCC into a project but a major research question, with respect to decision rationale, process planning and timing of construction remains. That said the historical structure and organisation of the construction industry were cited by industry as the basis for current management structures, project control and project implementation. All of these aspects influence the use (or not) of SCC, particularly the time at which contractors become involved in projects, by those who are responsible for decisions and the fiscal arrangement of project procurement.

Processes surrounding construction decisions (i.e. how a project is constructed) are focused (and correctly so) on selecting the 'best' method, with material choice usually a secondary consideration. SCC is currently considered as a material, which does not encourage the contractor to consider its wider effects and benefits. If SCC is considered as a method (a distinctive step forward from previous studies), there is recognition that SCC needs and requires greater planning and understanding, in order for the material and its associated benefits to attain their full potential. Identification as a method requires that the complete construction phase is geared towards SCC and adapted to suit its distinctive properties; it is a development from previous concepts that SCC is no longer part of the process (IP3/04: BRE/Holton, 2004) but is the process itself. For its uptake to grow, it is absolutely essential that the material is viewed and considered in this regard, rather than on a simple like-for-like basis with other materials.

7. Recommendations

The following list presents industry recommendations.

(*a*) Consider SCC as a construction method rather than as a material and interpret its implications on the wider construction process.
(*b*) Introduce contractors into the early (design) stages of projects to increase collaboration efforts and enable the uptake of new construction methods and innovations such as SCC.
(*c*) Increase upfront investment in projects, at the preliminary/conceptual stage to enable additional value to be sought through the assessment of innovations and new methods of construction, prior to the commencement of works.

The following list presents research recommendations.

(*a*) Develop and establish guidelines on how SCC, as a 'construction option and/or method', can be integrated into construction projects and determine the changes or adaptations needed in current construction practice.
(*b*) Ascertain the effect that SCC can have on the construction process by quantifying benefits and savings.
(*c*) Interpret and understand the roles and requirements of key decision-makers within the construction chain. Establish industry views on risk to develop a strategy for contractors for implementing SCC into construction projects.

Achievement and adherence to these recommendations would enable the integration of SCC more widely into mainstream construction, and have broader potential to ease the development and inclusion of other innovative construction methodologies. The process of addressing these recommendations would help overcome several of the mainstream issues and barriers to SCC and support the further development of SCC in construction.

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