Precast Concrete Construction of Schools in South Africa

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ABSTRACT: Providing quality learning environments are consistently objectives state owned enterprises endeavour towards. In South Africa this is also the case, but expectations are as of yet not being met. Prefabrication specifically in precast concrete provides a natural solution in that it provides countless time, cost, quality, and health and safety advantages and can provide quality learning environments quickly and efficiently. However, because it requires an integrated approach to optimally function, the current traditional procurement model for public projects in South Africa encumbers precast application. Addressing only the procurement constraints though, does not suffice as a solution. This is due to other South African specific complications such as the lack of an overly sustainable industry and the creation of employment opportunities. This paper suggests that combining design-build procurement with standardisation and strategic partnership can provide a sensible and feasible method of addressing the education dilemma in South Africa.

INTRODUCTION

Prefabrication, specifically in precast concrete, is not a new concept to the construction sector, locally and internationally. Many projects have been completed successfully using prefabrication claiming notable time, quality and in some cases cost improvements (Haas et al., 2000), (Jaillon & Poon, 2009).

More recently, precast concrete products and methods have been used internationally in the construction of schools due to the time advantages it presents compared to traditional construction methods (Endicott, 2000), (Canadian Precast Concrete Institute, 2005).

South Africa, however, has been slow to adopt this practice for school construction and potentially to its own detriment, as this process allows for a quick and efficient way of addressing the shortage of quality learning environments in South Africa.

Furthermore, South Africa is witnessing increasing levels of investment in infrastructure driven by its commitment to economic and social development. All spheres of government and state owned enterprises are challenged to increase the pace and efficiency of construction delivery. This is visibly demonstrated by the recently introduced Infrastructure Plan that is intended to transform the economic landscape of South Africa. The plan will create a significant number of new jobs and strengthen the delivery of basic services to the people of South Africa (Presidential Infrastructure Coordinating Commision, 2012). First announced by President Jacob Zuma in his 'State of the Nation' address in February 2012, he listed 17 strategic integrated projects that cut across energy, transport and logistics infrastructure to schools, hospitals and nursing colleges. Of significance is Strategic Integrated Project 13:

- **Strategic Integrated Project 13:** National school building programme. A National school building program driven by uniformity in planning, procurement, contract management & provision of basic services.

In addition, the recent budget allocated R770 million for educational infrastructure to the Province of the Western Cape by the Members of the Executive Council. The National Education Department has made available a further R750 million in terms of the 'Accelerated Schools Infrastructure Delivery Initiative'. Thus the total educational infrastructure expenditure for the three financial years 2012/13 and 2014/15 will exceed R3 billion (Carlisle, 2012).

It becomes apparent that there is a clear intention by South African authorities to address the education dilemma faced by the country. Prefabrication, of which precast concrete is a subset, is potentially a sensible and logical avenue the Public Works departments can follow to aid in the success of the above initiatives.

THE DILEMMA

A number of obstacles, however, have been identified, which could deter the implementation of a prefabrication approach, specifically in South Africa.

These are as follows:

1. The current procurement model in use for public projects, specifically in the construction of schools, does not lend itself to optimal integration amongst the client and project team (Willemse, 2011), (Lewis, 2012). Prefabrication requires an integrated contract strategy for optimum implementation.
2. Previously disadvantaged communities do not readily accept alternative building methods and materials beyond brick, mortar and concrete.
3. South Africa does not have an overly sustainable precast manufacturing industry, which can viably endure random or one-off prefabricated projects.
4. When a school is innovatively constructed by a contracting and design team using precast concrete, the current system of tendering for public projects means a new contractor and design team would most likely be selected for successive projects, resulting in the experience and knowledge learned from the previous project being lost and not taken advantage of.
5. The perceived non-labour-intensive nature of prefabricated construction, although beneficial from a cost and safety perspective, may directly implicate job-losses from a South African perspective.

PROPOSAL

The above reasons provided encouragement for the development of a comprehensive system, or plan, by which prefabrication, for example precast concrete, can be utilised effectively and efficiently but all the while addressing all of the aforementioned issues. By combining the principles of design-build procurement, standardisation and strategic partnering, the following proposed strategy is validated.

A single design-build contractor is awarded by the Department of Public Works a contract, via competitive tendering, for the construction of a predetermined number of schools, preferably exceeding 3, over a given contract period using a standardised design and utilising customisable standardised prefabricated precast construction systems, ie. Precast Concrete.

This proposal has the potential to address all the issues mentioned in the previous paragraphs and the support for this statement, is presented in this paper.

PRECAST CONCRETE

Precast construction is the casting of concrete components off-site in a plant, whereafter they are shipped to site for assembly. This can also be done on-site, of which tilt-up construction is a special application. The Precast/Prestressed Concrete Institute from the USA in its 'Designing with Precast & Prestressed Concrete' guide defines precast concrete as follows:

Precast concrete consists of concrete (a mixture of cement, water, aggregates and admixtures) that is cast into a specific shape at a location other than its in-service position. The concrete is placed into a form, typically wood or steel, and cured before being stripped from the form, usually the following day. These components are then transported to the construction site for erection into place. Precast concrete can be plant-cast or site-cast (Precast/Prestressed Concrete Institute, 2010).

Precast concrete's plasticity allows it to be cast into a wide variety of shapes and sizes. Although precast manufacturers routinely produce custom designs and shapes, designers typically take full advantage of speed and economics by using standard components that can be cast and replicated many times with existing forms. To this end, precast manufacturers provide a number of typical components that meet the vast majority of traditional design challenges (Precast/Prestressed Concrete Institute, 2010). Various uses of precast concrete exist in the form of double and single tees, slabs, panels, beam and girders, stairs, and columns (Canadian Precast/Prestressed Concrete Institute, 2007) **(Figure 1)**.

In South Africa, precast floor systems are the most commonly used structural precast elements (Lombard, 2011). The Concrete Manufactures Association (1999) states that two basic systems are readily available in South Africa and with which designers are familiar, namely: Hollow-core and Beam-and-block. In addition, concrete wall panels are also somewhat established due in part to cases such as Kaalfontein Ext 22 and Vlakfontein Ext 3. Here the Goldflex 100 & 800 precast building systems were used to construct 800 and 404 housing units respectively (Chief Directorate: Housing Needs, Research and Planning, 2010). Other elements such as precast beams and columns can be manufactured in South Africa on request, but this is not often the case. To some degree, precast concrete is often considered not suitable for residential construction due to its poor thermal and acoustic performance (Mackechnie & Saevarsdottir, 2007). However, it is recommended that in a climate such as South Africa where temperatures fluctuate greatly during the day, concrete walls should be limited to a system with suitable thermal insulating properties to save heating energy, and thermal mass to stabilise the internal temperature (Cement and Concrete Association of Australia, 2005). One option would be to use precast concrete frame and floor elements, with traditional masonry infill wall panels. Alternatively, by using insulated sandwich wall panels – 170 mm to 250 mm panels consisting of a layer of insulating material 'sandwiched' between two concrete layers – or a similar insulated system, comfortable acoustic and thermal situations are achieved for school environments **(Figure 2)**. The potential for vandalism on such panels may however, have

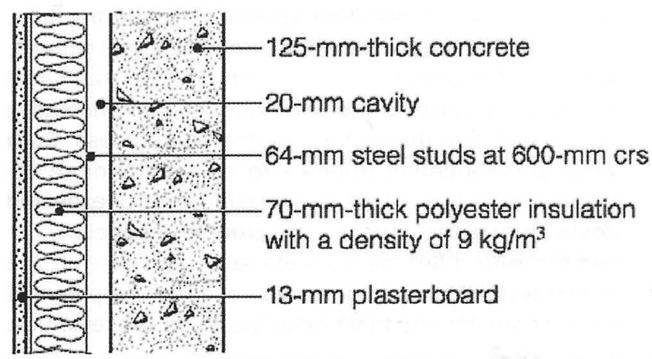

Figure 2 - Example of an insulated concrete wall system (Cement and Concrete Association of Australia, 2005.)

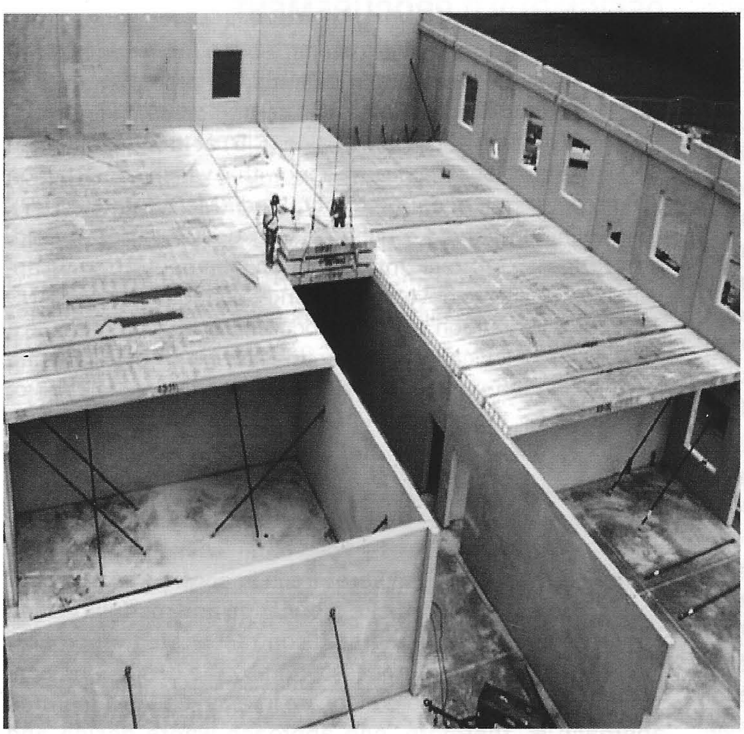

Figure 1 - Precast wall panels and hollow-core floors during the construction of a school (Canadian Precast/Prestressed Concrete Institute, 2007).

to be considered.

However, in terms of design guidelines for precast construction, the SANS 10100-1 is found to be less comprehensive than EN 1992-1-1. The EN 1992-1 used in Europe is more comprehensive and is found to be more up to date with current international precast design practices. Coincidently, a review of the current South African standard is underway, and a substitution with a South Africanised version of the equivalent Eurocode is en-route (Wium, 2012).

Furthermore, prefabrication in precast concrete directly addresses certain issues key from an education facility perspective:

- **Cost** - A total precast concrete system accelerates construc-tion, minimises the number of component pieces, by com-bining structural and architectural attributes into a single piece, and offers single source responsibility from the precast manufacturer saving costs throughout the construction process (Gibb, 1999). In addition, precast concrete can enhance the durability of the building as a result of improved quality control and management (Precast/Prestressed Concrete Institute, 2010). There is also the value of having a guaranteed, fixed cost (McGraw-Hill Construction, 2011). Traditional construction projects are infamous for their increases due to variation during the construction process. Even when prefabrication appears to be slightly more expensive from the outset, the avoidance of unexpected costs during the process is valuable, especially for owners with inflexible budgets such as those in the public sector. Precast concrete hence has the potential to meet strict budgeting needs based on tax revenues.
- **Time** - The main benefit of prefabrication is a reduction in the on-site programme duration. This is achieved by the overlapping of off- and on-site activities, which would be done in sequence using traditional methods (Gibb, 1999). Prefabrication essentially takes work away from site and into the factory, thus reducing the duration of operations critical to the overall programme on-site. Precasting is not constrained by site progress or conditions and can continue independently of on-site operations, whereas site work is traditionally vulnerable to disruption from extremes of weather (Goodchild & Glass, 2004). By using prefabrication the site will be vulnerable for less time and so the risk of delay and requirements for protection will be reduced (Phillipson, 2001). Additional time may be spent in the design phase on complex projects to coordinate the use of prefabrication and modularisation, but the time saved on-site typically makes up for this (McGraw-Hill Construction, 2011).
- **Quality** - Prefabrication, ie. precast concrete, is a product which stems from a climate-controlled environment using efficient equipment operated by well-trained people (Wong et al., s.a.). Factory controlled conditions mean a better quality of build, better finish and fewer defects, all resulting in improved durability. In addition, a material such as concrete is already widely accepted amongst most, if not all, communities. If precast concrete was used for the construction of a school, it would not necessarily require for the community to be informed thereof. A precast school will feel, look and perform similar, if not identical to a conventionally built school and the common school learner would be none the wiser. Additionally it provides a strong, institutional look that conveys an educational image. Architectural precast concrete panels use colours, textures, reveals, finishes, form liners, or thin brick insets to match any required design style. School names, emblems, and other custom touches can be embedded into panels, creat-ing unique accents (Precast/Prestressed Concrete Institute, 2010).
- **Health & Safety** - Construction sites in general are hazardous environments. On-site construction conditions often require workers to potentially be exposed to harsh weather conditions and precarious positions near roads, hazardous protrusions, and the like (Smith, 2010). In a report by the Health and Safety Executive (HSE, 2011) on workplace fatalities and injuries in Great Britain, fatal accidents in construction were found to be almost twice more likely than in the manufacturing sector. Prefabrication reduces the amount of work that is done on-site and there-fore reduces exposure to hazards (Gibb, 1999). Transferring much of the construction programme from an open site to a controlled factory environment reduces on-site time for workers and reduces the potential for site-based accidents and ill health (Taylor, s.a.). The conditioned, dry interior environment of the factory enables responsible manufacturers to make appropriate provision for the health and safety of their workforce. Precast concrete construction can hence minimise congestion and safety concerns on site and in the general vicinity of the school premises during construction. It does, however, remain a construction method, which requires a skilled and experienced contractor. Insufficient training in the setting out and placing of the components can be hazardous, therefore a well-trained, alert team as well as a well-founded health and safety plan is required for it to be implemented optimally and safely.

DESIGN-BUILD PROCUREMENT

The procurement concept in construction has been defined in many ways, but a working definition of procurement was developed by the International Council for Research and Innovation in Building and Construction (CIB) at its symposium in 1991, defining it as 'the framework within which construction is brought about, acquired or obtained' (McDermott, 1999). This definition served a useful purpose as it is both broad, encouraging a strategic interpretation, and neutral, being applicable not only to developed, market economies. The SANS 294:2004 in addition, defines procurement as a process (i.e a succession of logically related actions occurring or performed in a definite manner), which culminates in the completion of a contract for the provision of engineering and construction works, supplies, services or disposals (SANS 294:2004).

Many varieties of procurement strategies exist such as separated, integrated and management-orientated strategies. Although prefabrication can technically be used in any contract structure, most literature is in accord that prefabrication, pre-assembly, off-site fabrication and modularisation requires some sort of integrated contract strategy approach. Integration refers to a process whereby the design and construction processes of a project are interlinked. An integrated approach is, therefore, one approach where design and construction procedures ensue concurrently. This approach has shown to benefit the whole project (Goodchild & Glass,

2004) (Luo, 2008).

In studying the effect of prefabrication on construction sequence, time and cost, Mawdesley et al. (s.a.) developed three prefabricated suited procurement routes during the course of their research:

- **'Traditional'** Construction Procurement
- **'Hybrid'** Construction Procurement
- **'Ideal'** Construction Procurement

Traditional refers to separated contract strategies where construction and structural design is not integrated, and the project team is fragmented. In the 'hybrid' process, initial structural design requires adaptation to accommodate off-site manufactured construction. There is greater cooperation between the members of the project team, although fragmentation is still evident. The 'ideal' method, however, is described as a process where all aspects of design, architecture, structure and construction are carried out in parallel, thus allowing greater integration and co-operation between members of the project team.

For these reasons an integrated approach such as design-build procurement, where the design and construction teams work in unison, can be viewed as the best suited strategy for implementing prefabrication. Furthermore, it is a strategy which the Department of Public Works is willing to explore (Willemse, 2011).

As opposed to design-bid-build, design-build projects 'reduce the overall project duration' (Grobler & Pretorius, 2002). Procurement methods such as design-build allow for early decision making regarding prefabrication systems that can lead to improved coordination and constructability, and finally reduced construction time. In addition, Songer & Molenaar (1996) found benefits of design-build in terms of cost and quality, an added benefit with prefabrication. Design-build also allows for the delivery process to potentially create a smoother flow of information between design and construction organisations. Instead of a handover method, where one group of individuals designs a facility and then simply transfers the responsibility to the next party, design-build methods can collaboratively identify prefabrication as the construction method and execute it as such (Gibb, 1999).

Moreover, some major projects have been procured successfully in South Africa by design-build in recent times (Grobler & Pretorius, 2002):

- Saldanha Steel Plant (R800 million). *(Public)*
- Techno Centre for Vodacom in Bellville *(R116 million)*.
- Prison at Louis Trichard (R300 million). *(Public)*
- Nelson Mandela Bridge in Johannesburg *(R81 million). (Public)*

These successful projects, most of which were in the public sector, provide confirmation that design-build does indeed fulfil the requirements posed by the South African Constitution for a procurement strategy and that no distinguishing actions are required.

Furthermore, school projects have features that are well-suited to prefabrication/modularisation (McGraw-Hill Construction, 2011). Classrooms allow for the use of modular room design, and these projects also benefit from faster construction schedules. The Josiah Quincy Upper School in Boston utilised design-build successfully and combined it with precast concrete (Endicott, 2000) (Smith et al., 2000). Many other case studies exist, showcasing successful implementation of prefabrication in school construction (PCI Project Study, 2006) (Buchan Concrete Solutions, 2011) (Endicott, 2003). Each case study claimed numerous advantages of which shorter schedules were most prevalent. Additionally, all the case studies share one common characteristic – an integrated approach was used, ie. design and construction proceeded in parallel. The design-build procurement route seemingly is the obvious and preferred trend when it comes to prefabricated construction.

Although design-build is well tested today, it has its problems in that it is usually architect or contractor led. The concern is that if the process is architect led, design will overwhelm values of production, and in a contractor-led model, construction will be the only consideration, finding ways to possibly reduce design features in favour of cost or schedule reductions (Smith, 2010).

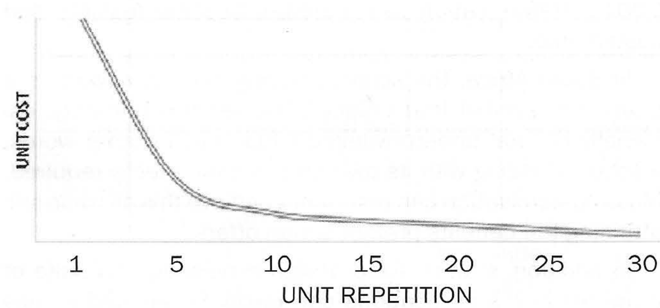

Figure 3 - Relationship between unit cost and unit repetition (standardisation) for precast concrete cladding (Gibb, 2001).

STANDARDISATION

Prefabricated components are essentially part of a manufacturing process which, similar to any factory produced product, works on the 'economy of scale' principle (Gibb, 2001). This simply means that it becomes more economical, if more are manufactured **(Figure 3)**.

In a South African market where prefabricated components are not used all that often, this is an issue. The point here is that although it is possible to construct a single school using prefabricated components, it is financially much more viable to the supplier/manufacturer if many buildings are built using their components (Taylor, s.a.). This suggests a concept of standardisation. Furthermore, standardisation and prefabrication are also considered by some as synonymous (Pasquire & Gibb, 2002). CIRIA (1997) and whilst they can be used individually, the greatest benefit is when they are used together and that benefits from advances in manufacturing industries can only be realised in construction where standardisation is accepted. The construction industry at large is dominated by numerous small and specialised subcontractors, who typically are not technologically advanced enough to embrace automation. The sector that represents factory built buildings (modular, prefabricated, panelised, precast, etc.) conversely is an exception (Neelamkavil, 2009). Therefore, since the products are built in factories, the principles of mass production and mass customisation that are the norm in manufacturing apply. Egan (1998) also argues that construction is not very different from manufacturing. He states that many buildings, such as houses, are essentially repeat products, which can be continually improved and more importantly, the process of construction is itself repeated in its essentials from project to project.

Standardisation, however, is still predominantly perceived as a repetition of components, all having similar dimensions and hence leading to a bland uniformity in the end product (Smith, 2010). This is an inherent characteristic of the mass production concept, whereby large production numbers decrease capital costs. However, this approach is unfavourable and especially so when building schools. The consumer seeks a unique solution to the situation, and therefore the concept of mass customisation comes into play.

Mass customisation combines the principles of mass production and automation to create a manufacturing process whereby standardised components can be tailored to each specific project but also addresses the need of the manufacturer for a constant flow in the production line (Gibb, 2001). Prefabrication can therefore become feasible and sustainable.

In South Africa, the school building can be viewed as a beacon or symbol that uniquely defines a community, especially in rural underprivileged situations. In other words, a school building with its own unique character is required. Mass customisation can potentially achieve this all while still attaining the benefits prefabrication offers.

In addition, standardised design consisting of a suite of drawings and specifications can easily be applied across a wide range of projects, and seen as a potential complementary solution (James, 2011). This does not mean that buildings will all look the same but rather that the designs can be tailored. The aim is to both improve the efficiency of the process of building many schools, but also to facilitate feedback into the design of education environments through periodic reviews of these standard designs, therefore reducing unnecessary design and construction costs (CELE, s.a.).

The economies of scale principle is satisfied and standard prefabricated components can therefore be manufactured or 'mass customised' in the most feasible way possible.

STRATEGIC PARTNERING

One of the principal issues identified by James (2011) in his Review of Capital Education, with the current system of school construction in the UK, is the lack of learning and systematic improvement of quality, cost and time from one school building project to another. This has been caused directly by the design and procurement process, which has resulted in most schools designs being one-off. Among the many knock-on problems that this has created are the high costs of both design and construction, variable quality, a need for every school to pass through an arduous cycle of checks and balances and no opportunity for improvement.

Moreover, Egan in his Rethinking Construction Report (1998) states that the conventional processes assume that clients benefit from choosing a new team of designers, constructors and suppliers competitively for every project they do. Instead he says that on the contrary repeated selection of new teams inhibit learning, innovation and the development of skilled and experienced teams. Critically, it prevents the industry from developing products and an identity - or brand - that can be understood by its clients.

It starts to become evident that what is required is for teams of designers, constructors and suppliers to work together through a series of projects, continuously developing the product and the supply chain, eliminating waste in the delivery process, innovating and learning from experience. Smith (2010) agrees and states that continued alliances that join for multiple projects can yield better results the second or third time around.

This can further be extended to the use of prefabrication. Smith (2010) claims that a client and contractor, who build together often, may find prefabrication beneficial because the systems that are developed may be employed in other projects. This is especially true for project teams that work together on a series of building ventures. The added benefit is that project team members also continue their relationship with the fabricator, who may or may not be the contractor, but becomes a key player in delivering the facilities. Research has suggested that performance, in terms of cost, time, quality, constructability, fitness-for-purpose and a whole range of other criteria, can be dramatically improved if participants adopt more collaborative ways of working (Bresnen & Marshall, 2000).

Consequently, a good deal of attention has been directed towards examining the issues mentioned above and as result the concept of 'strategic partnering' comes to the foreground. The most commonly cited definition for **strategic partnering** is that proposed by the Construction Industry Institute (1999):

A long-term commitment between two, or more, organisations for the purpose of achieving specific business objectives, by maximising the effectiveness of each participant's resources. This requires changing traditional relationships to a shared culture without regard to organisational boundaries. The relationship is based on trust, dedication to common goals and an understanding of each other's individual expectations and values. Expected benefits include: improved efficiency and cost effectiveness, increased opportunity for innovation, and the continuous improvement of quality products and services (CII, 1999).

Strategic partnering takes place where two or more firms use partnering on a long term basis to undertake more than one construction project (Matthews, 1999). It is generally accepted that strategic partnering relationships accrue time, cost and quality benefits on individual projects, but the scale of the benefits increase as each project undertaken profits from the lessons learnt from previous projects, ie. it allows for continuous improvement (Grajek et al., 200) (Weston & Gibson, 1993) (Bennet & Jayes, 1995).

Moreover, this concept of strategic partnering has the potential to act as the catalyst in how to combine the principles and benefits of 'standardisation' with a design-build procurement strategy. Forming a 'strategic partnership' between a client, design-build contractor and precast manufacturer is regarded as the optimal solution to the issue of implementing precast concrete construction in schools.

The 'strategic partnership' formed between the client, designer, supplier and design-build contractor after a successful open tender creates a situation that stimulates innovation. Methods and techniques can be tested with each party being fully aware of their respective roles, due to the clear lines of communication which design-build and strategic partnerships offers.

Additionally, due to not being limited to only one project, the design-build contractor carries with it experience and lessons learned from each successfully completed previous project onto the next, and so becomes more proficient, resulting in better, higher quality schools delivered in shorter periods and with increased efficiency. Systematically an industry knowledgeable and proficient in precast construction will be created.

Also, the use of precast concrete components in building projects drastically reduces the amount of work on site (Polat, 2008). According to a study by Tam (2002), there could be a 43% reduction in site labour consumption if there is a shift from the in-situ site casting to prefabrication design (Wong et al., s.a.). This factor may be an advantage in developed countries, where the cost of labour is far higher than in developing countries, but when viewed from a developing country's perspective, the use of prefabrication indirectly implies job loss (Gerrie Willemse, 2011).

Strategic partnering, however, counters this by:

1. Granting precast manufacturers a confirmed number of orders for products, who are then assured of a constant flow of income. This translates directly to an increase in both employment and job security at the manufacturing plant;
2. Awarding the design-build contractor guaranteed employment for a fixed period, which will provide job security for employees, with the potential to increase the labour force. In addition, this could result in sustained training and skills development;
3. Allowing the design-build contractor to satisfy further employment opportunities by employing local labour on each project, to complete the on-site work such as foundations, site clearance, etc. and
4. Giving the opportunity for 'Satellite' factories to be temporarily set up at the project location, which would create local employment for the community. This would create a situation where the project is done *'by the community, for the community'*.

DISCUSSION

Some barriers do exist, which could encumber the successful application of the above proposal, and negate some of the potential valuable results. These barriers are as follows:

- The extent to which precast concrete is used and is partly subject to the capabilities, facilities, expertise and skills available to the project team. Due to the scant use of prefabrication in the South African industry, specifically precast concrete, these factors might be found wanting.
- The current South African design codes and standards do not provide sufficient guidance in the design of structural precast concrete construction. This limits the extent to which it can be implemented, as insufficient technical guidance places restrictions on the designs of architects and engineers.
- For a design-build procurement strategy to succeed, a clearly defined project scope is required. The client, in this case the Department of Public Works, will need to be knowledgeable of the strategy and formulate clear project requirements by compiling an appropriate performance specification.
- The potential limitations of the thermal and acoustic properties of thin precast systems may need special attention when choosing an appropriate structural system.

The above constraints are however not impossible to address, and can be accomplished as follows:

- By repeated **instructed** use of precast concrete and prefabrication construction systems, a knowledgeable industry will eventually be created. A knowledgeable industry will demand the most efficient solution to problems, which precast concrete has the potential of being - and so create a demand for precast products. Demand will necessitate a supply and systematically a sustainable precast industry will result.
- The current design codes are in the process of being revised to a South Africanised version of the Eurocode. This code is much more comprehensive than the current SANS 10100-1 and provides ample guidance, in the use of precast concrete construction. Additional guidelines on typical details applicable in South Africa, however, may be needed.
- Through proper education about the benefits and contractual ramifications associated with a design-build strategy, the Department of Public Works, would become knowledgeable and hence understand the requirements of the strategy, and a well-defined scope should be compiled. In other words, an informed client who understands the benefits of precast construction can dictate the type of construction they require for their projects and in this way stimulate the precast industry.

CONCLUSION & RECOMMENDATIONS

The aforementioned suggestions although possible remain theoretical, due to an inherent lack of proof or data of where it was implemented successfully. Case studies do exist where precast concrete was successfully used in the construction of schools, and, furthermore, some international successes exist. However, in South Africa either there are limited or no examples showing successful partnerships on school projects.

In theory, though, this proposal is achievable and is subject solely on how innovative the client strives to be in achieving their specific goals. In a socio-economic situation such as the one in South Africa, where a large numbers of quality education facilities are desperately required, the above proposal is both logical and feasible.

However, to prove the validity and credibility of the aforementioned proposal this would require an actual 'pilot' project. The client, in this case the Department of Public Works, would need to follow for the most part the guidelines presented. Keeping in mind that the specific precast components and system and how it is utilised, remains the prerogative of the project team. The project should be well-documented, so as, to determine reasons for success or failure and so the strength of the proposal.

With its prospective advantages this could potentially pave the way for an efficient and sustainable South African precast industry.

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