COMPARISON OF PRECAST CONSTRUCTION COSTS – CASE STUDIES IN AUSTRALIA AND MALAYSIA

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In their efforts to bring about improvements in build quality and increasing construction productivity, many developing countries have suggested policies to increase mechanisation or prefabrication in their respective industries. This paper presents a strategy to optimise construction output by examining the relevant political, social and economic circumstances, and related constraints for the adoption of precast concrete technology. Case studies of precast concrete building costs in Melbourne, Australia and in Perak, Malaysia clearly illustrate the technological trade-off between capital and labour in the production function. The results indicate that the higher labour costs in Australia leads to a more economical precast solution whereas the low wages of migrant construction labour in Malaysia precludes the use of the more capital intensive precast technology. Current fiscal incentives for the adoption of industrialised building systems in Malaysia are clearly deficient. The impact of labour policy, employment of migrant labour, training, and technology is discussed to identify appropriate policies, reforms and incentives that could increase the adoption of prefabricated components into buildings and perhaps strengthen the construction industry in the long run.

Keywords: Australia, developing countries, labour, Malaysia, precast concrete.

INTRODUCTION

Many developing economies have been reported to be looking towards improving the quality of the products of construction and increasing the productivity of the sector with greater use of mechanisation, prefabrication technology and upgrading the skill of workers. Various precast concrete building systems were created in the early 1970s by construction companies in Europe and the US to cope with increasing demand for housing. High levels of precast utilisation were reported in Denmark, Netherlands, Sweden and Germany in the 1990s (Construction 21 Steering Committee, 1999).

In many countries, prefabrication is applied in the building sector to enhance productivity, improve quality, and cope with a shortage of skilled labour. However, in land scarce Hong Kong, the Housing Authority had advocated the usage of precast concrete methods since the mid-1980s and contributed to major precasting innovations in the industry. Although the Hong Kong Construction Industry Review Committee (CIRC) recommended a wider adoption of prefabrication to improve the quality and to reduce the generation of construction waste, Jaillon and Poon (2009) reported that the private sector still relies heavily on cast in-situ methods of construction involving the use of timber formwork, in-situ concreting, substantial amount of wet trades and bamboo scaffolding. In the same article, Jaillon and Poon reported major advances in

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precast construction techniques involving volumetric and modular precast elements, and large increases in number of precast elements used in public housing projects. It is interesting to note that incentive schemes were required to encourage the private sector to promote the use of prefabrication such as prefabricated non-structural external wall in the Joint Practice Note 2 (Government of Hong Kong, 2002).

Similarly, precast concrete was introduced in the early 1980s in Singapore, and have resulted in volumetric precast elements being used to provide additional space to existing high rise apartment blocks for the Public Housing Upgrading Program. The main driver for adopting prefabrication technology was to reduce Singapore’s dependence on foreign labour and technology through increased construction productivity. Given the many technical and social constraints of operating in a highly built-up environment, Lau and Tay (1996) reported that prefabrication has improved the efficiency and cost effectiveness of concrete construction while at the same time minimise disruptions for their upgrading programs.

A survey on the use of precast concrete systems in Turkey and the US (Polat, 2010) indicated that American respondents considered restrictions on transportation, poor communication, and the lack of qualified specialised contractors as the three most important barriers to the extensive use of precast concrete systems in the US market. On the other hand, Turkish respondents ranked poor communications amongst parties and the lack structural engineers and specialised contractors as the most important factors in Turkey. Polat suggested that the cost of exploiting labour-intensive methods of construction may be much lower than the cost of implementing advanced technologies such as precast concrete systems in a developing country.

Precast concrete construction in Australia took off in the 1990s when designers and building owners realised that the economics and speed of construction of precast walls and floors were favourable compared to conventional in-situ systems. Benefits of precast flooring such as the long-spanning ability to eliminate conventional concrete beams and therefore the need for formwork during construction was recognised early (National Precast Concrete Association Australia, 2009). Reports of cost savings of 10% of the structure costs by using precast walling and flooring were common.

The objective of this study is to analyse the proportion of labour and capital as inputs to the construction sector, and aim to identify and recommend appropriate policies and reforms that could strengthen the construction sector in developing economies. The paper will examine the cost structure of precast and conventional methods of construction in Australia and Malaysia, and review the extent to which the supply of low wage migrant workers in Malaysia affects the choice of technology for the construction of buildings.

This study approaches the determination of an appropriate technology by examining an isoquant map of changing quantities of labour and capital at which the same quantity of output is produced. An isoquant map shows the extent to which a construction firm has the ability to substitute between two different inputs at will in order to produce the same level of output.

APPROPRIATE TECHNOLOGY

In economics, production refers to the process of converting of inputs into outputs. For example, the process of construction can be defined as the conversion of raw materials such as timber, concrete and steel into a building suitable for habitation or for other human activities. The inputs or resources used in the production process are called factors of production. Possible inputs for construction may be grouped as follows: materials, machinery, labour, capital goods, land and entrepreneur. The role of the entrepreneur here is to combine the other factors of production in order produce a building, and to make a profit.

When evaluating options for constructing a building, a mix of inputs may be employed in production. An isoquant (see Figure 1) relates the quantities of one input to the quantities of another input. It indicates all possible combinations of inputs that are capable of producing a given level of output. Isoquants are typically drawn as capital-labour graphs, showing the technological trade-off between capital and labour in the production function. This corresponds to the employment of labour or the use of machinery in a construction activity. For example, point A in figure 1 indicates a high amount of capital and a low amount of labour for a given output. Point B on the other hand indicates a lower amount of capital and a higher amount of labour for the same output.

Isoquants are typically convex to the origin reflecting the fact that the two factors are substitutable for each other at varying rates. Adding one while holding the other constant eventually leads to decreasing marginal output. Isoquants are typically combined with isocost lines in order to solve a cost-minimisation problem for given level of output. These isoquant maps will be utilised to illustrate the choice between conventional methods of in-situ concrete construction with precast concrete methods where labour is substituted with concrete components prefabricated in a capital intensive manufacturing facility.

Ganesan (1994) showed that for economies with a surplus of labour, employment maximization was the key to achieving optimal construction output. This employment maximization objective resulted in the promotion of labour-intensive techniques. While adopting a labour intensive technique may achieve a 10-15% gain in the total employment in the sector, the choice of technology would also depend on the total volume of investment or the projected growth of the sector in terms of construction demand. In countries where it is difficult to recruit and manage labour, construction firms may find the utilisation of machinery over labour to bring about cost savings and to earn greater profits. A technology should be considered appropriate if it represents a combination of resources, processes and techniques most likely to satisfy the social and economic goals of the construction sector.

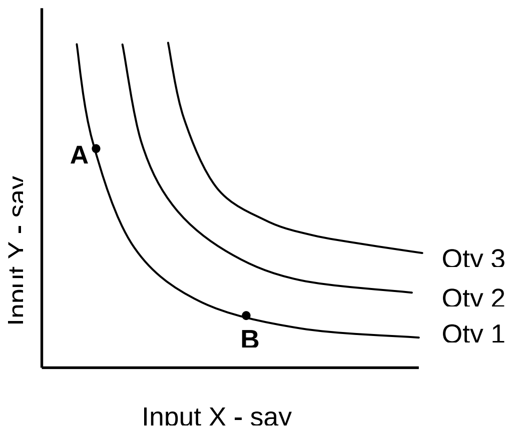

Figure 1 Isoquant map showing three isoquants each representing a different quantity of output

CASE FOR PREFABRICATION

Primarily, the objective of precast technology or prefabrication in general is to enhance productivity at project, company and industry level, reduce construction time, reduce wastage and improve quality. In many developing countries, it may be proposed as one of a suite of strategies for the construction industry to adopt advanced systems and technologies to enable construction companies to penetrate global markets and export professional services and construction expertise. The introduction of greater mechanisation and prefabrication was also proposed in developed countries to improve the performance of their respective construction industries (NAO, 2001)

In 1999, the Malaysian government initiated a program to introduce prefabrication methods into the construction industry with the aim of improving productivity, quality and safety. An eight-year road map to drive the adoption of industrialised building systems (IBS) in order to reduce cost, improve quality and reduce the dependence on migrant labour was introduced in 2003 (CIDB 2003). The main IBS systems proposed include pre-cast concrete, advanced formwork system, steel framing systems, prefabricated timber frames, and block work systems (such as interlocking concrete masonry units). Key targets to be achieved include a gradual reduction of the percentage of migrant workers in the construction industry from the existing level of 75% in 2003 to 15% in 2009, and to increase utilisation of IBS from 30% of total public housing in 2004 to 70% in 2008. Financial incentives such as the abolition of a 0.25% levy on low, and medium cost houses, and a 50% levy reduction for building incorporating more than 50% IBS components were announced in 2003. In 2005, buildings with at least 50% IBS components were exempted from this levy altogether to further encourage adoption of IBS components.

A survey carried out in 2003 indicated that the utilisation of IBS in building construction was extremely low at approximately 15% (Shaari, 2003). Earlier efforts by the government to encourage greater mechanisation in the industry have not gained traction as the construction companies continue to practice conventional methods of in-situ construction.

METHODOLOGY

Based on the review presented above, the case for promoting pre-cast technology in a developing country is obvious and has been proven in many instances to bring about immediate gains in productivity, shorter construction periods, improved quality and safety performance, and in numerous cases a reduction in cost. There is clear evidence to indicate that the concept of a greater productivity with large-scale precast buildings can be achieved in Malaysia (Lai, 2005).

Two case studies were conducted by Yong (2010) to examine the input costs for pre-cast building projects in Malaysia, a developing country and Australia, one of eight highly industrialised countries as defined by the OECD. The projects were selected based on availability of suitable projects at the time of the study and as such are not to be interpreted as representative of the cost of pre-cast construction the their respective locations.

Case Study in Melbourne, Australia: a three-storey residential building

In a case study on a residential building in Melbourne which utilised precast prestressed hollow core planks with precast prestressed inverted-T beams, Yong (2010) identified a number of significant cost differences between pre-cast concrete versus a conventional in-situ reinforced concrete solution. The building at Octavia Street in the suburb of St.Kilda include a single level basement and two above ground levels providing a total built-up area of 1,154 square metres. The walls were also precast concrete panels. A cost estimate of the structure was obtained from the builder for the supply and installation of all the precast components. In order to compare this prefabricated system with a cast in-situ option, an alternative post-tensioned slab and beam system was worked out and costed based on cost indices published in Rawlinsons (2010). The purpose of adopting a post-tensioned band beam and slab option was to ensure that the same column and beam layout could be used for both the precast and the post-tensioned systems.

Case Study in Perak, Malaysia: a four-storey student hostel

A number of hostel blocks were proposed for an institute of higher learning in the state of Perak, Malaysia where the builder was obligated to construct 4 blocks with the use of precast components while the remaining blocks were to be constructed with conventional in-situ technology. Each hostel block provided a total area of 3,088 square metres of floor space. As both precast and in-situ construction methods were to be employed, it was possible to obtain construction drawings and cost estimates for both these modes of construction. A reinforced concrete structural frame was the proposed structural form with a slab and beam arrangement. The walls were all in clay brick with cement render on both faces. In comparison, the proposed prefabricated system was precast columns, inverted-T beams supporting hollow core precast prestressed planks.

COMPARISON OF PRODUCTION COSTS

The precast system of hollow core planks and inverted-T beams work out to be approximately AU$416 per square metre and a large proportion of this cost is attributed to the manufacture, supply and transportation of these precast components to the building site. Site labour and machinery (cranes were the largest single cost item) constitute only a quarter of the total cost as shown in Table 1 below. The cost of the walls have been omitted to ensure comparability with the Malaysian case study. In comparison, the post-tensioned in-situ slab and beam option would cost approximately AU$539 per square metre; a 30% increase over the precast solution. This is mainly attributed to a higher material cost and doubling of the on-site labour cost. The cost for crane rental was similar due to the requirement for higher capacity cranes for lifting the precast components compared against lower capacity cranes for a longer duration for the in-situ option.

The project in Malaysia worked out to cost RM250 per square metre for the cast in-situ option with reinforced concrete slabs, beams and columns. (The exchange rate between the Australian Dollar and the Malaysian Ringgit is AU$ 1.00 = RM 3.20. Source: Reserve Bank of Australia, April 2011.) This conventional construction method necessitated the deployment of a large of number of workers to fabricate and install sawn timber formwork and timber props to support the fresh concrete. In comparison, a fully precast solution with hollow-core slabs and planks, beams and columns, cost RM411 per square metre, an increase of more than 60% over the cost of the cast in-situ concrete. The supply cost of the precast components is more than double the supply cost of materials and forms for the cast in-situ option as shown in Table 1. The reduction in site labour from RM59 to RM23 per square metre does little to mitigate this large increase in material supply cost.

The results indicate two important observations in the cost structure: (a) the supply of precast components is cheaper than the supply of materials and forms in Melbourne where as the supply of precast is more than double the cost of materials and forms in Malaysia, and (b) the cost of site labour for cast in-situ construction is double that of precast construction at both locations.

Table 1: Comparison of construction costs in Australia and Malaysia

Case Study Items	Australia Unit cost (AU$, %) (per sq.m)	Malaysia Unit Cost (RM, AU$, %) (per sq.m)
Precast System (Slab and Beam)	AU$ 416 (100%)	RM 411, AU$ 129 (100%)
- Manufacture and Supply of Materials	AU$ 302 (73%)	RM 360, AU$ 113 (88%)
- Site Labour	AU$ 63 (15%)	RM 23, AU$ 7 (6%)
- Crane Rental	AU$ 51 (12%)	RM 28, AU$ 9(7%)
In-situ P/T or RC Suspended Slab and Beam	AU$ 539 (100%)	RM 250, AU$ 78 (100%)
- Supply of Materials and Forms	AU$ 356 (66%)	RM 175, AU$ 55 (70%)
- Site Labour	AU$ 126 (23%)	RM 59, AU$ 18 (24%)
- Crane Rental	AU$ 56 (11%)	RM 16, AU$ 5 (6%)

Manufacturing Costs

Yong (2010) attempted to examine the differences in manufacturing cost by comparing the costs for cast in-situ slabs in Australia and Malaysia as shown in Table 2. It is evident that the supply and installation of formwork is a significant portion of the total slab cost in Australia, to the extent that it exceeds the material cost for the slab. The cost of formwork is the main driver for the push towards greater use of precast components. In Malaysia, the supply and installation of sawn timber formwork cost approximately RM 7, or 12% of the total cost of a suspended reinforce concrete slab.

Table 2: Cost comparison for cast in-situ slab construction

	Unit cost (per sq.m)	Cost Break down (%)
In-situ PT Suspended Slabs (Australia, AU$)	AU$ 243	
- Supply and fix concrete, steel and PT system	AU$ 90	37 %
- Supply and fix formwork	AU$ 153	63 %
In-situ RC Suspended Slabs (Malaysia, RM, AU$ equiv.)	RM 53 (AU$ 17)	
- Supply and fix concrete and steel	RM 47 (AU$ 15)	88 %
- Supply and fix formwork	RM 7 (AU$ 2)	12 %

Labour Costs

The cost differences in the two case studies may be explained by the vastly different wage structure in the two countries. The construction labour force in Australia is predominantly local and highly skilled, attracting premium wages. In contrast, the construction labour in Malaysia consists of migrant workers from neighbouring countries, often working illegally and unregistered, and earning a pittance as unskilled workers. Table 3 shows the differences in daily wages for both skilled and unskilled workers. Note that the daily wages in Australia does not include the additional cost to the employer such as superannuation, annual leave, allowances, and rostered days off. There are no compulsory contributions for legally employed migrant workers in Malaysia. The presence of these migrant workers in large numbers naturally put downward pressure on the wages for local workers in the same industry. Skilled local workers tend to migrate to higher income economies such as Singapore, Hong Kong and Japan.

The high daily wages for the tradesmen in Australia contributes to the high cost of formwork construction as this process is very labour intensive. On the other hand, the low wages in Malaysia contributes directly to the lower cost of conventional construction methods with cast in-situ concrete. This observation confirms the assertion by Shaari (2003) that construction firms in Malaysia have continued to adopt labour intensive practices due to the availability of cheap migrant labour instead of investing in plant and equipment for the manufacture of prefabricated components.

Table3: Daily wages for construction workers (Fair Work Australia 2010, CIDBM 2009)

Worker Level	Reported Daily Wage
AU-CW Level 1(new worker)	A$ 115 (573.00 per wk)
AU-CW Level 3 (certified tradesman)	A$ 128 (637.60 per wk)
AU-CW Level 9 (tradesman level II)	A$ 150 (750.40 per wk)
MY-General CW (Foreign)	RM 50 (AU$ 16)
MY-General CW (Local)	RM 60 (AU$ 19)
MY-Skilled CW (Foreign)	RM 100 (AU$ 31)
MY-Skilled CW (Local)	RM 150 (AU$ 47)

ISSUES AND RECOMMENDATION

These case studies have identified two methods of construction where two resources; labour and technology (or capital) are interchangeable. Pre-fabrication technology is widely adopted in Australia to reduce its reliance on labour whereas migrant labour is brought into Malaysia to maintain low construction costs and indirectly cause an over reliance on labour intensive practices. Firms operating in these economies have obviously chosen an input bundle that costs as little as possible in each location.

Labour policy, employment and skills training for local workers

The Malaysian government had been encouraging the influx of a large number of construction workers from Indonesia and Bangladesh to support the local construction industry as the local labour force was reluctant to work in the construction industry – labelling it as dirty, dangerous and difficult. This labour policy has the effect of keeping construction labour at an extremely low wage rate compared to other sectors of the economy employing local indigenous labour. Although the deployment of migrant workers has its associated social issues, an attempt by the government to reduce the number of workers from Indonesia in 1998 brought the industry to a near standstill and the government had to reverse its decision due to pressure from developers and construction firms (Abubakar, 2002). Economists believe that if Malaysia had not allowed the massive influx of migrant workers, local construction firms would have been forced to innovate, automate to boost productivity to maintain their competitiveness so that these firms could move up the value chain.

It has been acknowledged (New Straits Times, 2006) that the migrant workers remit a large proportion of their wages back to their home countries and cause a substantial outflow of the local currency; a total of RM7.6 billion in 2005. The situation is further exacerbated by the fact that most of the migrant construction workers are unskilled workers and are required in large numbers due to their lower productivity. The short-term nature of their work visa does not encourage their employers to send these workers for skills training preferring instead to repatriate them when work is scarce. The over-reliance on migrant workers is linked to the reluctance of local workers to be trained and to work in the construction industry. Although six training academies were established with a capacity to provide skills training to local construction workers for 14,000 trainees per year, only 2,000 trainees were undergoing training at these facilities in 2002. Few actually gained employment within the industry, citing poor working conditions (New Straits Times, 2002).

Construction technology and the introduction of Industrialised Building Systems

The Malaysian construction industry had faced cyclical pressures of growth and crunches over the last 30 or 40 years and in the mid-2000s experienced shrinking outputs in real terms due to various economics pressures as the economy transformed from a manufacturing base to a services-led economy. Other structural issues in the construction industry such as the long-term nature of the technology development and the short-term project-based orientation of contractors complicate the decision by construction managers to invest in technology.

Although IBS has been proposed in the mid-1990 as the means to reduce reliance on labour and to increase productivity and quality by the government and industry groups, this proposal remains as a rhetoric with little progress achieved over the last 20 years. Despite exhortations by the Master Builders Association, a body representing the majority of the construction firms in Malaysia, not many construction firms have reported implementing IBS components in their projects preferring instead to construct using the most economical means. Their actions clearly indicate that IBS methods have not been able to achieve a better value compared to existing construction technology and cheap migrant labour.

A survey of architects and engineers in Malaysia (Shaari, 2003) has indicated that many designers are not fully aware of the potential benefits of prefabrication or are insufficiently trained in the application of prefabrication techniques in their designs. Although the technology has been available in the domestic market since the 1980s, there has been very little growth in the demand for prefabricated components, with the demand arising predominantly from low-cost high-volume medium-rise housing units. This has also led to an impression by the public that prefabrication is mainly used for volume housing and to a resistance by property owners to purchase any prefabricated buildings. Local designers have also expressed a reluctance to re-work designs that have been developed based on an in-situ approach to cater for prefabrication as their fees have been put under severe pressure in recent years.

Quality of prefabricated components

An important consideration in the issue of capital-for-labour substitution is that prefabrication usually provides for better quality control of the finished product. Prefabrication has often been regarded as the solution to cope with the shortage of skilled labour in many instances. Preliminary investigations into the productivity of IBS construction in Malaysia by Lai (2005) seem to suggest that the increased productivity with prefabrication was readily achieved in some cases but the quality of prefabricated components remained in doubt. The issue of quality in this capital vs. labour balance will be the subject of a separate in-depth study.

Incentives for IBS

Since the introduction of the Construction Industry Development Act in 1994, all registered construction companies must pay a levy of 0.25% of the value of the contract price for projects exceeding RM500,000 in value. This levy was intended to support the continuing development of the industry by the provision of skills training and investments in research and development. The levy was reduced to 0.125% in

2003. To encourage the adoption of IBS components in buildings, the government exempted the 0.125% levy on buildings with at least 50% IBS components. There had been various reports from construction firms that the use of IBS components will cost 15-20% more compared to conventional methods, not including the initial investment in plant and machinery (New Straits Times, 2004). In comparison, the removal of the 0.125% levy may not be sufficient to offset the cost of utilising IBS components and will hardly stimulate greater IBS usage.

Contrary to earlier government projections, recent reports (New Straits Times, 2009) have indicated that the number of migrant construction workers in Malaysia remained at 320,000 and that wet trades are still predominant in the industry. The adoption rate of IBS for government construction projects was at 70% although the government has mandated in 2007 that all government projects have to utilise IBS components.

CONCLUSIONS

The two case studies have illustrated the technological trade-off between capital and labour in the production of concrete buildings. Construction firms in a developed economy with high labour wage rates can easily opt to increase capital input and decrease labour input to minimise costs. On the other hand, construction firms in a developing economy with access to cheap migrant labour can choose to keep construction costs down by utilising greater labour inputs.

The cost comparisons clearly indicate that the choice of inputs for construction is market driven, and that financial incentives to increase the adoption of prefabricated components must be coupled with a reduction in the supply of cheap migrant labour. This labour policy of engaging cheap migrant labour in Malaysia has the effect of keeping construction labour at an extremely low wage rate, discourages the entry of local workers into the sector, results in a net cash outflow via remittances, and with their large numbers creates numerous social problems.

The financial incentives offered by the government to the construction firms were not sufficient to overcome the higher investment cost of prefabrication systems. Additional measures to increase the volume of prefabrication may include the assurance of a sustained demand for prefabricated components for public projects, greater awareness and cooperation amongst designers and construction firms on the benefits of prefabrication, and viable fiscal incentives for capital investments.

REFERENCES

Abubakar, S. Y. (2002) Migrant Labour in Malaysia: Impact and Implications of the Asian Financial Crisis, East Asian Development Network, Kuala Lumpur, Malaysia.

Construction Industry Development Board Malaysia (CIDBM) (2003)\ Industrialised Building Systems (IBS) Roadmap 2003-2010, Kuala Lumpur, Malaysia.

Construction Industry Development Board Malaysia (CIDBM) (2009) Upah Pekerja Binaan, Jan 2009 (in Malay), Kuala Lumpur, Malaysia.

Construction 21 Steering Committee (1999) *Re-Inventing Construction*, Ministry of Manpower and Ministry of National Development, Singapore.

Fair Work Australia (2010), *Building and Construction General On-site Award 2010,* Australia.

Ganesan, S. (1994), “Employment maximization in construction in developing countries”, *Construction Management and Economics*, **12**, 323-335.

Government of Hong Kong (2002), *Joint Practice Note 2: Second Package of Incentives to Promote Green and Innovative Buildings*, Buildings Department, Lands Department and Planning Department, Hong Kong.

Jaillon, P. (2009), “The evolution of prefabricated residential building systems in Hong Kong: A review of the public and the private sector”, *Automation in Construction*, **18**(3), 2239-2248.

Lai, K. W. (2005), *Construction labour productivity study for conventional cast in-situ and precast construction methods*, Master of Science thesis, Malaysia University of Science and Technology, Malaysia.

Lau, J.M, and Tay, L. (1996), “Precast Concrete – Solution of choice for upgrading public housing in Singapore”, *PCI Journal*, 12-22.

National Audit Office (2001), *Modernising Construction,* The Stationery Office, January 2001, London, UK.

National Precast Concrete Association Australia (2009), *National Precaster*, **53**, August 2009, Australia.

New Sunday Times (2002), *Skills training for Indon workers if locals shun jobs*, 29 Mar 2002

New Straits Times (2004), *Stand on your own*, 18 Sep 2004

New Straits Times (2006), *Foreign labour dilemma*, 25 Sep 2006

New Straits Times (2009), *System to halve foreign labour*, 20 Mar 2009

Polat, G. (2010), “Precast concrete systems in developing vs. industrialized countries”, *Journal of Civil Engineering and Management*, **16**(1), 85-94

Rawlinsons (2010), *Rawlinsons Australian Construction Handbook 2010*, Rawlhouse Publishing Pty Ltd, Australia.

Shaari, S. N. (2003), *IBS Survey: Survey on the Usage of Industrialised Building Systems (IBS),* Malaysian Construction Industry, Construction Industry Development Board, Kuala Lumpur, Malaysia.

Yong, T. N. (2010), *Feasibility of Precast Concrete Construction System in Malaysia: A Comparative Study between Australia and Malaysia*, Research Project Report, The University of Melbourne, Ausatralia.