4.3 VALUE CHAIN ISSUE GROUP

By Aruna Pavithran
Lucis Pty Ltd for The Warren Centre

Executive Summary

Steel-framed construction has a much lower share of the multi-storey construction market in Australia than it does in the US or UK. This assessment was conducted to understand steel-framed construction for medium-rise commercial buildings in Australia and where there might be opportunities to improve it. The medium-rise market was selected by the Steering Committee as a sizeable market with good potential for growth in steel usage.

A case study approach was adopted to produce an empirical and factual analysis, in the style of an internal benchmarking analysis. The small sample assessed – four steel-framed buildings and one concrete-framed building – show no systematic effect in the use of a structural steel frame on overall construction outcomes when compared with a similar concrete-framed building. The case studies show a range of steel-framed construction outcomes: some that are more cost- and time-effective relative to concrete, some that are similar and some less. The findings contradict a fundamental perception held in the market that steel framing is consistently more expensive and difficult to implement.

The analysis for the assessment was conducted in three parts:

Cost

Three of four steel-framed cases studied were less expensive per square metre of Gross Floor Area (GFA) than the concrete comparison. Where steel was less expensive, detailed cost analysis showed that structural steel added 6–13 per cent of Total Construction Cost to the relative cost of a frame, and saved 7–12 per cent of Total Construction Cost in preliminaries and wages compared to the concrete case study, summing to little or no effect on relative cost in each case. This suggests the additional costs in steel framing were saved in people-related site costs.

Time

Analysis of construction time showed no observable relationship between the use of steel or concrete framing and the time efficiency of construction. It also showed that the use of techniques such as the 'jump-start' do not always result in a comparatively faster time to completion. With consistent affirmation from project managers of the speed of steel-frame erection and jump-starts, this suggests that the benefits of these strategies are not fully realised in practice.

Risk

Issues considered to be common difficulties in the use of structural steel, such as long lead times, had no observed impact on the value chain. Of the realised risks observed in the case studies, the greatest source of 'normal' risk in the construction value chain is in the way the builder chooses to program erection. This is referred to in this report as Building Proposition risk, and encompasses builder competencies such as the sequencing of tasks, the use of process innovations and the choice of suppliers. Of the proportion of these risks attributed to the accuracy and reliability of the steel supply chain, perceived risks were much greater than actual risks realised.

As well as these findings, various characteristics contributing to the performance of the construction value chain were noted. First, not one of the cases observed was completed on the original completion date, showing a remarkable tolerance for unpredictability in timeliness in construction in Australia. This tolerance extends to variations, where steel framing is considered unviable due to its unresponsive supply chain. In fact, only 'structural variations', such adding a stairway, are more difficult with steel framing, whilst other variations that are unviable in concrete are achievable in steel.

The case studies also showed builders create contingencies in construction budgets by up to 5 per cent of total, to allow for possible additional or unforeseen costs that cannot be recouped under a typical fixed price contract. Any difference between these contingencies and the final cost overrun effectively constitutes a 'builder's reward' over and above their imputed profit margins of 4–6 per cent (in these case studies). Interfacing between steel and other construction activities arose as an area of difficulty, and estimation does not favour innovation in construction processes or materials.

The opportunities identified in the construction value chain are founded on reducing the risk burden to the builder and releasing the contingencies held in construction budgets. The first of these opportunities is repackaging the construction process into risk-minimising components. This strategy involves placing the risk where the skills exist to best handle it (e.g. making riggers/fabricators responsible for interfacing steel columns with the slab) and may not work where dramatic variations or highly aggressive timeframes will be tolerated. Using web-enabled collaborative planning will create a more transparent information environment and aid the seamless collaboration required to reduce the builder's risk burden. Finally, the measures currently used to gauge construction performance, e.g. floor cycle time, are not always directly related to value chain outcomes. Industry-wide measurement for performance is strongly recommended to create more visibility and focus on value chain performance.

For the steel industry, a focus on creating a highly responsive supply chain for structural steel will reduce the perceived and actual risk in steel supply. In this context, the responsiveness required is the swift delivery and installation of the correct product to site where a 'structural variation' is incurred. Addressing this aspect of the supply chain will improve the overall performance of steel supply in construction.

But, why change? The issues affecting value chain performance identified in this assessment are largely known and tolerated across the industry, at an estimated cost of up to 5 per cent of turnover (i.e. up to $3 billion of the $57 billion commercial construction industry). The true opportunity forgone in this status quo is effective process innovation and the opportunity to reallocate productive resources, at an incalculable cost to the Australian industry. Ultimately, it is up to the leaders of industry to decide in favour of transformational change.

A more extensive study, assessing a larger number and spread of buildings, is recommended to validate the findings in this report.

Introduction

Steel-framed buildings comprise a much smaller proportion of the construction market in Australia compared to the US and UK. A survey conducted by The Market Intelligence Co in 2005 quotes steel frame usage to be 13 per cent of commercial multi-storey construction in Australia, compared to 50 per cent in the US and 70 per cent in the UK. It was not clear, at the outset of this project, why the Australian construction industry and its decision-making developers preferred concrete to steel. Several contributing factors were nominated by experienced members of the construction industry:

- shortage of skills – both availability of skilled workers, such as architects, consulting engineers, shop detailers and steel fabricators, and quality of skill base
- more expensive when costed – i.e. that the same floor plan would be more expensive constructed in steel than concrete
- more expensive in construction – i.e. that variations and rectifications associated with steel frames were more expensive than concrete.

These issues had not been factually evaluated for their impact on the construction experience. Furthermore, there had been no assessment of other inefficiencies in the process of construction and their impact in the use of steel frames. It was the goal of this project to determine where there could be more value realised in the process of construction of steel-framed buildings, and to suggest some ways that the steel industry might help in realising that value.

It is important to note that the promotion of steel framing, or a critique of concrete framing, was not the objective of this project. Rather, a fact-based understanding of the current issues in steel-framed construction was the primary goal of this assessment.

Assessment approach

Construction is characterised by the involvement of many parties, each with a focus on a different aspect of the ultimate goal – a completed building. Indeed, the process of construction employed for any given building depends on the unique configuration of the design, site, the experience of the main parties and their choice of subcontractors to execute the work, to name but a few. Thus, the construction of a building has many hundreds of variables which may be assessed for their incremental contribution to the success of the process. For example, the choice of a jump-start, or the use of mobile vs tower cranes, each has an impact on the time and cost of the project, as well as knock-on effects to many other activities.

To simplify the task of determining the important variables in the construction process, a consultative approach was adopted. First, a Value Chain team was assembled, comprising senior and experienced members of the steel and construction industries (See Appendix C). This team confirmed the dimensions of cost, time and risk as being the most critical outcomes of the construction value chain.

The approach adopted for this assessment was designed to allow a robust factual analysis of the construction process while catering to time and resource constraints. An empirical approach was chosen, in the style of an internal benchmarking study, using the actual construction experience of five case studies: four steel-framed buildings and one concrete-framed building. Selection criteria were employed to make the cases as comparable as possible to each other:

- recent, i.e. completed within the past three years
- medium rise commercial[5], i.e. 5–10 storeys
- Metropolitan location
- closely connected to an initiative team member, to allow ease of data gathering.

The five buildings were chosen by the Value Chain team and are described in Appendix A: Case study descriptions. They are referred to in this report as Building W, Building X, Building Y, Building Z and Concrete comparison.

This assessment focused on the 'notable outcomes' of each case study in terms of time, cost and risk. These notable outcomes were largely identified through discussion with each building's project manager, and included major variations and rectifications, process innovations, specific delays or problems experienced on site and high-cost or unusual design items. Further notable outcomes were identified by comparing the time, cost and risk experiences of each case study, thus identifying unusual circumstances for which causes could be investigated.

The small sample size means that insights drawn from this study are unable to be extrapolated across the whole industry. Furthermore, as each building is unique, it is difficult to draw direct comparisons between their value chains, despite the efforts to select case studies as similar as possible.

The analysis and findings presented in this report allow for known differences between the buildings and their construction processes wherever possible. The caveats in the analysis methodology are also balanced in part by the contribution of the Value Chain Group. This Group assisted in the interpretation of information and analysis over several sessions during the course of this assessment. The consultative process has enabled a practical interpretation of the information gathered from the case studies and some confirmation of the findings arising from analysis of the data.

The views and findings presented in this report are solely of the author, and should be treated as indications of the value chain experience in construction in Australia. This is a useful yardstick for consideration by the leaders of industry, insofar as the results of even this small sample contradict perceptions held in both the construction and steel industries.

5 Medium rise commercial construction was chosen as a sizeable market where steel framing poses a viable alternative to concrete. ABS figures from 2003 show that office buildings were the largest source of construction turnover at 19 per cent of total. Of these, 42 per cent were for buildings less than $5 million value, and 20 per cent between $5 million and $20 million.

The Construction Value Chain

The value chain perspective presents a componentised view of the construction process. Each component or value chain step is defined to show the addition of incremental value towards the output of the whole process, which for construction is a completed building.

The benefit of a value chain perspective for this assessment was in aggregating the contributions of the many participants in construction into a manageable number of value-adding steps. This allowed the quantification of the effort (i.e. time, cost, risk) required at each step, compared with the value achieved at its conclusion.

The definition of the construction value chain used in this assessment is described in Figure 1.

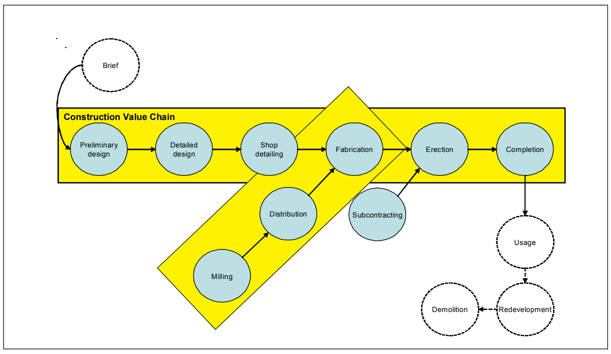

Figure 1: Construction Value Chain

Table 1: Value Chain steps

Value Chain step	Activities	Participants
Preliminary design	Drawings for submission to council Development approval (DA)	Architects Owner/developer Estimators, either inhouse to developers or third party Possible consultation by builder, engineers and fabricator
Detailed design	Engineering drawings	Architects Consulting engineers Possible consultation by builder and fabricator
Shop detailing	Steel detailing	Detailer
Fabrication	Steel fabrication	Steel fabricator
Erection	On-site fabrication Excavation/foundation Frame Finishes Fitout Façade	Builder Subcontractors
Completion	Handover Cost recovery	Builder Owner/developer

Findings

The findings of this assessment are presented in three parts. The first part covers the quantitative assessment of the relative impact of the use of steel frames in construction. Following this is a discussion of some key characteristics of the construction value chain as noted in the case studies. The third part outlines broad action areas that, based on the previous findings, are likely to realise significant benefits for the participants of the construction value chain.

The quantitative part of the assessment shows there is no systematic difference on total construction cost in the use of steel frames or concrete frames. The case studies showed that time in steel-framed construction could be better or worse than concrete, although there is some suggestion that the time advantages of steel were not fully exploited in the cases studied. Total risk in the value chain is also unaffected by the use of steel frames, although where there was perceived risk associated with steel, higher costs were incurred to manage them.

These findings run counter to commonly held beliefs in the construction industry. A more extensive study, covering a larger number and spread of cases, is recommended to validate the findings presented here. As the findings stand, they seem to indicate that the method of construction chosen by the builder and other participants of the value chain is the most important contributor to value-chain performance (i.e. cost- and time-effective within tolerable risk).

4.3.1 IMPACT OF FRAME MATERIAL ON THE VALUE CHAIN

Cost: No systematic cost difference between steel and concrete frames

Comparing value chain costs of the case studies yields some insight into the relative cost proposition of concrete and steel frames. In order to remove differences of building size from the data, a measure of Total Construction Cost (TCC)[6] per square metre of Gross Floor Area (GFA) was used. The results show three of four steel-framed buildings are less costly than the concrete-framed comparison. This appears to contradict a common perception that steel-framed buildings are necessarily more expensive than a concrete-framed equivalent.

6 Total Construction Cost has been defined as all costs of construction as well as any rectifications and cost overruns.

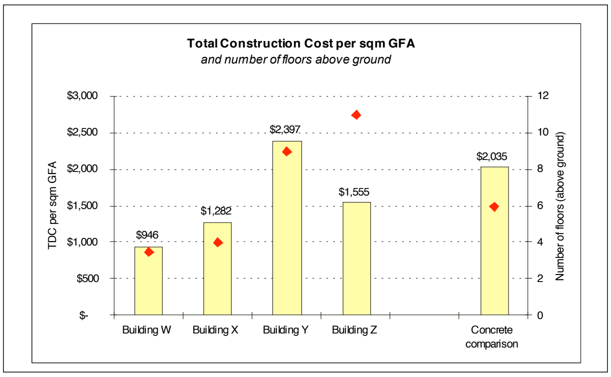

Figure 2: Value chain cost comparison

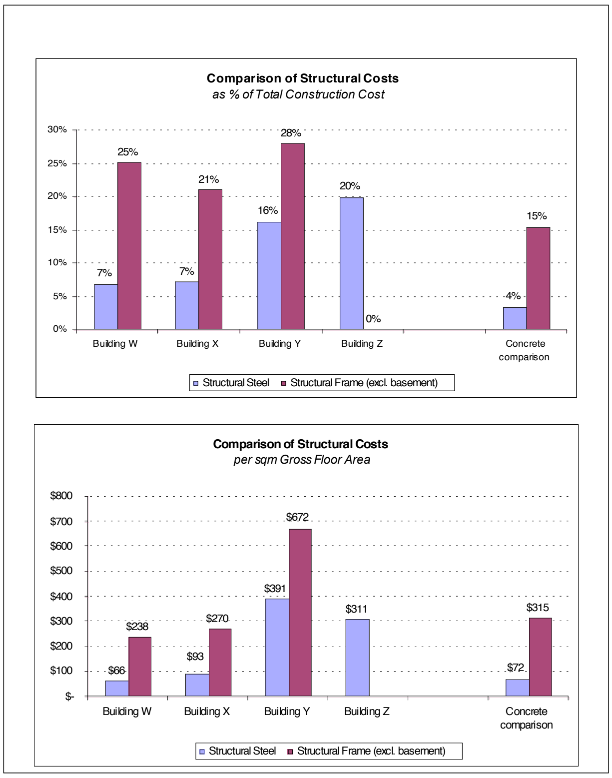

Figure 3: Comparison of Structural Costs as % of TCC

Further analysis, as illustrated below in Figure 3, shows that the structural steel building frames[7] contributed to 21–28 per cent of TCC. The concrete-framed case study shows a structural frame cost of 15 per cent of total development cost, which is lower than all the steel-framed examples. However, per unit cost comparisons show the opposite result, in that two structural steel-based building frames are significantly less expensive per square metre of GFA than the concrete comparison[8].

7 'Structural frame' has been defined here as all the structural steel (which includes reinforcement) and labour, plus concrete slabs and formwork. It does not include the cost of the basement, ground floor slab or roof.

8 The other two steel-framed case studies incurred major structural rectification and planned variation costs respectively, which may explain some or all of the excess per unit costs.

THE Warren CENTRE
FOR ADVANCED ENGINEERING

STEEL –
FRAMING THE FUTURE

The University of Sydney

Project Report

Co-published by
The Warren Centre for Advanced Engineering
Engineering Link Building J13,
University of Sydney NSW 2006 Australia
www.warren.usyd.edu.au

SYDNEY UNIVERSITY PRESS
University of Sydney Library
www.sup.usyd.edu.au

Sydney University Press
Fisher Library F03
University of Sydney
NSW 2006 AUSTRALIA
Email: info@sup.usyd.edu.au

ISBN13 978-1-920898-45-8

Printed in Australia at the University Publishing Service, the University of Sydney

ACKNOWLEDGEMENTS

This project received substantial funding from:

- AusIndustry's Industry Co-operative Innovation Program
- BlueScope Steel
- OneSteel

And tangible in-kind support from:

- Lucis
- The Australian Steel Institute
- Minter Ellison Lawyers
- Evans and Peck

The project was only possible due to the commitment of a number of individuals and organisations in particular:

- Sandy Longworth, Project Champion
- Peter Thompson, Visiting Fellow
- Richard Barrett, Visiting Fellow
- Brian Mahony, Project Manager
- Geoff Winter, Project Initiator

Members of the project management team and team leaders:

David Ansley
Trevor Gore
Reg Hobbs
Chris Humphries
Andrew Marjoribanks
Robert Mitchell
Aruna Pavithran
Dick Prince
David Ryan

An Australian Government Initiative
AusIndustry

CONTENTS

ABOUT THE WARREN CENTRE FOR ADVANCED ENGINEERING

The Warren Centre for Advanced Engineering is the leading Australian forum for advanced engineering issues, recognised for its inclusive, forward-looking approach and the wide impact of its many achievements.

The Centre is a self-funding, independent, not-for-profit institute operating within the Faculty of Engineering at the University of Sydney, controlled by representatives from industry and elected by the University's Senate.

It has three principal objectives:

- to stimulate the application and further development of new engineering technology.
- to encourage the integration of innovation and engineering technology into the development of Australia's public policy and wealth creation.
- to provide independent comment and advice to government and industry on these and related issues.

The Warren Centre:

- identifies and supports major projects that bring together people at the leading edge in selected fields of engineering technology to develop new technical insights and knowledge in those technologies and accelerate their application in Australian industry.
- holds industry forums for companies in specific industry segments to explore opportunities of common or joint interest that will accelerate the development and/or exploitation of technology.
- organises events such as seminars, lectures and conferences that explore contemporary technology issues and disseminates the results of the Centre's activities.
- produces electronic and printed material to promote discussion and build awareness of contemporary, advanced engineering issues.
- recognises people and projects that make a unique contribution to encouraging excellence and innovation in all fields of advanced engineering.

Since opening in 1983, the Centre has gained wide recognition for its unique approach and its achievements in diverse fields of engineering technology and industry development.

THE Warren CENTRE
FOR ADVANCED ENGINEERING

Engineering Link Building J13
Sydney University NSW 2006
Telephone: +61 2 9351 3752
Facsimile: +61 2 9351 2012
Internet: www.warren.usyd.edu.au
E-Mail: warrenc@eng.usyd.edu.au