AUSTRALIAN STEEL INSTITUTE

AusIndustry ICIP Report
Task Brief #3 Cost Modeling

PROJECT OUTLINE

Steel framing in Australia has been a minority selection behind post tensioned concrete (PT) and reinforced concrete (RC) as a frame option in multi level construction. In high rise residential because of the short spans, reinforced concrete has predominated and in the longer spans beyond 8m post tensioned concrete has been in favour. Composite steel framing is the preferred framing method in many developed countries worldwide but has not taken hold in Australia beyond a small percentage primarily due to perceptions on cost, risk and difficulties in understanding and costing the fire protection needs.

In recent times the steel share has increased from 3 to 13% and the emergence of the Steel Contractor model has provided a vehicle for the value proposition elements to be taken to market. This has resulted in a number of high profile examples of steel framing including Latitude East and the Macquarie Bank building in Sydney and the Southern Cross towers and Lonsdale street in Melbourne.

This project seeks to provide some clarity around the cost effectiveness over a continuum of steel vs PT concrete in a low to medium rise building so that the steel fabricators can understand pricing and their competitiveness at any point in time. Its secondary purpose is to provide Quantity Surveyors with market based fabricated steel pricing so that they will be more accurately informed.

This report sets out the results of the study of the comparison of two identically spec'd holistic steel and concrete framed buildings. The concrete building is an existing building in the metropolitan area of Sydney.

No additional foundation requirements were allowed for with concrete as it was built on Sydney sandstone base. This is a disadvantage to steel as often considerable additional cost is incurred for concrete in this area. The design was reworked by the architect and designers to produce a fully specified steel framed building. The façade was not considered in the design as it was considered common to both designs. Apart from this the buildings were fully designed taking into account the structural requirements, foundations, services. The concrete building utilized a Bondek non composite decking system as it was considered the most competitive option at the time.

The preliminary costs were broken into variable costs and fixed costs so that the effect of the greater speed of construction of steel could be calculated. Being a 4 story building the greater speed of steel framing was limited and would be amplified for additional stories.

The fully costed models were then aggregated into an Excel cost model to summarise key elements and compare the overall effect of costs of steel vs concrete.

ACKNOWLEDEMENTS

This study funded jointly by the ASI and the AusIndustry ICIP program is a result of commissioned services of Rider Lovett Becknell Quantity Surveyors, Arup Engineers and Cox Richardson Architects. Thanks are given for the generous support of Damien Judge RLB, and Anthony Ng, OneSteel Manufacturing in particular and Peter McDonald, Arup and Nick Tyrrell Cox Richardson for their generous allocation of time.

OBJECTIVE **(from ICIP Task Brief)**

To have a working model that demonstrates relative costs of PT concrete vs Composite Structural Steel framing for a medium rise commercial building.

To be able to monitor relative system costs at a high level by inputting costs of labour, steel , concrete etc as costs move in the market place.

To disseminate this information within the steel fabrication industry and in the market

DELIVERABLES

Working cost model including a mechanism for taking into account speed of construction.

Interface with AIQS and their standard measures process

Communication on outputs

EXECUTIVE SUMMARY

A low to medium rise building was selected as suitable for this cost modeling exercise as this constituted the target market as determined by the ASI Steel in Buildings Marketing Committee. A recent 4 story existing PT concrete building was selected for this study. Contractors, Rider Lovett Bucknall, QS, Cox Richardson, Architect and Arup Engineers were employed to establish the alternative design in steel with OneSteel Manufacturing providing the base design and drawings for Arup to finalise.

The model provided a base for which initial quantity surveyor file information could be used to understand what data is available to Quantity surveyors in the market.

Secondly by updating with fabricator information a relative comparison of steel framing vs concrete could be provided. In fact the relative cost comparison of steel vs concrete was tracked by state to show little difference in costs in the eastern states and SA with a small jump in WA. Concrete prices varied more widely by location, however.

This model is proving useful as a tool to inform the fabricators interested in steel in multilevel buildings on the relative competitiveness of steel vs concrete for this building type.

It is also proving invaluable as a mechanism to inform the Australian Institute of Quantity Surveyors AIQS on current cost data.

The results generated in late ‘07 proved conclusively through the eastern states and in Adelaide that steel was typically competitive with concrete. In all cases studied steel was roughly cost equivalent with concrete , however adding in speed of construction this cost equality was bised toward steel as the most cost effective option.

This competitive edge was eroded however with the succession of steel increased over ‘08 until steel was typically non compeditive with concrete in this model. Subsequent to this steel prices have started to fall significantly and it is anticipated that the competitive situation will return.

THE STEEL DESIGN

The Building

- The building in this study represents a typical low rise commercial building in a metropolitan area industrial estate. The building is representative of best practice in industrial estate development. This generic design presents a structural steel frame solution for a new 4 storey office building, providing commercial Grade A space of approximate NLA of 8000m^2. The four office levels (namely ground, first, second and third) and roof are suspended, and each extend over approximately 2000m^2.
- 200 m^2 of centralised compactus area is provided on each of the office levels.
- A double height foyer is formed by the omission of any slab at First directly above
- The internal area at Ground incorporates a 150m^2 area of set downs within the slab for foyer finishes and a central wet areas; the remainder floors have 80m^2 set downs areas located centrally between cores for the wet areas.
- A large plant enclosure of approximately 300m^2 is designated at the roof.
- The building is air conditioned with a chilled beam system
- The building has been designed to meet a 5 star AGBR rating under the Australian Building Greenhouse rating scheme and also a 5 star under the GBCA rating scheme.

Details of the steel design:

- Loadings: - Office Area 2036 sq m per floor - Live Load: 3kPa (reducible) - Additional Dead load: 1.5kPa
  Compactus: 10kPa (no reduction) - Slab: 120mm re-entrant deck - normal weight concrete 2400kg/m3
- Floor Vibrations: AISC/CISC Murray Method for offices.
- Building is fire engineered so that no passive protection is needed on the beams. - Columns 2 hr protected with fire spray or encasement.

Structural Form

- All structural framing is provided using hot rolled steel (i.e UB, UC, CHS, RHS) – special fabricated structural members are not required. There are no specialised or complicated fabrication methods required for the frame.
- The foundation to the building has not been considered in this study; if a basement is not provided, a ground bearing slab, a foundation raft, or similar can be substituted at Ground, and the associated framing should be omitted from the material take off.
- The building’s 12.5 x 8.4 m grid offers an 8.4m span (longitudinal) primary beams arrangement, which in turn support secondary beams spanning 12.5m span (laterally) at 2.8m spacing.
- In order to counteract deflection of the steel beams under their ‘construction condition’ (i.e. prior to them developing composite action with the slab), the composte beams are precambered where required.
- Where possible the beams are designed to act compositely with a 120mm deep slab, which is cast on a continuously spanning re-entrant steel deck, by the provision of through-deck welded studs and mesh reinforcement.
- The direction of the steel deck toughs are parallel with the primary beams and as such, the dimensions between the stud centres are able to be closed or opened as appropriate to maximise

the steel member size and to optimise the appropriate number of studs. The studs to the secondary beams are placed within the troughs to the decking which spans parallel to the beam.

- Floor to floor heights are typically 3.7m; all columns are founded at 3m below the Ground
- The building is serviced by chilled beam cooling. Beams supporting Roof, Third, Second and First host an extensive arrangement with over 100 web penetrations per level to accommodate the ductwork's reticulation within the ceiling's service void within the depth of the floor beams. There are no requirements for web penetrations to Ground supporting beams.
- The web penetrations are rationalised into just 4 types, and their design have been iterated with close attention to the balance between final choice of beam section vs floor to floor heights vs the requirement for a non- stiffened web penetration
- Close integration with the mechanical duct design results in just 2 beams per floor being provided with bottom flange notches
- Cast in plates have been designed for the connection between the reinforced concrete cores and intersecting steel beams. Each floor has specific requirements for the plates' positioning, with 15 to 20 plates per level being required. L bar reinforcement is provided between the core walls and the composite slab. A drilled 'flexible' fin plate is site welded to the cast in plate and the supported beam's web is drilled match the fin plate.
- Cantilevering slab edges provide a column free façade on the lateral ends of the structure. This is possible by having the canilevr primary beam extend through the CHS supporting column. The portion of the column above and below the beam is welded to the beam, effectively being delivered as one assembly. The CHS columns bolt between these assembelies at every level on site.
- Beam to beam connections are provided by drilled 'flexible' fin plate welded to the supporting beam. The supported beam's top flange is notched and its web is drilled match the fin plate.
- Beam to column connections are also provided by drilled 'flexible' fin plates welded to either the column's flange or web. When connecting to the column web, the supported beam's flanges are notched for fit.
- The remainder UC columns are only spliced once above level, at a suitable level so as to be useful within an appropriate mansafe system during erection. The section size of the column alters to a more economic section above the splice.
- A façade system's secondary framing is not included within the Generic Design, however appropriate loading has been allowed for in the design for a façade to be vertically supported on each level's perimeter edge beams.
- Building is fire engineered and sprinklered so that no passive protection is needed on the beams. - Columns 2 hr protected with fire spray or encasement.

ENGINEERING DETAIL

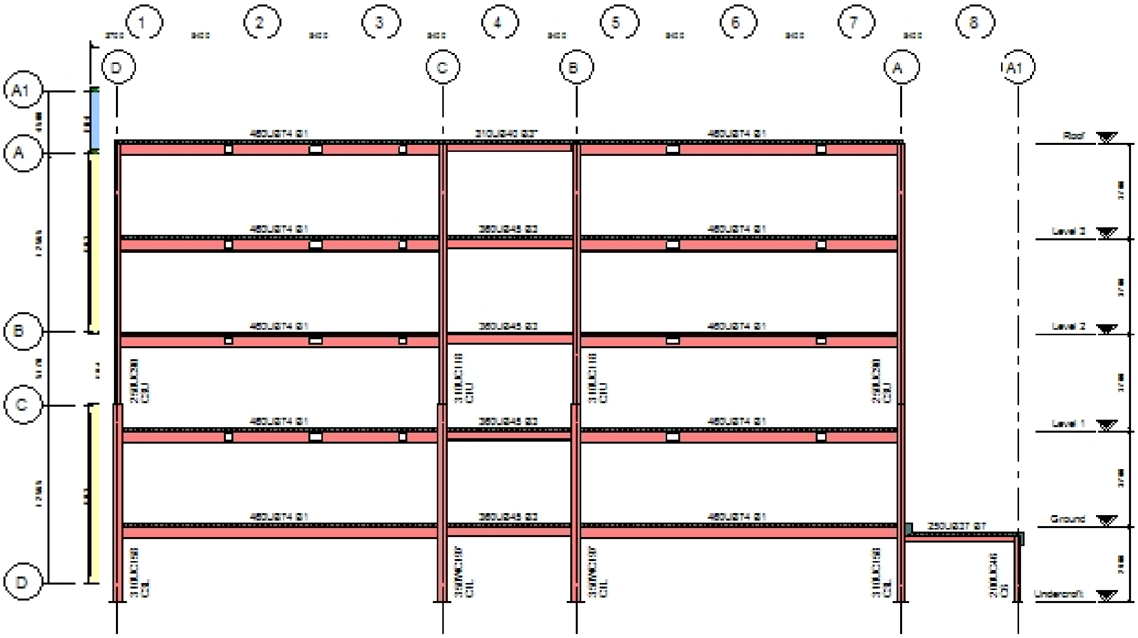
The Generic Design of the structure is to conform to AS4100 & AS2327.1.
All steel is typically Grade Onesteel 300PLUS. The 508CHS columns are Grade 250.
All cambers are to be linearly precambered.
Through deck welded studs are 19mm diameter x 100mm (95mm after welding)
All bolts to be M20 8.8/s
Slab to be 120mm overall, on a 1.0mm Bondek re-entant steel deck; normal weight 32Mpa concrete

(2400kg/m^3) with SL82 mesh.

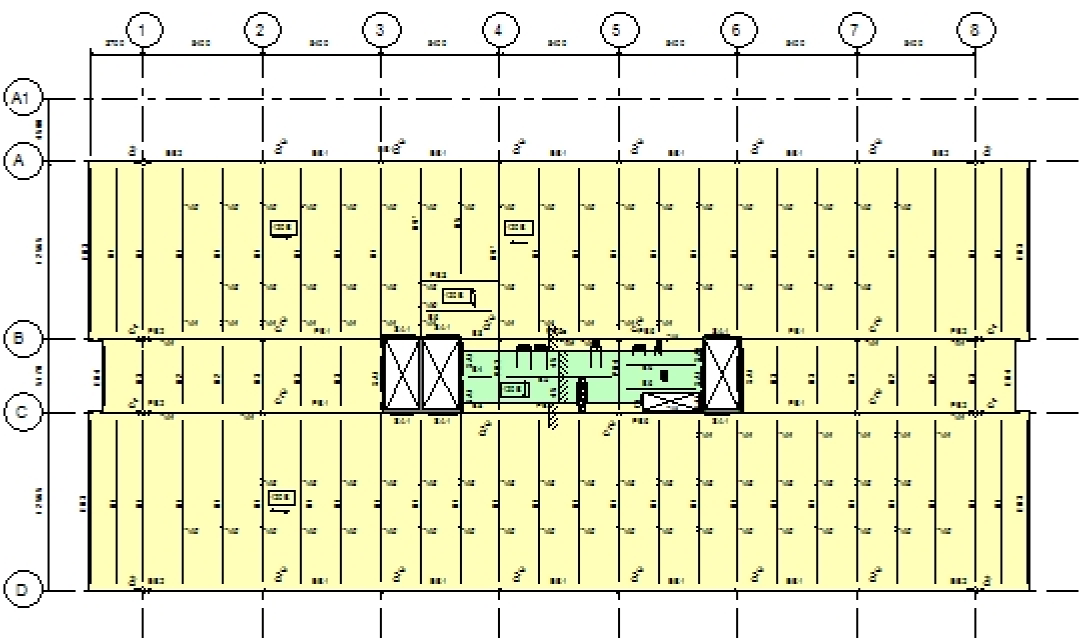
Loading		
Area/Description	**Superimposed Dead Load (kPa)**	**Live Load (unreduced) (kPa)**
Offices Partitions Ceiling/services (under L1)	 1.5	3.0 -
Compactus	0.5	10.0
Foyers	15	5.0
Toilets	3.5	2.0
Ground floor external	5.0	5.0
Roof – plant area	1.5 + 40mm topping	7.5
Roof – normal	0.5 + 85mm topping	2.0
Façade loading		2.0 kN/m each level
Construction loading	Construction loading during in accordance with AS2327.1	

Beams and Slabs Serviceability limits		
	Deflection limit under total load	
Element	**Spans**	**Cantilevers**
Beams and slabs		
Generally	L/250	L/125
Supporting masonry	L/500	L/250

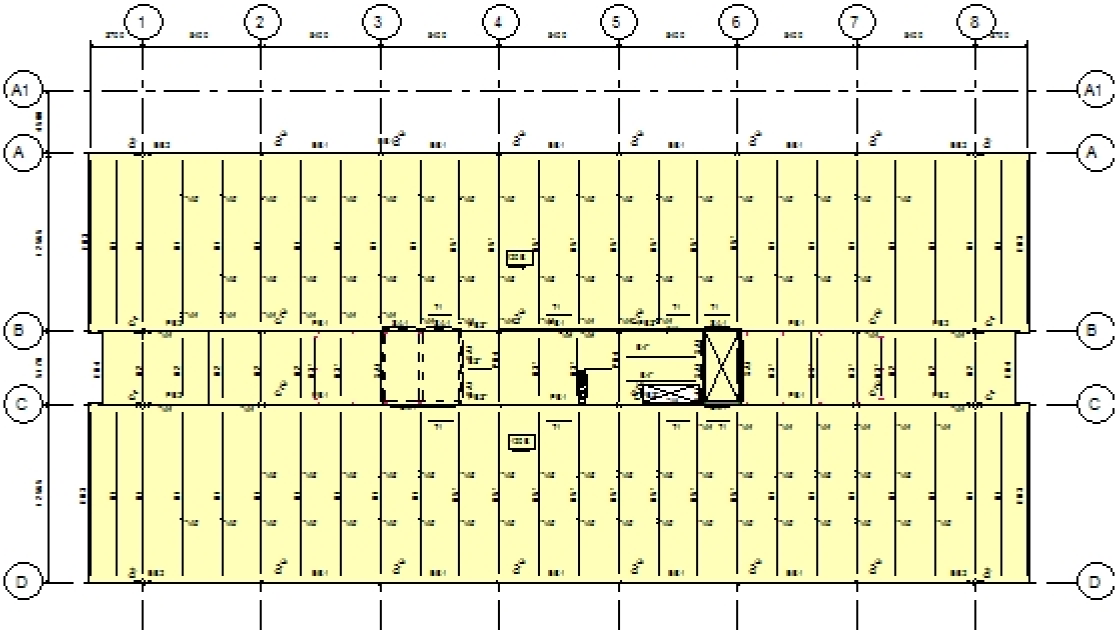
Engineering Detail - Plan View



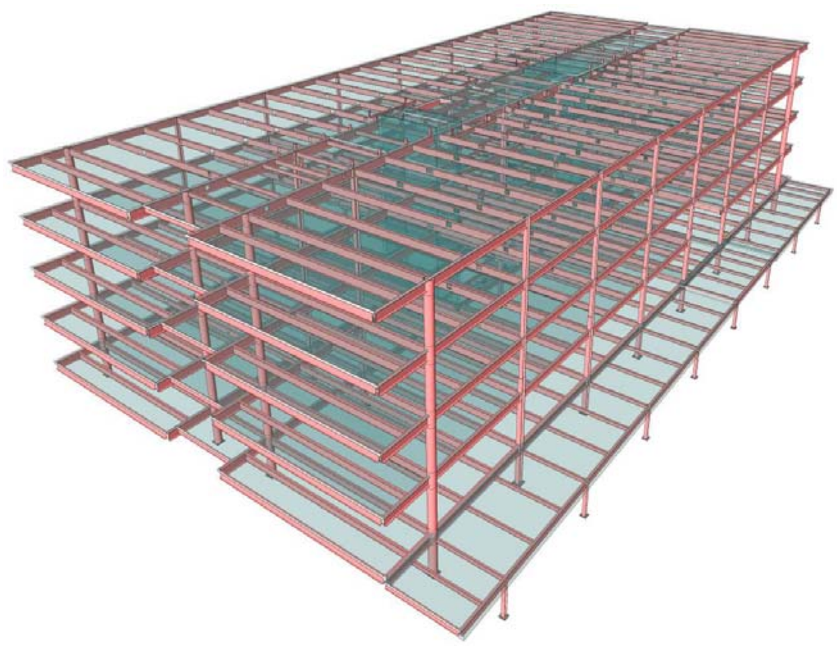
Ground Floor Framing - Structural Plan



1st Floor - Framing Structural Plan

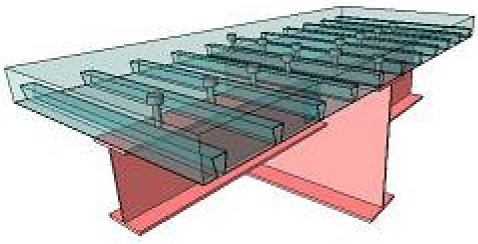


Roof Framing - Structural Plan



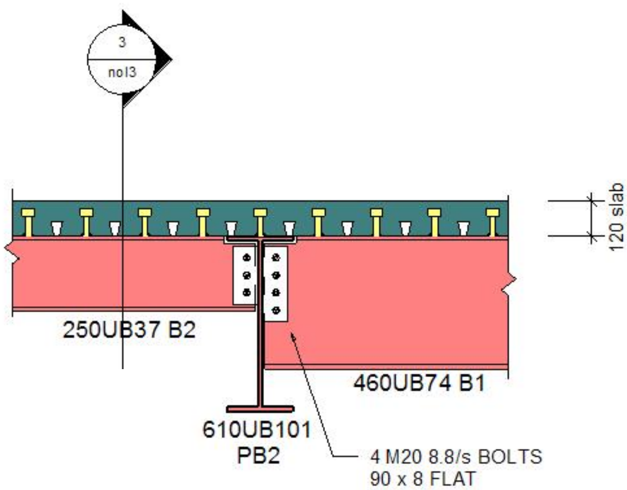
Schematic of Steel Frame

Showing basement level and four stories of commercial office space. This building provides a total area of 8000 sq metres predominately column free floor plates of approximately 2000sqm. It includes a ground floor lobby and car parking for 196 cars including 3 on street spaces for couriers.



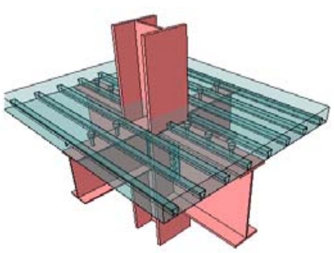
Floor Zones (1)

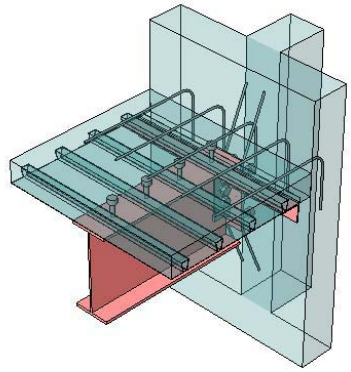
Composite beam and slab showing Bondek deck, studs , primary beam and secondary beam connections.



Floor Zones (2)

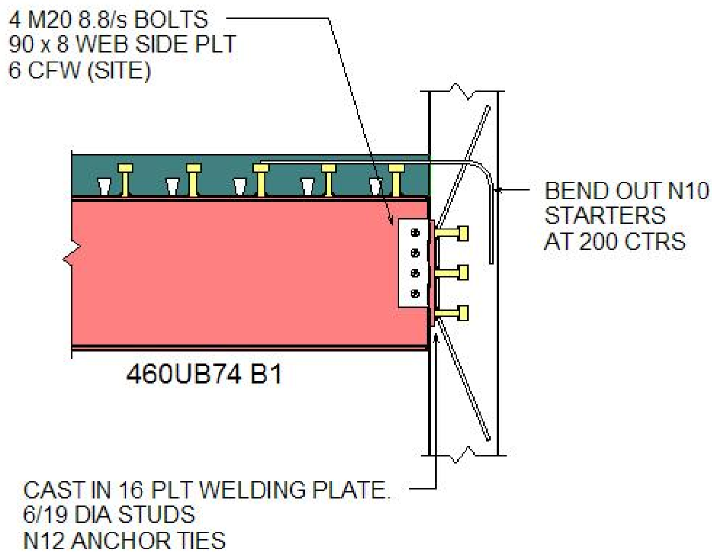
Deck and bolted primary to secondary beam connection detail





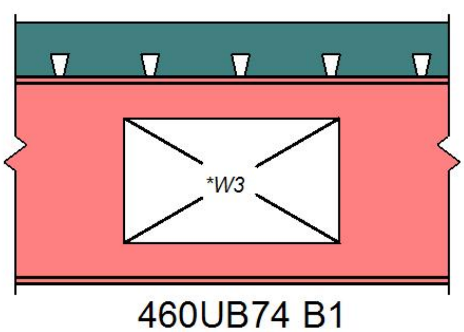
Floor Zones (3)

Connection into core showing reinforcing configuration



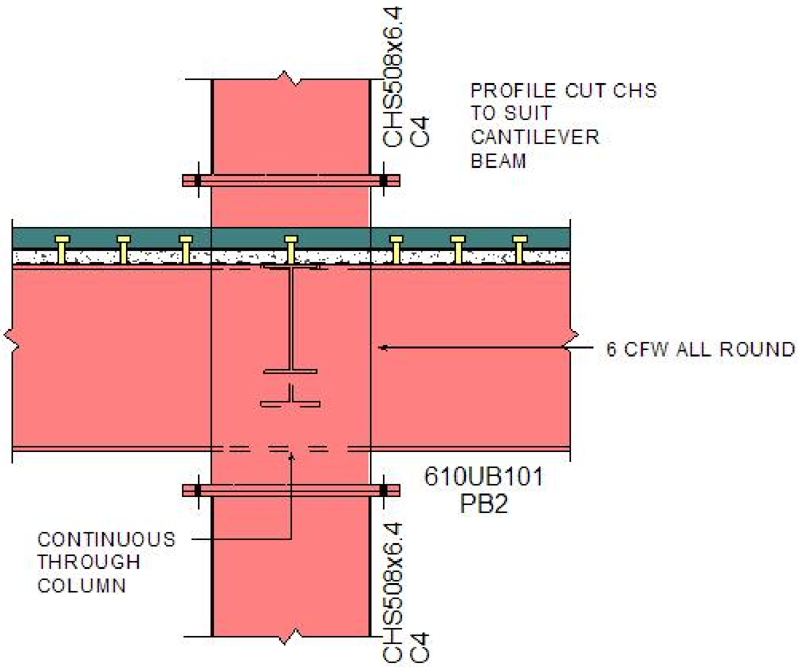
Floor Zones (3a)

Composite beam and slab showing bolted connections to column



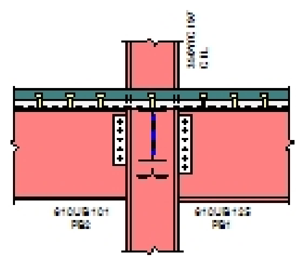
Unreinforced Penetrations

(typical to primary beam)

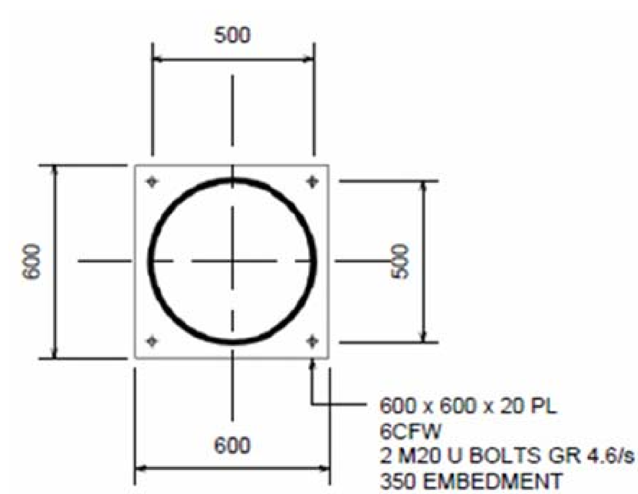


Column Splicing Detail

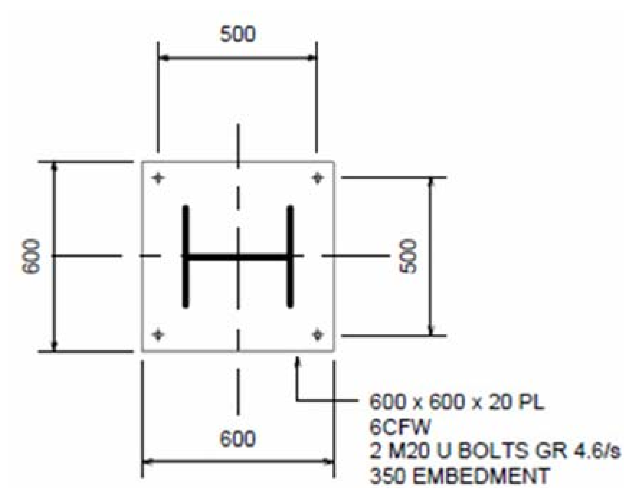
CHS 508mm sq x 6.4mm wall showing primary beam penetration through column and splicing detail of the vertical tubular column



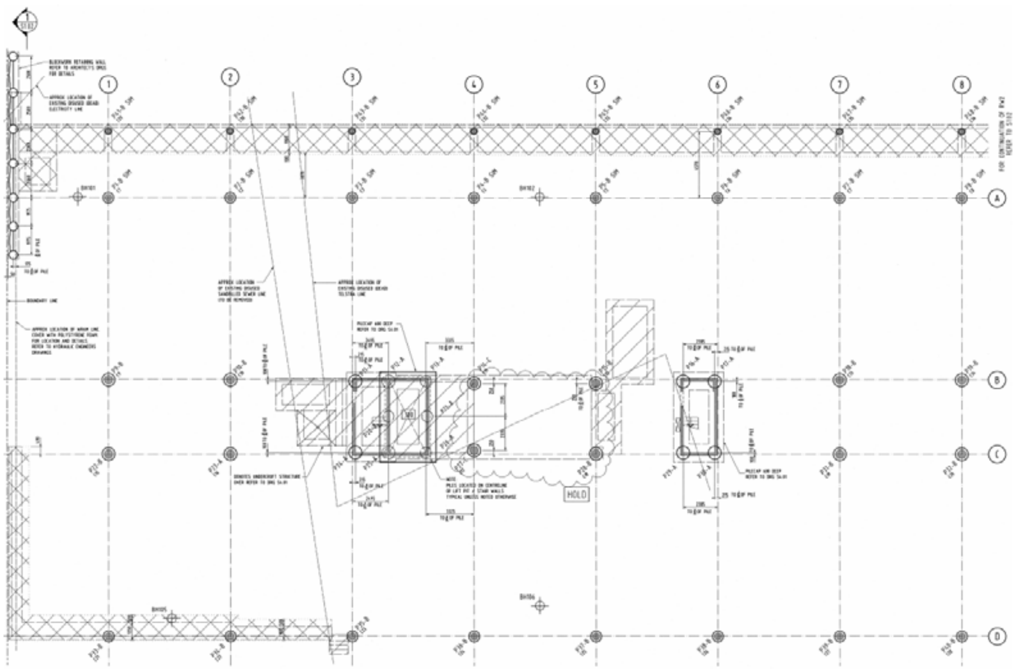
Holding Down Bolt Detail for CHS Column



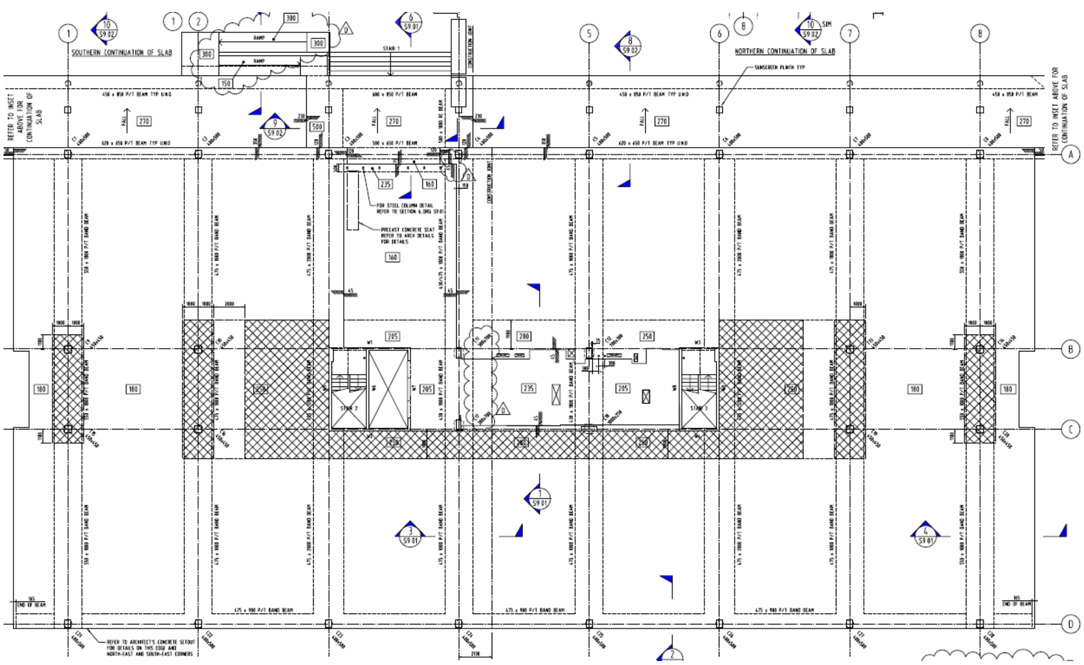
Holding Down Bolt Detail for UC Column



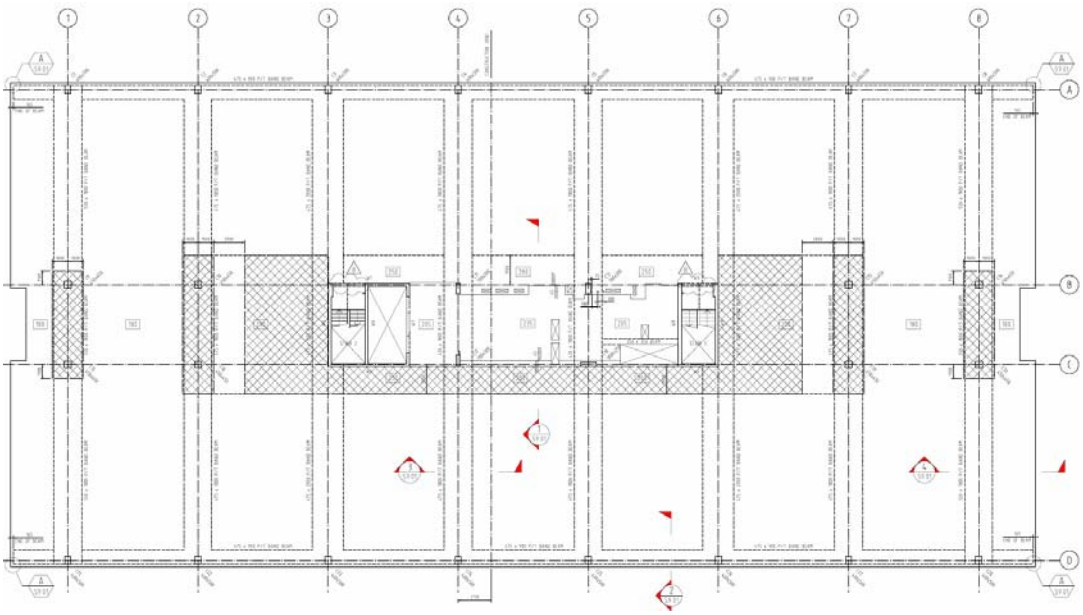
The Concrete cost detail including foundations, ground floor, basement, and upper floors has been obtained from Rider Lovett Bucknall based on recently compiled costs from completed and tendered projects.
Aspects of the concrete design are as follows;



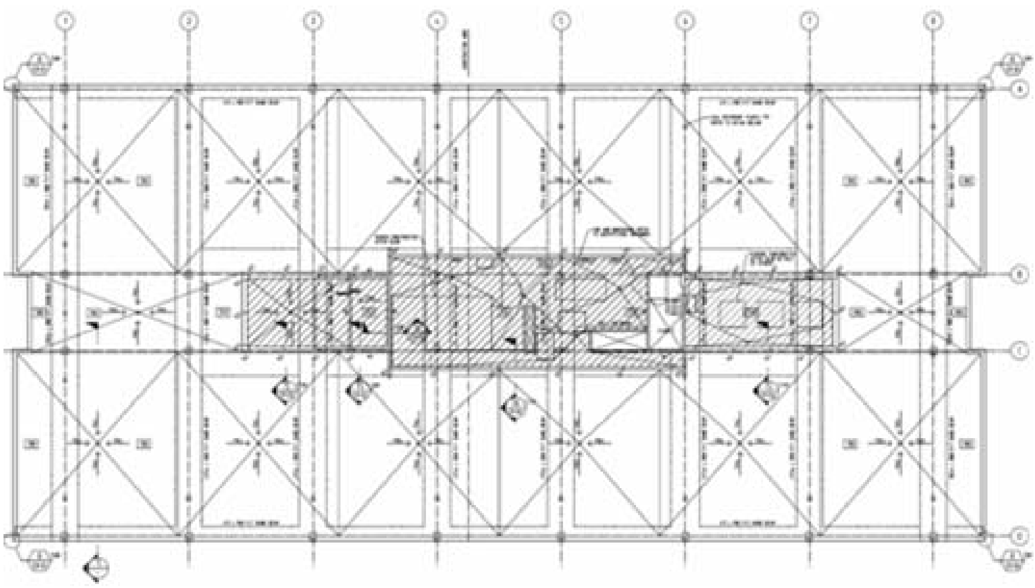
Foundation and column layout



Ground floor layout

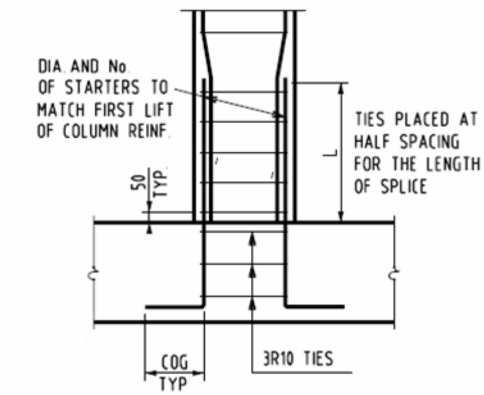


Levels 2 and 3



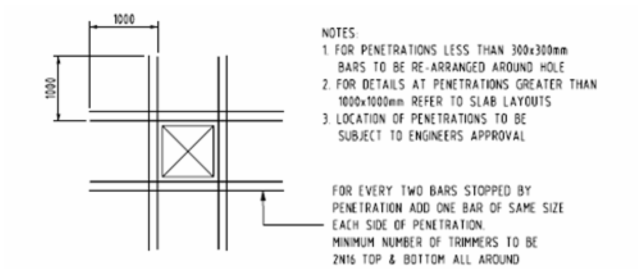
Roof Layout

Typical Details

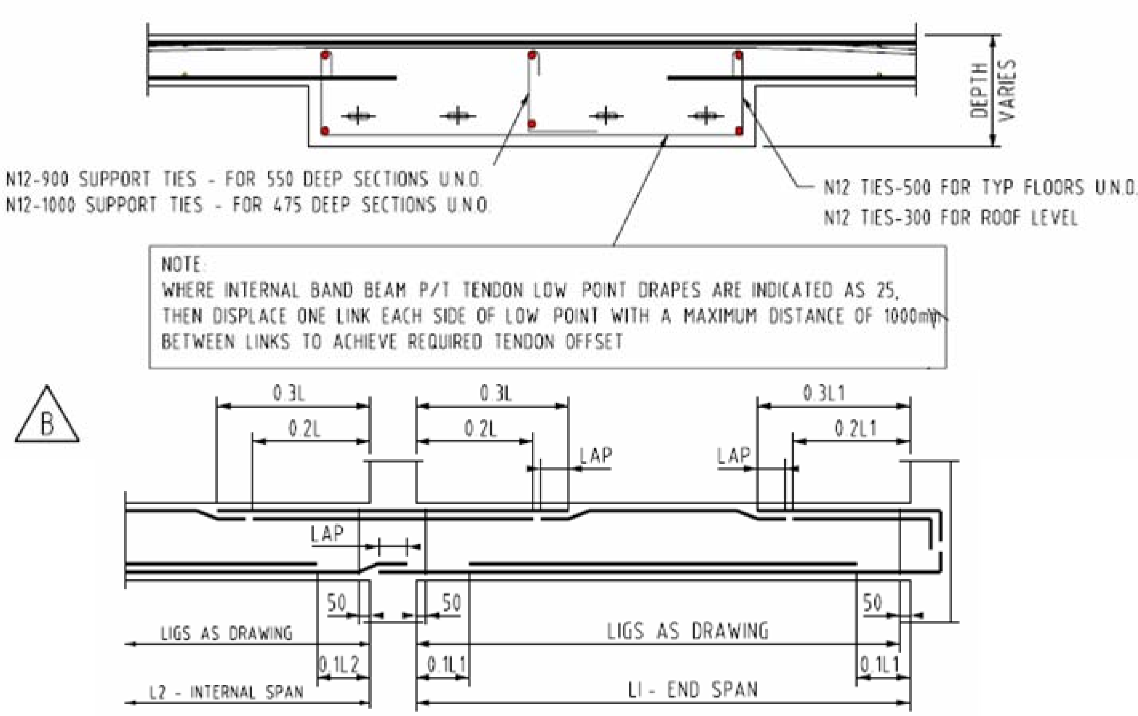


TYPICAL STARTER DETAIL U.N.O.

NOTE: STARTER BARS TO BE SURVEYED
INTO POSITION BEFORE CONCRETE IS SET

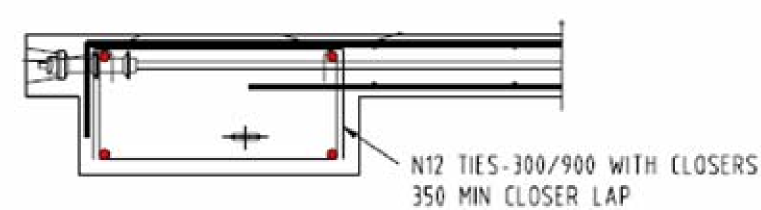


TYPICAL DETAIL AT SLAB PENETRATIONS



TYPICAL BEAM REINFORCEMENT LAYOUT

(UNLESS NOTED OTHERWISE ON DRAWING)



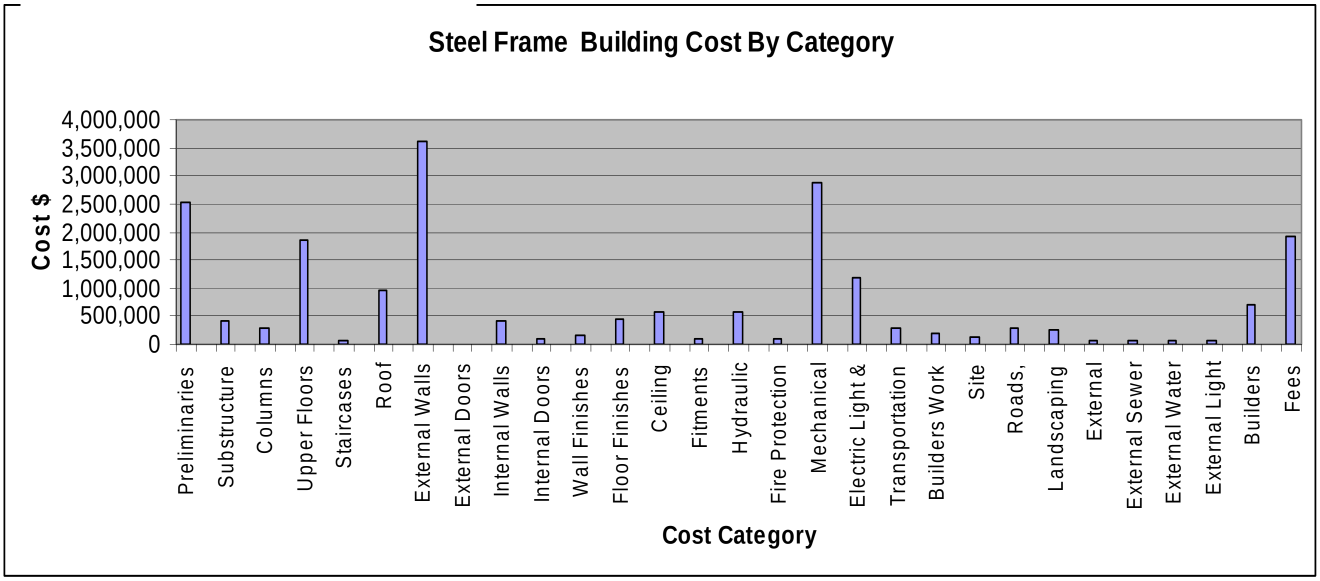
TYPICAL EDGE BAND BEAM

(UNLESS NOTED OTHERWISE ON PLAN)

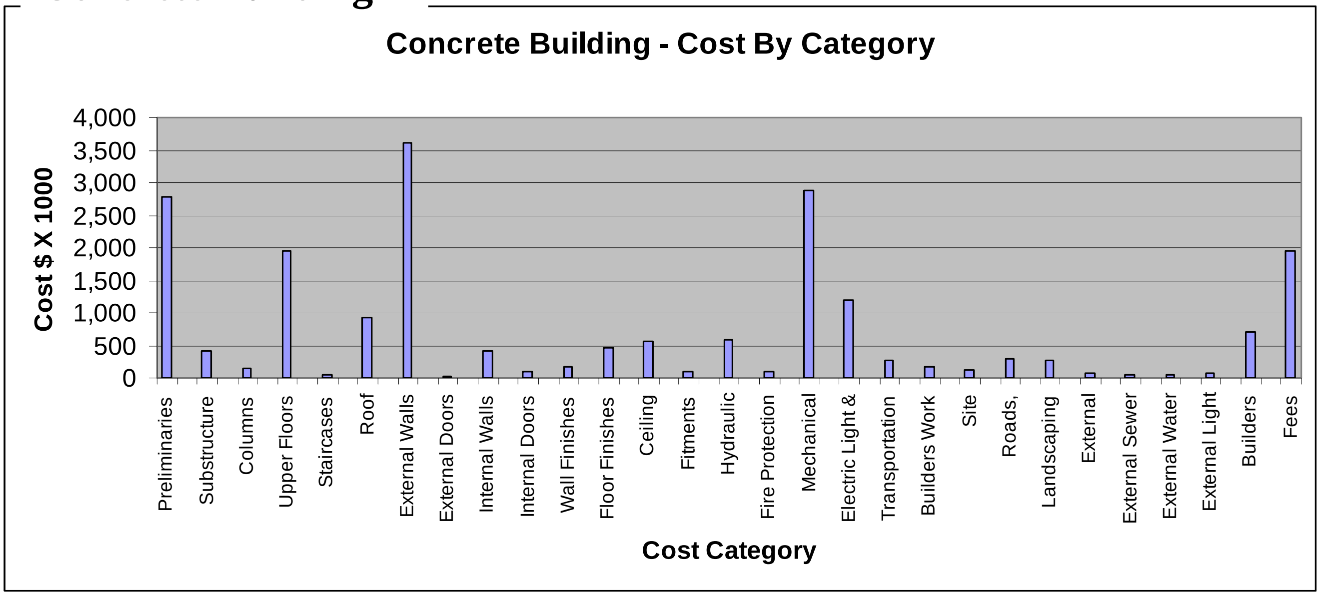
Analysis

Costs were compiled based on RLB file data for concrete and steel. Steel Costs were itemized against the bill of materials for concrete.

Steel Framed Building



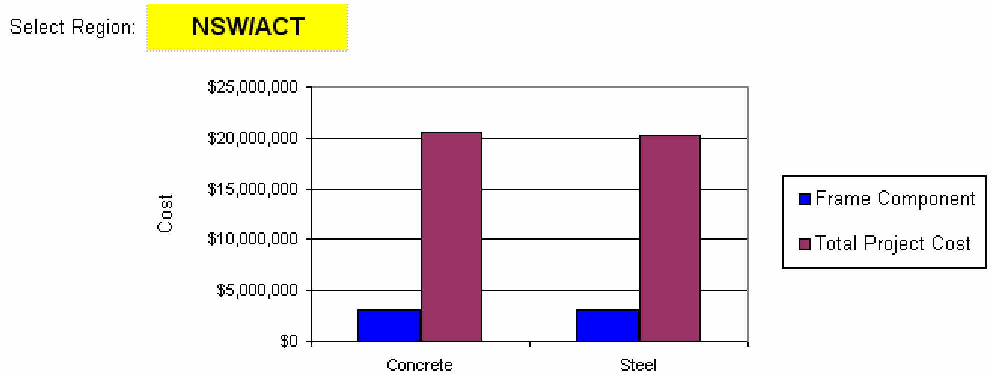
Concrete Building



Based on the initial QS file data steel was not competitive. However this was reversed when actual industry data was used.

INITIAL PRICING NOV '07

Initial work was done with an advanced 'steel in buildings' fabricator, utilizing costs based on modern CNC equipment. There costs were independently verified by RLB in conjunction with the initial fabricator Sebastian Engineering and compared as follows:



COST SUMMARY

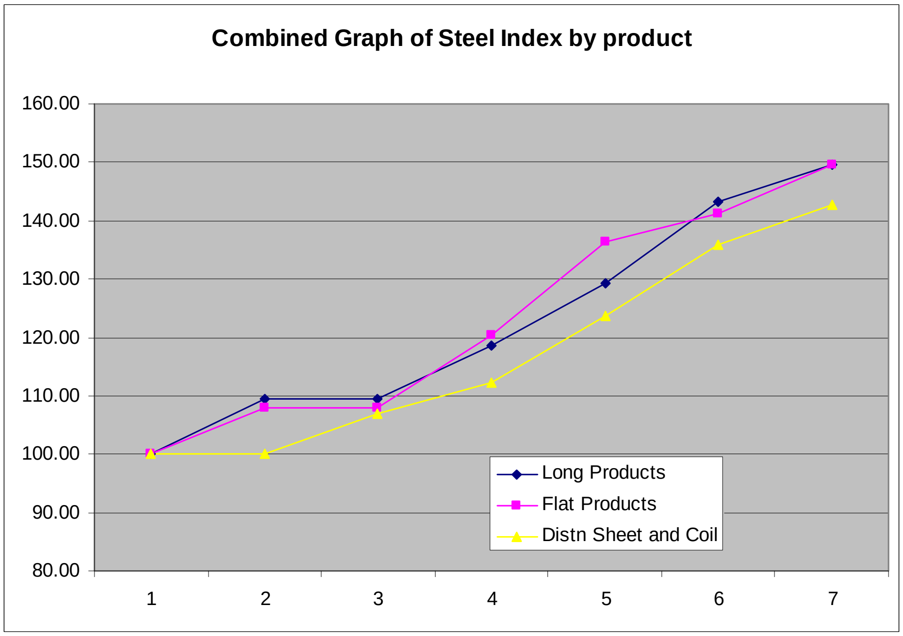
	Concrete Building	Steel Building	Steel Building Saving	
Frame Component Cost	$3,042,284	$3,114,144		
Total Project Cost	$20,505,749	$20,290,456	$215,293	1.0%

The above comparison shows that the actual material costs were about equal but that savings made in the preliminary cost area due to speed of construction offered a measurable level of cost saving to the builder.

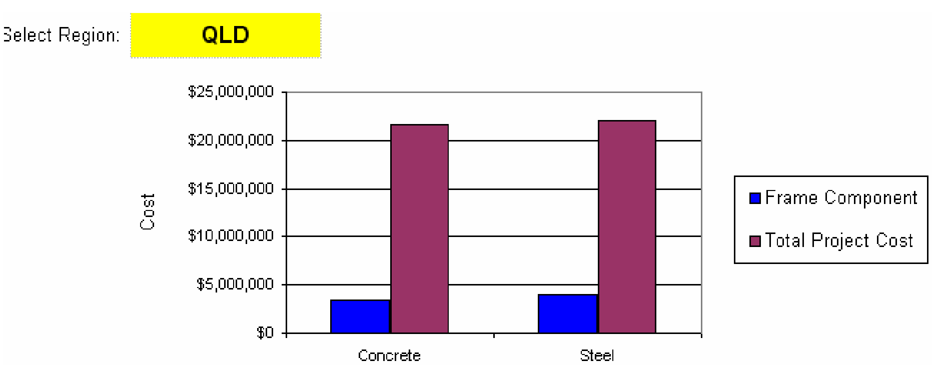
Fabricated actual cost data then was compiled from NSW, Qld Vic and SA fabricators and compared with the concrete data. In all instances steel based on current market data was shown to be competitive.

PRICING UPDATE JULY '08

During the 08 calendar year substantial cost increases were incurred by the global steelmakers driven by increasing raw material costs and increasing demand from China.
An analysis of the effect of these increases is indicated in the attached chart with Jan 08 as the basis of 100 for the index.



This cost comparison exercise was updated in July 08 based on known steel and concrete increases and the competitive situation of steel framing vs concrete was found to be reversed with concrete being marginally more competitive than steel.



COST SUMMARY

	Concrete Building	Steel Building	Steel Building Saving	
Frame Component Cost	$3,347,093	$3,972,850		
Total Project Cost	$21,584,593	$22,070,173	-$485,581	-2.2%

The Value of Steel in Construction.

a) Speed of construction

Independently verified in this model the construction time for steel was 14 weeks compared with 19 weeks for concrete. Analysis of all major building works in the last 3 years has produced a body of evidence that the main cost advantage of steel comes when the builder takes advantage of the inherent speed of construction. As construction times vary from project to project it is the steel contractor that can identify actual time advantages on each building project. This speed of construction can be converted into cost savings when preliminary costs are identified as fixed and variable.

In this model the fixed vs variable preliminary cost elements were identified as follows;

	Fixed Preliminaries	
1	Authority charges and fees	
2	Insurances and bank guarantees	
3	Professional services, legal, surveyors etc	
4	Security	
5	Cleaning	
6	Site establishment	
	Time Related Preliminaries - Original basis = 46 weeks total construction, Frame component = 14 weeks.	
		Quantity for Original 46 weeks
7	Project manager	38
8	Site supervisor	46
9	Engineer	46
10	Contract administrators	46
11	Programmer	8
12	Site foreman	32 struct, 20 finishes
13	Site labourer	3x40
14	First Aid	46
15	Hoist Driver	28
16	Temporary fencing	46
17	Temporary shed and accommodation hire	46
18	Temporary site services	
19	Site supplies generally	46
20	Site administration costs	46
21	Tubular scaffolding	
22	Mobile scaffolding	46
23	Scissor platform	46
24	Tower crane	
25	Mobile crane	46
26	Major plant items / Hoist etc	
27	Minor plant and tools	46

b) Minimal Disruption

Because most activity is off site steel construction is well renoun for reducing disruption for the site and surrounding area. This is important in CBD locations or sites close to residential areas. Steel construction occurs is lesser time, reduces noise , dust and cartage associated with waste removal. There are considerably reduced truck movements and deliveries can be timed to suit the local traffic conditions and hence keep traffic disruption to a minimum.

c) Lighter weight

Steel framing as a rule of thumb is 80% the weight of a concrete solution. This has advantages in the size of foundations, column loadings and of course the ability to modify an existing frame by adding stories. Many recent examples exist in Sydney where the light weight construction of steel has enabled reuse of existing buildings or existing foundations and columns. In particular, 77 King St, Kent St Church, Latitude East and the Macquarie Bank building in the Sydney CBD in recent times.

d) Off Site manufacture

Off site fabrication in closely controlled CNC operating conditions improves the quality of construction. Manufacture is not affected by on site trades or the weather and results in considerably less people on site resulting in less safety risk exposure to the builder.

e) Environmental benefits

This aspect of construction is emerging as a factor in choice of building systems. Issues here involve embodied energy, thermal mass, carbon footprint and life cycle analysis (LCA). In the absence of independent factual LCA data the market is turning to a points assessment such as the GBCA. These type of schemes are not however designed to support Steel in infinitely recyclable and in Australia approximately 95% of all structural steel in recycled or reused.
It has been shown that embodied energy as a criterion is unworkable as it does not value recycling and reuse properties of materials, and thermal mass considerations are satisfied by all types of concrete and steel composite construction.
The carbon footprint work is incomplete but studies overseas show a tendency to close comparisons in the carbon footprint of concrete and composite construction.

Accurate Costing of Structural Steelwork

Work with the Australian Institute of Quantity Surveyors (AIQS)

A major component of this project was to communicate accurate cost information to the Australian AIQS community.
In light of the significant cost increases in ’08 the following communication was released to the AIQS through their e newsletter.

To the AIQS

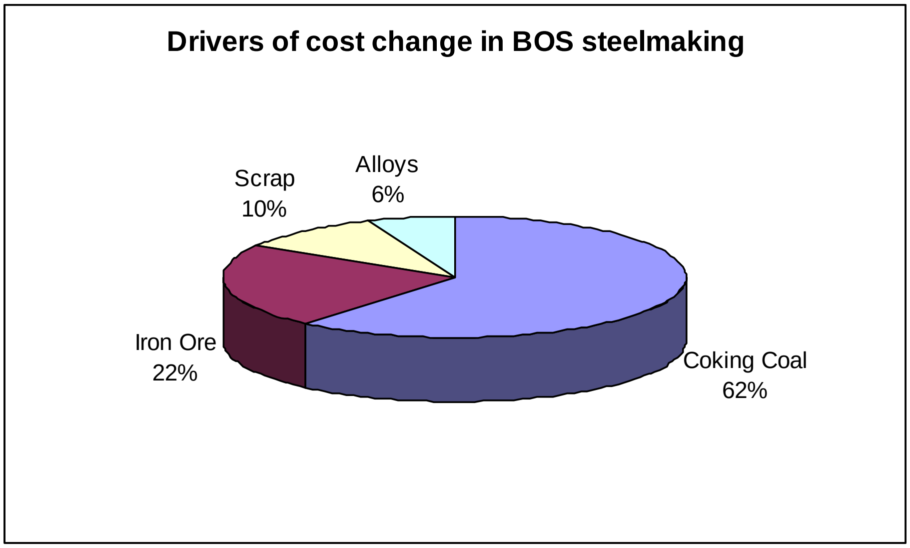
Australian Steel Institute Communication on Steel Pricing

This information is intended to be a guide for quantity surveyors working in the area of steel in buildings.

The recent steel volatility has created an environment which is quite unprecedented in the steel industry.

Cost Drivers
Steel costs driven by the major cost elements of iron ore, scrap and coking coal have risen substantially throughout 2008. eg.

Coking Coal	300%
Iron Ore	65%
Scrap	100%
Alloys	100%

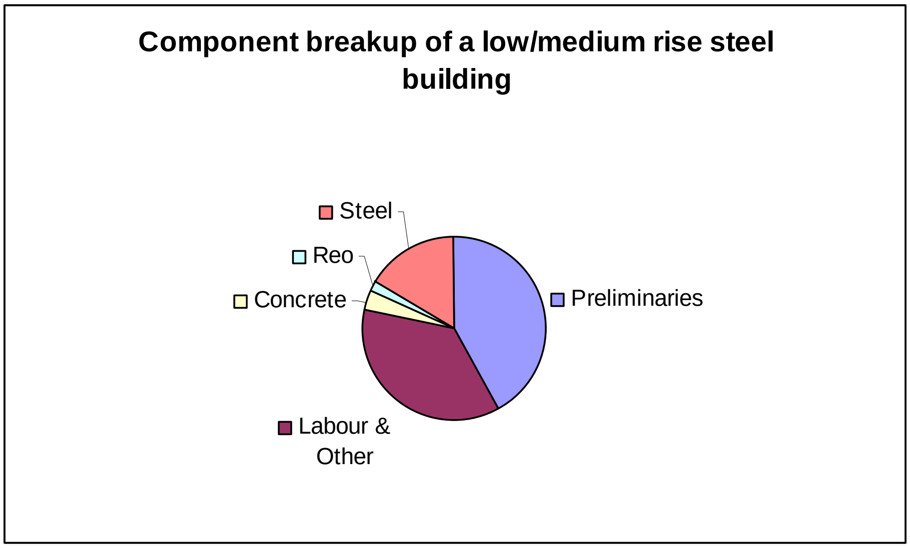


Refer the ASI web site www.steel.org.au ref Steel Indicators, to view monthly updates of the effect of the current global steel pricing situation. This includes graphs on coal, fuel, ore, alloys and scrap as international cost drivers, global supply and pricing information and economic indicators.

Availability
As world demand for steel surges with gaps in supply of feed materials there has been restrictions in exports from some foreign countries. The drying up of the previous level of imports to Australia has meant that steel is in shorter than normal supply.
The Australian steel companies are producing at record levels and the shortfall in supply is due generally to the gap in supply of imports; the trading houses not being able to get full supply or because traders have been able to get higher prices elsewhere. The steel companies in some instances may allocate material from rollings to ensure adequate servicing of their customers and to avoid speculation.

Building Costs
It is significant however that labour in fabricating steel has not been affected by the same drivers and therefore it generally is only the steel section component that has increased. This steel component varies from job to job with architectural steel being more labour intensive than straightforward beam and column construction which represents approximately one third to one half the value of the total fabricated price.

The past 3 years has seen an increasing trend to build multi-level buildings in structural steel. This is a direct result of the steel industry's growth initiatives in this market segment. Increasing steel material prices have led the building industry to ask if this means that steel framed buildings will no longer be competitive. To answer this it is necessary to look at the material cost in relation to the total building costs.



Basis; ICIP AusIndustry cost model

While recognizing the effect of the increasing cost of steel is on the choice of steel framed buildings it can be seen that reducing the preliminary costs and labour costs is going to make a big impact. Speed of construction for steel or reduction in foundation costs can still achieve this balance and make steel framing still a competitive option in the current pricing climate.

ASI fabricators who have indicated that they are prepared to assist with current cost information for the QS community are as per the attached list.

Index
Steel products have incurred price increases at various rates. Structural steel, (plate and steel beams) and particularly PT strand and reinforcing have risen the highest. Sheet steel and product with more value add like purlins and cladding have not risen to the same extent.

The ASI has looked at a steel index for contract price variations, however with the big disparity in price increases by product an index is not ever going to be representative of the basket of steel product in any one project.

Therefore for contractual variations it is recommended that steel cost variation clauses be negotiated with the fabricator and variation between price paid and any contract variation be verified with the steel distributor, if necessary.

Multi Level Building Fabricator Contacts

For an extensive list of ASI fabricators and contact details view the ASI web on www.steel.org.au

Company	Contact	Number
Qld		
Brisbane Steel Fabrications	Lindsay Allen	07 38934233
Beenleigh Steel Fabrications	Mark Finney	07 38036033
NSW		
Sebastian Engineering	Mark Sgaravizzi	02 46266066
Vic		
Page Steel	Chris Piacentini	03 99311600
Monks Harper	David Hentschke	03 97940888
GFC Industries	Glen Millar	03 93579900
SA		
Samaras Structural Engineering	Michael Samaras	08 84477088
Advanced Steel Fabrications	Leno Zanardo	08 84477100
Manuele Engineers	Vince Manuele	08 83741680
SA Structural	Michael Mangos	08 82855111
Ahrens Group	Mark Smeeton	08 85249045

Contact David Ryan National Manager Marketing 02 99316608 for further information.

Cost Data Provision to the AIQS

The following communication was posted to the AIQS state bodies for Qld, NSW and Vic. Jan 09

AUSTRALIAN STEEL INSTITUTE

SUBJECT ; Cost information for steel in composite construction for the Eastern States Australian Institute of Quantity Surveyors AIQS.

Discussions have been held at State level on how the Australian Steel Institute (representing those steel contractors and fabricators with an expressed commitment to the building industry) can provide assistance to the AIQS at a time of volatile steel pricing. Discussions centered on provision of real time information that may assist the quantity surveyors with steel rates based a recent and complete building model. The ASI has taken the Cox Richardson design, Arup engineered model used for the recent AusIndustry ICIP project and averaged eastern state rates for steel fabrication.(Previous work had established for the fabricators contributing that there is marginal variation only across Qld, NSW and Vic) This is intended to give the AIQS community a guide on erected steel rates for buildings of a similar nature, on a quarterly basis. Further queries may be taken up with the steel fabricators directly. **The model and ASI activity associated with this material is funded jointly by the ASI and the Australian Government as a funded initiative under the Industry Cooperative Innovation Program.**

Contributing Fabricators

Sebastian Engineering NSW
Monks Harper Vic
Page Steel Vic
Lysaghts Design and Construction NSW
Steel Fabrications of Australia (Brisbane Steel Fabrication)

The Building

- This generic design presents a structural steel frame solution for a new 4 storey office building, providing commercial Grade A space of approximate NLA of 8000m^2.
- The four office levels (namely Ground, First, Second and Third) and Roof are suspended, and each extend over approximately 2000m^2.
- 200 m^2 of centralised compactus area is provided on each of the office levels.
- A double height foyer is formed by the omission of any slab at First directly above
- The internal area at Ground incorporates a 150m^2 area of set downs within the slab for foyer finishes and a central wet areas; the remainder floors have 80m^2 set downs areas located centrally between cores for the wet areas.
- A large plant enclosure of approximately 300m^2 is designated at Roof.
- The building is air conditioned with a chilled beam system.

Structural Form

- All structural framing is provided using hot rolled steel (i.e UB, UC, CHS, RHS) – special fabricated structural members are not required. There are no specialised or complicated fabrication methods required for the frame.
- The foundation to the building has not been considered in this study; if a basement is not provided, a ground bearing slab, a foundation raft, or similar can be substituted at Ground, and the associated framing should be omitted from the material take off.
- The building's 12.5 x 8.4 m grid offers an 8.4m span (longitudinal) primary beams arrangement, which in turn support secondary beams spanning 12.5m span (laterally) at 2.8m spacing.

- In order to counteract deflection of the steel beams under their ‘construction condition’ (i.e. prior to them developing composite action with the slab), the composte beams are precambered where required.
- Where possible the beams are designed to act compositely with a 120mm deep slab, which is cast on a continuously spanning re-entrant steel deck, by the provision of through-deck welded studs and mesh reinforcement.
- The direction of the steel deck toughs are parallel with the primary beams and as such, the dimensions between the stud centres are able to be closed or opened as appropriate to maximise the steel member size and to optimise the appropriate number of studs. The studs to the secondary beams are placed within the troughs to the decking which spans parallel to the beam.
- Floor to floor heights are typically 3.7m; all columns are founded at 3m below the Ground
- The building is serviced by chilled beam cooling. Beams supporting Roof, Third, Second and First host an extensive arrangement with over 100 web penetrations per level to accommodate the ductwork’s reticulation within the ceiling’s service void within the depth of the floor beams. There are no requirements for web penetrations to Ground supporting beams.
- The web penetrations are rationalised into just 4 types, and their design have been iterated with close attention to the balance between final choice of beam section vs floor to floor heights vs the requirement for a non- stiffened web penetration
- Close integration with the mechanical duct design results in just 2 beams per floor being provided with bottom flange notches
- Cast in plates have been designed for the connection between the reinforced concrete cores and intersecting steel beams. Each floor has specific requirements for the plates’ positioning, with 15 to 20 plates per level being required. L bar reinforcement is provided between the core walls and the composite slab. A drilled ‘flexible’ fin plate is site welded to the cast in plate and the supported beam’s web is drilled match the fin plate.
- Cantilevering slab edges provide a column free façade on the lateral ends of the structure. This is possible by having the canilevr primary beam extend through the CHS supporting column. The portion of the column above and below the beam is welded to the beam, effectively being delivered as one assembly. The CHS columns bolt between these assembelies at every level on site.
- Beam to beam connections are provided by drilled ‘flexible’ fin plate welded to the supporting beam. The supported beam’s top flange is notched and it’s web is drilled match the fin plate.
- Beam to column connections are also provided by drilled ‘flexible’ fin plates welded to either the column’s flange or web. When connecting to the column web, the supported beam’s flanges are notched for fit.
- The remainder UC columns are only spliced once above level, at a suitable level so as to be useful within an appropriate mansafe system during erection. The section size of the column alters to a more economic section above the splice.
- A façade system’s secondary framing is not included within the Generic Design, however appropriate loading has been allowed for in the design for a façade to be vertically supported on each level’s perimeter edge beams.
- The Generic Design of the structure is to conform to AS4100 & AS2327.1.
- All steel is typically Grade Onesteel 300PLUS. The 508CHS columns are Grade 250.
- Through deck welded studs are 19mm diameter x 100mm (95mm after welding)
- All bolts to be M20 8.8/s
- Slab to be 120mm overall, on a 1.0mm Bondek re-entant steel deck; normal weight 32Mpa concrete (2400kg/m^3) with SL82 mesh.

Erected Steel Rates as of Dec 08 Average of participating Eastern State Steel Contractors/Fabricators

Key Rates - Steel Framed Building

Region: Eastern States Average	Steel Rate $/unit	UNIT	
Universal Beams UB (150UB to 410UB)	5,629	t	
Universal Beams UB (460UB to 610UB)	4,232	t	
Universal Columns UC (100UC to 200UC)	6,123	t	
Universal Columns UC (250UC and 310UC)	4,354	t	
Welded Columns WC	4,782	t	
Large CHS (508 and 610 diam)	7,761	t	
100x100x6EA	13,464	t	
Connections plates, caps and base etc	6,084	t	
Allowance for holding down bolts	394	No	each
Allowance for bolts in connections	6	No	each