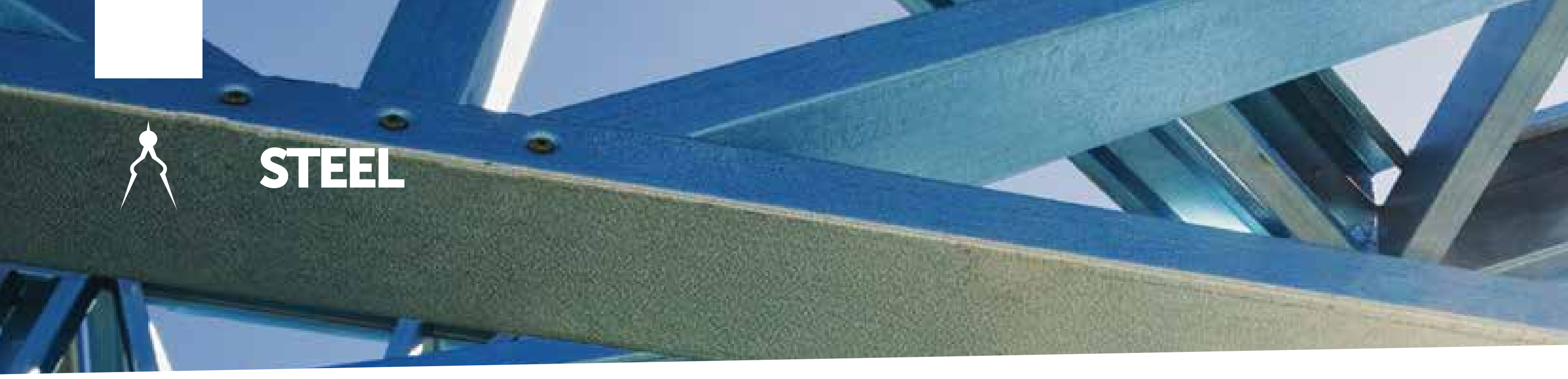
THE VALUE OF USING STEEL

COST-EFFECTIVE AND LONG LASTING

Steel provides a particularly high quality, safe, and cost-effective solution for building structures, delivering value both during the initial construction, and over the full lifecycle of an operating structure.



STEEL

Choosing steel as the key construction material from the outset of a building structure project can provide a myriad of benefits, from savings in the construction schedule, through to on-site labour and logistics cost-efficiencies. The use of steel can also minimise impacts on the design of other major elements within a project, such as cladding and service installations.

The choice of material for both framework and form generally occurs early in the design process, and is often based on early design principles, limited information and budget costings. While it is possible to change framework material at a later stage—which happens regularly when a steel option is presented—choosing a steel solution from the outset can have several positive outcomes.

According to Peter Key (National Technical Development Manager, Australian Steel Institute), "Cost is obviously a key consideration in the decision-making process, but it should not be the only one. It is vital to support informed decision-making with realistic cost information at the conceptual design phase, before it is then refined during the detailed design phases."

"This may be a challenging task given that the cost of structural steel can fluctuate throughout the economic cycle and steel frame costs are also heavily affected by project-specific key-cost drivers, such as program, access, spans, and building form," said Key.

"In addition, the initial construction cost of a structure is usually only one small component of its long-term lifecycle cost. In fact, it is estimated that the initial construction price of a building accounts for only approximately 2% of the life-cycle cost over a 30 year period. Therefore, value engineering should realistically take account of the life-cycle cost of a structure, not just its initial construction cost."

VALUE ENGINEERING

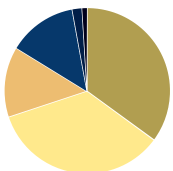
"The most effective approach to reducing steelwork construction costs is through pragmatic value engineering. Steelwork responds exceedingly well to considered approaches to rationalisation, with the potential to reduce costs in all phases of the building supply process," said Key.

"Ideally, value engineering should commence at project inception when the capacity to influence design outcomes and the benefit to the final design are the greatest. Specific value engineering workshops early in the project planning and conceptual design process can help maximise value for money. The definition of what is good value on any particular project will change from client-to-client and project-to-project."

STRUCTURAL FRAME COST COMPONENTS

To rationally cost a constructed steelwork project at each stage of the design development process, it is therefore necessary to have an appreciation for the approximate relative cost components of a completed steelwork structure.

Figure 1: *Breakdown of Steel Framed Multi-Level Building Costs* (see below) offers a typical breakdown of costs for a multi-level steel framed building. Note that it represents the structural steelwork frame only, which generally accounts for 10% of the overall building cost.



The raw material cost accounts for approximately 30% to 40% of the finished structure cost, with fabrication accounting for another 30% to 40%. Therefore, while a minimum structure weight is an admirable objective, if achieving this objective comes at the expense of overly complicated fabrication or connections, any cost saving in weight are likely to be overridden by an increased fabrication cost.

"The art and science to a cost-effective overall structure lies in the right balance between steel tonnage and fabrication complexity. Value engineering aims to find that right balance," said Key.

The construction cost accounts for 10% to 15% of the finished structure cost. Factors that mitigate the erection cost should be examined carefully. Prefabrication of assemblies, the extent of repetition, the piece count and the ease of assembly of connections can all significantly impact on the construction cost of the framing

Fire protection is another 10% to 15% of the finished structure cost. According to Key, "A fire-engineered solution can significantly reduce the cost of fire protection, including negating the requirement for any fire protection in some cases. An initial investment in fire engineering will, for all but the simplest of structures, have a very positive return on investment."

Engineering is a small percentage of the finished structure cost. A contractual arrangement that incentivises value engineering can lead to a significant multiplier effect in relation to savings in overall project cost.

The supplied cost (raw material + fabrication) of the fabricated steelwork represents a very significant 60% to 80% of the finished structure cost. It is therefore very important that the correct representative cost figures are used, often quoted as $/tonne.

COSTING STRUCTURAL STEELWORK

The approach to costing structural steelwork necessarily varies depending on the stage of the project design development. The accuracy of any costing exercise depends on the level of design information on which it is based.

At very early stages of project evaluation, a Quantity Surveyor may utilise simple area-based ($\$/m^2$) rates for different types of structural steelwork-based buildings. As the design progresses, and information becomes available on the type of steelwork and member sizing, the $\$/m^2$ rates can be refined with input from fabricators, culminating finally in a 'hard-number' quotation from selected fabricators during tendering.

"An important part of obtaining a value-for-money solution is taking the opportunity to value-engineer the design during the design development. Early engagement with fabricators and steel detailers can help inform the selection of the member and connection details to achieve the right balance of structural weight versus simplicity of fabrication and erection," said Key.

DESIGN COST PLANNING

The type and accuracy of cost data depends on the level of design information on which it is based and is therefore related to the design development stages, which are summarised below.

STAGE 1: BUILDING TYPE-BASED COSTING

Initial cost estimates before any substantive design is undertaken may be based on the costings of similar, already complete projects. Standard industry publications providing regularly updated cost indices for various types of construction may also be utilised, although care should be taken to understand the scope and limitations of these figures.

STAGE 2: STRUCTURAL SYSTEM-BASED COSTING

Once some early-stage design development has been undertaken, the structural engineer should be able to provide indicative area-based tonnage rates (kg/m^2) for the different structural systems present in the building (such as suspended floors, columns, secondary infill steelwork, and so on).

A more refined estimate of the erected structure cost can be developed once several factors are understood, including: the area or linear meterage of the respective structural systems, a realistic rate for supplied and fabricated steelwork (\$/tonne) for each of the structural systems, and the corresponding erection rate.

"At this stage, it is important to have a realistic, representative cost per tonne for the particular structural system type. The fabricated cost per tonne for steelwork can vary significantly depending on the complexity of fabrication and the type of raw material. However, the type of fabricated steelwork utilised for standard multi-level building construction is usually at the lower end of the cost per tonne range," said Key.

STAGE 3: ELEMENTAL COSTING

As the design progresses, information on member sizing and connection detail should be made available by the project's structural engineers. At this stage, the structural system can be broken down into four prototypical components:

- Main members: carry the primary loads through to the foundations, and include beams, columns and trusses.
- Secondary members: carry specific loads or trimming openings and the like. These members are usually smaller than the main members but may involve similar levels of fabrication.
- Fittings and connections: including bracing, stiffeners and the connections that transfer load between structural members.
- Miscellaneous items: such as temporary steelwork, steel decking for composite floors and stair units.

BUILDING INFORMATION MODELLING AND COSTING

"Building Information Modelling (BIM) is becoming increasingly prevalent, particularly as it provides an opportunity for achieving higher-quality and more accurate costing at earlier stages of a project's lifecycle," said Key.

So-called 5D modelling (3D + project schedule + project costing) makes use of the element-based 3D modelling in BIM to overlay cost data, including down to the element level. If current accurate cost data is utilised in the model, the overall project cost may be continuously and virtually automatically updated as design development within the BIM model evolves.

STEEL

THE VALUE OF STEEL

Steel delivers significant value in several areas, from safety and efficiency, through to cost-effectiveness and quality assurance.

SAFETY

The use of steel reduces the number of workers on site considerably—steel construction utilises approximately 10% to 20% of the labour required for concrete. This reduces a builder's accident liability rate considerably.

Accurate, efficient off-site construction reduces the amount of handling required, with preassembled steel construction packages lifted straight from the truck to the building in construction sequence.

SPEED

Off-site steel fabrication means quality issues are solved off-site, thereby saving time. Plus, steel construction is universally recognised as significantly faster than concrete construction. This improved construction speed markedly improves preliminary costs.

QUALITY

Every batch of steel produced is certified and traceable, and fabrication can be driven by 3D modelling and numerically controlled fabrication equipment, providing the surest guarantee of quality construction.

EFFICIENCY

Steel is structurally efficient, and buildings are considerably lighter as a result. Foundations are lighter and cheaper relative when compared to concrete. Just-in-time deliveries can be sequenced and synchronised with the construction program. Steel is fabricated in controlled conditions with little waste.

SUSTAINABILITY

More than 95% of all structural steel is recovered and reused or recycled. Steel by weight is the most recycled material in the world without degradation or loss of quality. Plus, steel buildings inherently lend themselves to addition and modification easily and quickly

WASTE REDUCTION

Significant savings can be made through waste reduction compared to concrete construction. In addition, considerable savings are made when it comes freight—the use of steel means significantly fewer truck movements—because the use and removal of formwork is eradicated.

References

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- www.steel.org.au/focus-areas/steel-in-buildings/steel-costing---multi-level-construction/
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