COMMON REGIONAL STANDARD FOR COLD-FORMED STEEL FRAMING

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ABSTRACT: *As more and more Australian engineering developments take place in the East Asia region, common regional standards are highly desirable but are they feasible? This paper discusses the feasibility of establishing common regional standards. It argues that this is only feasible if (i) there is a genuine need for the standard, and (ii) the proposed standard is a framework performance standard. Such standard will be useful as a technology transfer vehicle for new technology not yet established in the region and therefore have better chance of success. It will also facilitate the trading of structural products in the region as the standard can serve as common means of technical communication. Judged by these criteria, a common regional standard for cold-formed steel framing is achievable.*

KEYWORDS: performance, standard, steel framing, cold-formed steel structures

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1 INTRODUCTION

As more and more Australian engineering developments are going to take place in East Asia region, common regional standards are highly desirable as they offer considerable advantages for all stake-holders. These include fast technology transfer between countries, level playing fields for competition and promotion of free trade. Many past attempts to harmonise regional structural standards have gained little acceptance despite general agreements on technical features and on their desirability. This paper attempts to outline the criteria to make such a project successful. It will then argue that a common standard for cold-formed steel framed construction could be made to work for the region.

2 ACCEPTANCE CRITERIA

A number of features are necessary for the acceptance of a common regional standard:

- Genuine need: first and foremost is that there must be a genuine need for such a standard that is not in existence in any of the countries concerned. Most countries already have a structural standard system and are not likely to accept a new standard to serve as replacement for an existing one. Thus, the proposed common standard must have something new to offer to the countries.

- Industry acceptance: industry acceptance is not likely to be universal if the new standard is seen as a competitor to existing industry. Its acceptance is more likely if there are economic gains for a particular industry sector.

- Practitioner acceptance: practitioner acceptance is more likely if
    - there is no established practice, and
    - the proposed procedure is relatively easy to carry out.

- Regulatory acceptance: regulatory acceptance is not likely if the new standard is seen as not in the national interest of the country or is in conflict with the country accepted practice. Its acceptance is more likely if it can be adapted to fit existing regulatory framework of the country.

From the above, it is seen that a framework performance-based model standard on a new topic has the best chance of acceptance. Performance-based standards are standards that describe what is required but do not prescribe specific solutions. The standards should describe the performance requirements and the methods to demonstrate conformance with requirements. The levels of performance can be left to each country to decide for itself via the adjustment of the capacity factor (ϕ) although an appropriate default ϕ should be suggested. Most countries will very likely accept the default level.

Such a standard will have the following advantages:

- It leaves room for innovations from local practitioners.

- It can be part of the existing system e.g. by referring to local loading standards for example.

- It leaves room for each country to have a final say on level of performance therefore not likely to receive resistance from regulatory authorities.

The above elements are necessary but not sufficient for success. One possible barrier is that the concept of performance-based standards may not be well understood by local practitioners who are more familiar with prescriptive type of standards. This barrier can be overcome with education. There are also international guidelines on how to write performance-based specification, such as ECE Compendium of model provisions for building regulations [1], ISO Housing – Description of Performance series [2] and ISO Framework for specifying performance in buildings [3].

3 FACTORS TO BE CONSIDERED IN STANDARD DEVELOPMENT

The development of a new standard is not an easy task. There are a number of aspects to be considered. These include technical, infrastructure, trade and social aspects.

(a) Technical aspects include engineering education and training, product conformance, design efficiency and alignment with international best practice.
(b) Infrastructure aspects include regulatory reference and enforcement, cost of standard development, technical expertise to develop and maintain the standard.
(c) Trade aspects include effects of standard on competition, innovation and regional trade.
(d) Social aspects include effects on building cost and building quality and on the sustainability of the industry.

Judging by the above factors, it appears that there are considerably more advantages in developing a common standard for the region than in developing country specific standards.

4 PROPOSAL FOR COLD-FORMED STEEL FRAMING

4.1 ADVANTAGES OF STEEL FRAMING

Light steel framing, fabricated from cold-formed sections generally less than 2 mm thick, is an economical form of construction for low rise domestic and similar buildings. The development of this technology and associated standards was pioneered in Australia and has spread to New Zealand and South Africa. Similar systems are also used widely in Japan and USA. At a recent East Asia Structural Engineering Conference, it has been observed that lack of standards is a barrier for the development of this industry in East Asia [6].

Cold-formed steel framing has many advantages over other forms of construction including:

(a) Its self-weight is small compared with other form of construction. This is particularly advantageous for construction on soft or variable soils.

(b) It is immune from termite attack and long design life for the framing systems can be confidently expected with current coating technology. For example, BlueScope is providing 50 year warranty on its products in Australia.

(c) The speed of construction on site, particularly with pre-fabricated steel framing systems, is much faster than traditional methods.

(d) The consistency and accuracy of cold-formed steel products makes the tasks of fixing plaster boards or other types of cladding easy, contributing to the speed of construction.

(e) Steel framing systems can be packaged and efficiently sent to remote communities where there is a shortage of building materials or inadequate local industry infrastructure.

(f) Steel frame construction also scores well in terms of contribution to sustainable development. For example, steel is reusable, recyclable and steel framing system is adaptable for change of occupancy which leads to longer life of buildings.

4.2 STANDARD TYPE AND CONTENT

The proposed standard will be a performance standard i.e. it specifies the aspects of performance that steel framed buildings require without imposing any specific solution. Performance standards are efficient and flexible, accommodating traditional methods while encouraging innovation. This will allow a wide variety of cold-formed section shapes and connections to be used, sourcing components from the most efficient suppliers. The proposed standard will not specify levels of performance and is not intended to replace national standards or regulation, but it will provide a standardized framework to be used for developing national standards and regulation. This approach facilitates innovation in building technology and makes regulations easier to be aligned across local and national borders in line with World Trade Organization requirements.
The types of buildings for which cold-formed steel framing can be used economically are generally low rise domestic or similar residential and commercial buildings up to 3 storeys.

Performance aspects relevant to steel framing include: structural (safety, serviceability and durability), fire safety, acoustics and energy efficiency.

Structural performance: Conventional framing usually consists of three sub-systems: roof, wall and floor systems. For each sub-system, three types of components need to be considered: members, bracings and connections. All components are designed to act together as a single unit. Performance requirements for each sub-system as well as for each component are to be described in the standard to facilitate the design. The loading requirements include basic permanent action (dead load), imposed action (live load) and wind action. Other actions that could be included are snow and earthquake depending on the likelihood of their occurrence. The roof system consists of roof cladding, roof and ceiling battens, rafters and joists and roof trusses often used as the main structural component. The wall system consists of wall cladding, studs, top and bottom plates, and lintels over the openings. The floor system consists of floor decking, joists and bearers. The bracings of roof, wall and floor systems must be considered separately with the underlying assumption that the ceiling and floor shall act as diaphragms to carry the racking forces from roof to wall to floor then to foundation. Connections between the sub-systems must be designed to fulfil this task.

Fire and acoustic performance: Fire safety in low rise buildings covers a number of issues such as means of escape, fire spread prevention, firefighting measures and fire resistance of the

structural elements. The fire resistance performance of the elements is dependent on national regulations and often described in terms of time it can maintain its function in a standard fire test. The acoustic insulation characteristics and fire resistance characteristics are often related so the measures introduced to achieve acoustic insulation can also achieve a certain level of fire resistance performance.

Energy efficiency: Thermal performance is about effective use of energy for heating or cooling purposes. The contribution that the building designers can make is to reduce the thermal transmission of the building envelope and to increase the air tightness. Cold bridging and condensation are issues likely to be encountered in cold-formed steel construction.

4.3 PROPOSED CONTENT FOR A COMMON COLD-FORMED STEEL FRAMING STANDARD FOR EAST ASIA

A standard is a necessary tool for the development of an industry. It sets a benchmark for design and provides confidence and stability for consumers, manufacturers and regulators.

Cold-formed steel framing for low-rise residential and commercial buildings is a relatively new form of construction in East Asia and a standard is necessary for the development of this industry in the region. While a common prescriptive standard for steel framing for the region may be difficult to achieve, a common performance-based framework standard that does not impose any particular level of performance but can be used to develop national standard to suit each country needs is feasible.

Common features for such a performance framework standard may include:

- aspects of performance: structural safety, serviceability and durability, fire safety, energy efficiency, acoustic etc. (individual aspects may or may not be included depending on needs);
- material specifications;
- loading specifications;
- structural performance of roof, wall and floor systems and components;
- connectors and types of connections;
- bracings;
- design by testing;
- assessment of structural characteristics of cold-formed components;
- manufacturing and assembly tolerances.

(d) This approach has many advantages including:

- facilitation of efficiency and innovations in steel frame design;
- facilitation of trade in the region to deliver high performance low rise residential and similar buildings;
- savings in effort and cost in the development of training and software;
- promotion of technical collaboration and technology transfer in East Asia.

4.4 ISSUES TO BE RESOLVED

A number of issues have to be worked through including:

- Performance attributes to be covered: structural performance is a common denominator but other aspects of performance need to be considered such as fire, energy and acoustic.
- While dead and live loads can be made common, approaches to the specification of wind and earthquake are not yet aligned in the East Asia region.
- Durability is a difficult subject to describe in performance terms. The selection of the protection measures is the key issue. A common approach to the durability question is needed. A paper on the subject was given by Kelly and Watson [4] at East Asia Structural Engineering Conference recently.
- Design verification by testing: because of the complexity in performing calculations for cold-formed thin steel, verification by prototype testing is accepted and used in Australia. However this could be a novelty in regional practice and effort may be required to gain acceptance. A paper on the subject was presented by Gad and Pham [5] at East Asia Structural Engineering Conference recently.

These issues however are hopefully surmountable.

5 CONCLUSIONS

This paper has outlined the basic characteristics required for the acceptance of common regional standards. Acceptance of industry, practitioners and regulatory authorities are needed for the standard to be successful. A performance-based framework standard for cold-formed steel framing appears to have all the desirable characteristics including new technology and ability to work in collaboration with existing requirements on loadings while the form of construction is standardized. The paper concludes that a regional standard of this type has the best chance of acceptance and can be made to work for East Asia region.

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