XXXIII IAHS
World Congress on Housing
Transforming Housing Environments through Design
September 27-30, 2005, Pretoria, South Africa

The 'New Queenslander': a contemporary environmentally sustainable timber house

Rosemary J. Kennedy, E. John Hockings, and Charmaine Kai

Centre for Subtropical Design, Faculty of Design and Built Environment
Queensland University of Technology, Brisbane, Australia e-mail: r.kennedy@qut.edu.au

Rex Addison

Addison Associates Architects Pty Ltd
93 McCaul Street, Taringa, Australia

Key words: timber housing, timber construction system, subtropical design

Abstract
This paper describes the outcomes of an applied research project aimed at developing a contemporary, environmentally sustainable housing approach that takes its lead from the qualities and attributes of the Queensland vernacular timber housing, and that can be widely adopted in a similar way to its traditional predecessor. There was no intention to revive the original 'Queenslander' house but to build on the qualities which have made the timber house such an attractive and sustainable housing typology to develop a contemporary timber design vocabulary for project homes in Queensland.

The design-led multi-disciplinary project took a critical approach to identifying the optimum solution that can be obtained by combining available building materials with market appeal and affordability, architectural design for lifestyle in Australian subtropical and tropical climates, engineering design, and environmental performance. It was also imperative that the timber systems developed be able to be adopted by the house building industry with minimal change to the conventional trade-based process of project delivery.

The research included a review of available timber products including composite products, and a review of regulatory issues which impact on the use of timber in residential construction. The findings of the reviews were combined with environmental design objectives to develop a new construction system for integrating timber products in residential design.

1 Introduction

This paper describes the outcomes of the first stage of a collaborative research project between Queensland University of Technology (Centre for Subtropical Design) and Timber Queensland Ltd, the peak industry body representing the forest and timber industries. The project aimed at furthering the construction and appeal of housing that is constructed predominantly of timber and is more environmentally sustainable and responsive than housing designs currently produced in the mainstream Queensland project home market.

Stage One of the project included an analysis of regulatory codes, standards and policies, and a selected suite of materials in standard sizes, using a predominance of local timber products, to establish parameters for a timber construction system which embraces environmental sustainability while appealing to both consumers and the Queensland project home industry. The construction system developed is described by technical drawings and details.

The research combined two main complementary strategies - research by design being the overall method of research, and a literature review with the research fields informed by the design questions.

2 Social, economic and ecological context

The context of the project to develop the “New Queenslander” includes the tradition of low-density detached timber housing in Queensland, the current position of timber in the project homes industry and current urban development trends. Issues that affect the choice of design and structure of houses in Queensland, such as sustainability, affordability and lifestyle are also considered.

2.1 Vernacular precedent

The vernacular high-set timber and tin form of Queensland housing developed as a responsive solution to residential design in the tropical and subtropical regions of Australia. The buildings, often set amongst abundant vegetation, were naturally ventilated and provided cool shaded places on verandahs, or beneath the house. Not only was this form of housing suitable for the local conditions, readily accommodating flat sites or hilly terrain, it was also very adaptable and has proven to be lasting. [1] Many timber houses built in the late 19th Century, and early 20th Century are still in use today, either as housing or reused for a variety of community and commercial purposes, and contribute to Queensland’s cultural heritage.

2.2 Current position of timber in Queensland’s project home industry

Currently, the detached house represents the majority of the built environment in suburban Australia. Many new project homes adopt generic designs regardless of local topographical or climatic conditions, resulting in a homogeneous housing stock proliferating across widely varying climate zones. In Queensland, these types of designs have marginalised local design knowledge and building practice, and often result in inappropriate outcomes that rely on energy-consuming appliances such as air conditioning for comfort. Since the 1960’s the majority of houses constructed in South East Queensland have been timber framed and brick veneer construction on concrete slab on ground. Due to costs and the speed of construction, concrete slab on ground has been widely preferred by the building industry over the low set raised timber floor system. [2]

2.3 Urban development trends

Recent subdivisions in south east Queensland are generating buildings that have minimum regard for climate and their landscape. Homes which are currently seeking to provide the largest house on the smallest block leave little room for shade trees to flourish and to provide much-needed tempering of these suburban environments.

Brisbane, and Queensland generally, does not have a strong history of higher density housing. A denser urban environment has generally been regarded negatively by the local population due to the perceived sacrifice of living standards and loss of amenity. Innovative models of locally appropriate higher density development for a subtropical or tropical built environment which respond to lifestyle, landscape and climate are critical for sustainable, compact urbanisation to be accepted by the local population.

2.4 Timber – an environmentally sustainable building product

Timber is justified as an environmentally sound material for Queensland's construction industry. The following summary of timber's benefits demonstrates that it should be highly valued as a building material which is renewable, recyclable, and which is significant in the carbon cycle.

Timber in the carbon cycle
Ideally the largest possible quantity of timber should be grown and used in buildings, through sustainable resource management. Forests and timber plantations act as 'carbon sinks' which absorb carbon dioxide (CO_2) from the atmosphere and store it as wood fibre or cellulose. The CO_2 remains bound in the timber even when it is converted into building materials. [3]

Local plantations
It is envisaged that by 2010 about 75% of all timber produced in Australia will be plantation timber. [4] Transport costs and greenhouse gas emissions from transport vehicles are reduced when timber materials are sourced from local plantations close to the area of demand.

Building resource and consumption
At each stage of a building's lifecycle, large quantities of materials, energy and other resources are consumed with significant environmental impact. The energy consumption of buildings includes embodied energy. Timber's embodied energy is low compared to other building materials, and an additional benefit is that it is recyclable. [5]

Energy efficiency
A timber building can be designed to be responsive to climate, that is, warm in winter and cool in summer. Timber buildings in subtropical and tropical climates, using correct applications of insulated ceilings and floors, and shading of walls and openings, can be naturally ventilated and comfortable to live in year round. [6]

Climatic design for tropical and subtropical environments
The most populated regions of Queensland are in the Subtropical Humid zone and experience a 'hybrid' climate [7] characterised by hot, humid summers and cool winters, which requires a combination of design strategies. A timber building, which is designed with permeable enclosures and minimal thermal mass is ideal to mitigate thermal discomfort caused by summer humidity, however a subtropical house will also benefit from some thermal mass to store the sun's warmth for winter

evenings. For this strategy to succeed, it is critical that the thermal mass does not receive direct sun during summer.

3 Survey of timber building materials and regulatory issues

3.1 Timber building materials

An inventory of building materials and their applications was developed for the environmentally sustainable timber house and matched with objectives and criteria determined from the research data. Several standard timber and associated building products were selected for their ability to meet the foregoing objectives, and evaluated according to criteria such as source of product (local or imported), treatments (any glues, resins or other treatments that may be harmful to people), flammability, finishes and applications.

3.2 Regulatory issues

Regulations and codes were analysed for issues which would impact on the use/choice of timber as a primary construction material for housing. The findings highlight some of the conflicts which occur between various regulatory issues, and between regulatory issues and the principles of sustainable design strategies.

4 Objectives for environmentally sustainable housing and implications for timber

A checklist of objectives for environmentally sustainable housing was developed, and applied to local circumstances. The following summary demonstrates that timber structural systems are ideal for meeting these objectives.

Allow for social, cultural, and climatic differences
Queensland’s project home market is currently dominated by homogeneous designs which ignore the benefits of local landscape and climatic attributes. Generally, these houses are very large compared to the size of the household, and the emphasis is on internal areas. A design approach which is better suited to Queensland’s coastal areas is to minimise solid enclosure and maximise outdoor space to support the informal lifestyle which the climate allows. Outdoor living areas provided by covered timber decks are ideal.

Pay attention to solar orientation and airflows
Timber construction allows for deep shading overhangs and cross ventilation. The latter is integral to maintaining openness and permeability for thermal comfort in subtropical and tropical climates.

Minimise environmental impacts on sites
Concrete slab-on-ground construction requires extensive cutting and filling of land and causes loss of habitat, interruptions to overland water flow and results in dramatically altered microclimatic conditions. The raised floors possible with timber construction techniques are much better able to accommodate sloping and ‘difficult’ terrain without major interventions on site.

Benefit from existing and future vegetation

Significant shade trees and vegetation offer many advantages in urbanised subtropical and tropical environments. Trees and topsoil should be protected during site work, and pesticides and chemicals avoided where possible. Timber houses can be planned around existing trees and accommodate significant future trees.

Be adaptable/flexible for a variety of household types

Dwellings should be socially, environmentally and economically sustainable. The flexibility of the timber house's structure and fabric means it can be easily adjusted to comfortably accommodate people with a diverse range of needs during all stages of their life. Timber construction's advantage is the ease with which alterations or additions can be made compared with masonry construction. This work can also be reversed with a minimum of fuss.

Design for future reuse

The timber house is readily adaptable for other uses. Timber construction components can be reused or recycled.

Be adaptable for retrofitting as new technologies become available and/or acceptable

Timber houses can be altered and future penetrations and services added with considerably less difficulty than houses of masonry or concrete construction can be.

Simplify the construction process

Timber's light and easy to handle construction elements minimise heavy transportation and heavy onsite lifting. The construction of the timber house minimises the number of trades required. Prefabricated wall, floor and roof frames minimise onsite time and cost. The raised timber floor system allows easy access to in-ground services and maximises flexibility for changes during construction.

Optimise material use

Computer aided design and documentation of construction projects and components means that timber products can be specified and ordered to within very narrow tolerances with very little waste. Prefabricated wall and floor frames and roof trusses minimise onsite waste during the construction process.

5 Construction system for a contemporary environmentally sustainable timber house

The acceptance of sustainable housing will require persuading the vast majority of people to adopt different lifestyles, supportive of sustainability. A construction system for a contemporary environmentally sustainable timber house must simultaneously address the complexities of designing more compact homes on steeper slopes and smaller sites using passive design strategies, and to address the negative perception that timber is a high maintenance building material. To this end, it was concluded that the protection of the timber material and the elimination of the negative perception were central to the success of the design concept.

It was considered that for climatic reasons and the prevention of weathering of materials that a timber wall system that stepped out as it went up would provide many benefits.

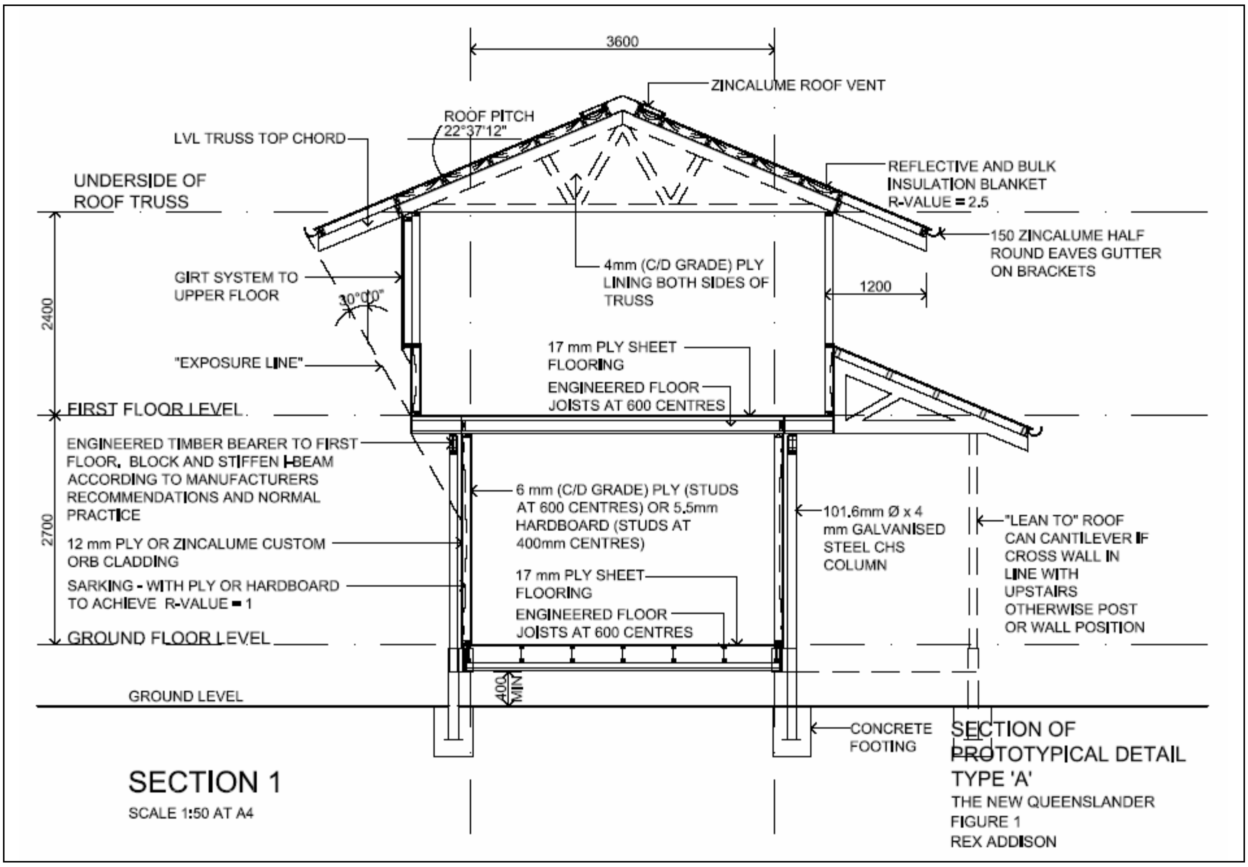

Figure 1: Section of prototypical detail Type "A"

Two systems emerged from the research by design approach. Both systems consist of a timber framed **self protecting wall system**, a timber framed floor system and a timber framed roof truss system.

Type A is a galvanised steel column/timber beam system that relies structurally on the steel loadbearing column that is external of the lower wall frame. Fig. 1. Both timber and steel are excellent materials which when used together complement each other's qualities. The Type A system uses the material that is best suited for the purpose.

Type B is a strutted and clad system that uses the load bearing properties of the lower wall frame to support the upper floor. Fig. 2.

The Type A floor system has a galvanised steel blade column supported at the edge of the floor frame. The Type B floor system is simply supported by a galvanised steel column directly underneath the floor frame. Both systems are simply supported by galvanised steel columns midspan, and have plywood floor cladding with full sheets to the module.

The lower wall framing in Type A allows a degree of flexibility because the steel post and beam is load bearing, rather than the wall frame. This allows window and door openings to be sized and positioned where desirable on the lower floor without disruption to the load bearing elements. This strategy is advantageous for design flexibility.

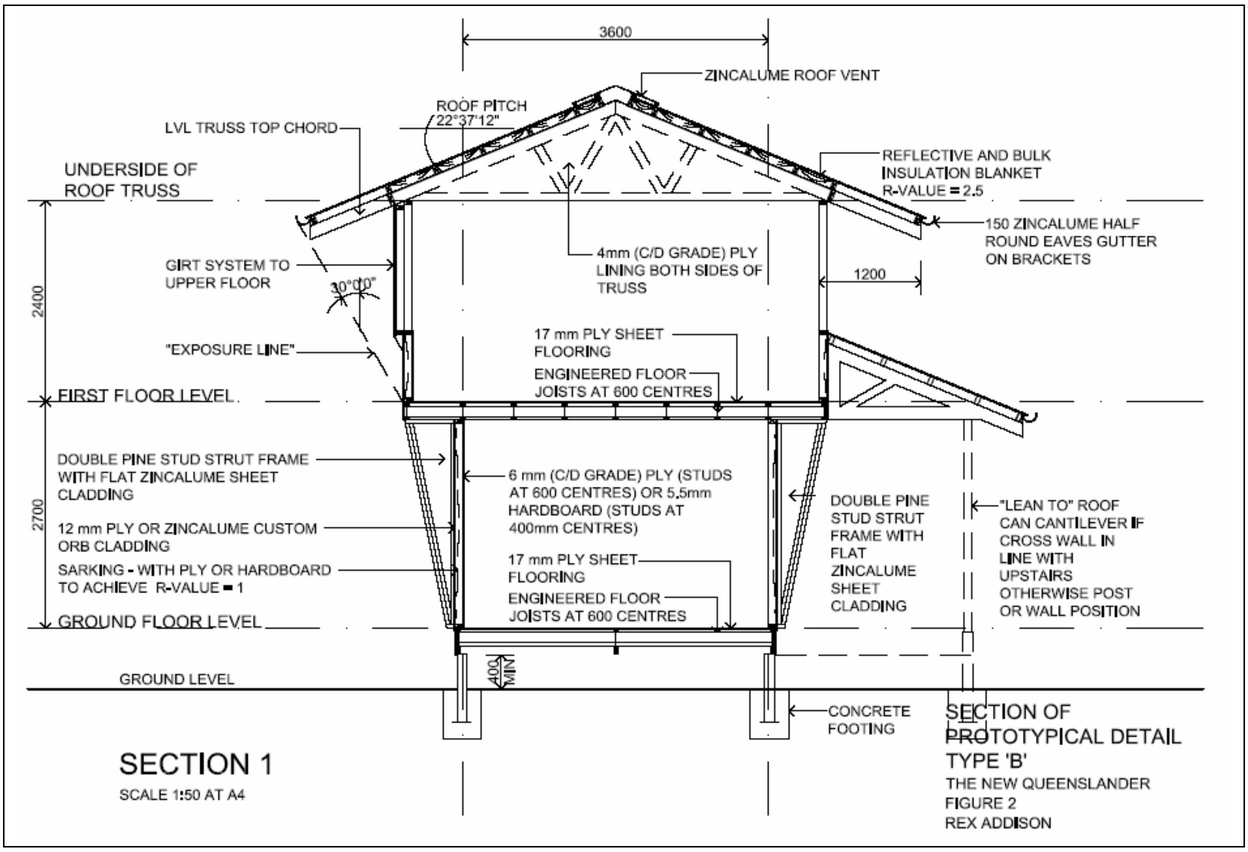

Figure 2: Section of prototypical detail Type "B"

The lower wall framing in Type B is load bearing and includes a standard prefabricated sheeted strut that supports the end overhang of the floor above. The upper floor joists in the Type A system are supported on an engineered beam that is protected at its ends. In the Type B system, the upper floor joists sit on the walls and strut walls below. In both systems, the upper floor provides weather protection to the lower floor with a 600mm overhang. The floor framing system of the upper floor is proposed to be the same as the current industry standard.

From the first floor upwards, both types are the same. The proposed upper wall system is 2400mm wide prefabricated panels delivered onsite. The upper wall is framed onsite with timber girts to form a "skin" further out. The girt system assists in providing some weather protection to the section of cladding below.

The roof trusses proposed are spaced at 2400mm centres and have an engineered top chord to allow a 1200mm roof overhang to protect the upper level. Roof purlins between the trusses allow for large overhangs on the gable ends for optimum weather protection. A steel sheeted roof is proposed for minimum heat retention and for rainwater collection. The roof system allows for ventilation at the ridge. The purlins are spaced internally at 600mm centres to provide ceiling fixing on the rake. This offers more generous spaces internally and allows the upper floor to have overhead fans.

6 Further research

The applicability of the systems will be tested in Stage Two of the project, when six housing types are designed for various conditions. The prototypes will address a variety of solutions for homes by responding to changing demographics, diminishing land supply, narrow lots, sloping lots, consumer lifestyle and amenity expectations. Applying the timber systems in a house plan is essential to uncover applications which will need to be detailed to complete the system. The aim of Stage Two is not only to demonstrate the system's adaptability and flexibility, but to check that the system satisfies the criteria articulated in Stage One.

A project team will be formed to develop the conceptual New Queenslander prototypes into built demonstration projects for homeowners and residential builders to observe. Demonstration projects are effective tools to display to the market and the building industry the features and benefits of an environmentally sustainable timber house which responds to subtropical conditions and lifestyle.

Detailed documentation and construction of the demonstration projects will allow the collaborators to effectively compare the New Queenslander prototypes with existing project homes in terms of construction costs, energy performance, thermal comfort, and maintenance and translate them into cost, time and energy savings or otherwise.

Reference

[1] Saini, B.S., Joyce, R. *The Australian House, Homes of the Tropical North.* Landsdowne Publishing Pty Ltd, Sydney, 1982.

[2] Williamson, J.B., Demirbilek, F.N. The Potential for Increasing Thermal Comfort through Selection of Construction Types in Brisbane, Destination Renewables from Research to Market ANZSES 2003. *41st Annual Conference of the Australian New Zealand Solar Energy Society*, Melbourne, 26-29 November 2003.

[3] Szokolay, S.V. *Architecture and Climate Change*. RAIA Education Division, Red Hill ACT, 1992.

[4] Plantation Timber Association of Australia. *Strategic Imperatives for the development of the plantation Timber Industry*. Plantation Timber Association of Australia, Kew East, 2001.

[5] National Timber Development Council. *Environmentally Friendly Housing using Timber – Principle.* NTDC & FWPRDC, January 2001.

[6] Sustainable Homes. *Sustainable Homes – a smart housing choice.* Sustainable Homes, Brisbane, 2004.

[7] Hollo, N. *Warm House Cool House, Inspirational design for low-energy housing.* Choice Books, Marrickville, 1995.