low Cost Rural Housing

CONCRETE SOLUTIONS

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Housing New Zealand
Housing New Zealand Corporation

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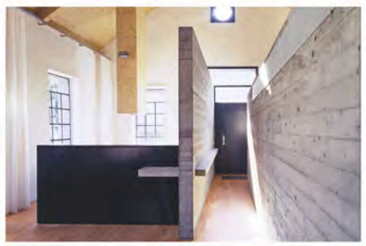

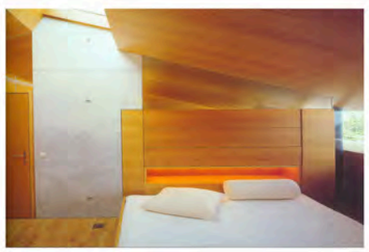

Executive Summary

This document presents two design schemes prepared by Island Architects Ltd. and commissioned by Housing New Zealand Corporation under the Low Cost Rural Housing Initiative. The schemes have been specifically designed for concrete constuction techniques, including site cast and precast formats. This project has not been designed for any specific site and has instead been designed to be built in a variety of sites in the Bay of Plenty or Northland regions. The design has been informed by literature, much of it published by Housing New Zealand Corporation.

Two unique schemes are presented. The first solution, presented as options for two to five bedrooms, is grounded on the site. This scheme observes more traditional methods of concrete and lightweight timber construction. Planning enables economies of scale in the use of concrete casting formwork and a minimum of construction details. The second option has been developed in response to brief requirements for building on multiply owned Maori land and pushes the envelope of stuctural engineering design and construction technology. This scheme is designed in modular fashion, not unlike the Habitat '67 project in Montreal, Quebec. Although the units are not designed to be stacked like that earlier project, it suggests a prefabrication process that would enable factory construction techniques and more importantly, the opprotunity to remove dwellings from the site should the need arise.

Both schemes explore new and innovative construction techniques in an efort to gain opimum benefit from each dollar invested. The project also pushes at the traditional boundaries of structural and thermal performance, more so in this project to minimise construction costs. As each design is developed into site specific solutions efforts should focus on these aspects to ensure optimum outcomes for residents.

Project Team

Client: Housing New Zealand Corporation
Wiki Walker

Architect: Island Architects Ltd.
Morten Gjerde
Andrea Ricketts
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Structural Engineer: Clendon Burns & Park
Philip Yong

Energy Consultant: e Cubed Building Workship Ltd.
Patrick Arnold

Quantity Surveyor: Monastra QS Consultants
Dave Monastra

Introduction

The brief is to provide a low-cost rural housing solution for concrete that will meet the current and future needs of HNZC clients. The brief requires that design solutions for two, three, four and five bedroom plans be offered. The brief is extended to interweave cost efficiency, appropriate cultural responses and technological benefits with appropriate planning solutions.

The houses have been designed for individuals & families in the Northland/Tai Tokerau & Bay of Plenty/Mataatua regions. Much of the land available to clients is multiply owned Maori land, a factor that has had considerable influence on our design for Scheme Two. The designs offered are not specific to any one site, as noted in the briefing document. Instead the houses have each been designed to be adaptable to a variety of site conditions and exposures.

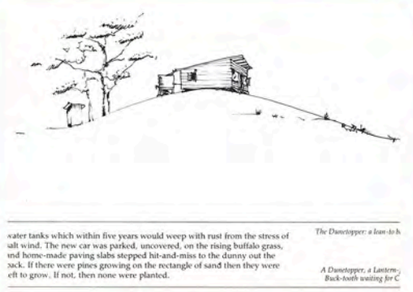
Research statistics indicate that some 80-90% of the client population identify as Maori whanau. This factor has directed and focused our further research to inform the design solutions. Appropirate housing must respect the economic capabilities of its client base – hence the need to minimise construction cost in this project – and also provide socially and culturally appropriate forms and spaces. Appropriate housing should also be desirable to those who will live in it and any form of rationalising must be done in a manner that does not diminish the desirability. This has been the main challenge of this project.

Tai Tokerau region

Mataatua region

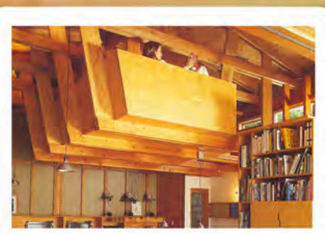
Colin McCahon, Northland

Above: Exterior & Interior Images of rural housing on the East Coast, Te Araroa 1991, source: HNZC Maori Women's Housing Project Research, c.1980's.



Above: a poor & typical example of rural dwelling layout. Source: The elegant Shed, "Dunetopper's" lean-to-baches of the 1950's still in use today

Tai Tokerau & Mataatua region images



Design Approach

Development of this project has followed a robust process informed initially by research. A considerable amount of published information from mainly New Zealand sources was scoured for relevant infomation. A number of particularly useful references were sourced from Housing New Zealand Corporation covering topics such as low cost housing and housing solutions for Maori. All the material collected and referred to in this project can be grouped in three categories:

Planning and design solutions generally
Design for low cost
Concrete design tools

Some of the more relevant and useful resources are based on interviews with low-income government-housed tenants, and include guides developed by architectural consultants specifically addressing design issues for Maori individuals & families as well as social/political reports prepared to inform Government policies. A list of the key information sour\ces is included in the bibliography in Section 7.

Climate Response
The two schemes offer potentially valuable benefits to the residents through effective use of concete. However it is important that site specific conditions are provided for as the design is developed and documented for construction. The living core extends right though the house in the four versions of Scheme One. With appropriate orientation of the house on the site this can enable residents to draw toward sunny north facing spaces in the winter months. It will be impotant to maximise north facing areas of glass to enable the sun to penetrate deep ino the space to warm the occupants and the areas of exposed concrete thermal mass. During warmer periods it is possible to withdraw into areas kept cool by the concrete. Open planning of the ‘living core’ enables flexibility to residents. They can orient their spaces to suit their own needs and achive optimum levels of comfort. Generous eave overhangs provide shading/cooling for the periphery wings and begin to stucture outdoor space.

Materials and Construction
The basis for this project has been to explore options with concrete materials at the core of the design. The concrete has been left exposed wherever it is used, both on floor surfaces as well as walls. We are confident that this approach will provide optimum cost efficency and long term durability. Prefabrication techniques have been planned for where practical and this proposal has been developed in consultation with participants in the concrete precasting industry. Timber has been used for infill partitions and for roof areas. The lightweight partitions enable higher insulation levels to be provided. Most importantly, these timber surfaces provide architectural warmth and interest, particularly when seen in relation to concrete surfaces.

Scheme One: Whare Taunga (anchored)
The shapes and spatial volumes have been developed to emphasise the exterior approach & interior entry spaces of the house, as these lead directly to the largest living & public areas. This is signified by lofty pitched roofs designed to reach their highest point above the entry spaces. As well as providing a generous welcoming and living/dining space, the edges of this central ‘living core’ operates efficiently to enable access to the peripheral bedroom and utility wings on either side. There is no corridor, therefore no wasted space, an important consideration for a project that aims to keep costs at a minimum. It is intended that this scheme also include a covered carport near the house for vehicle storage and to act as covered outdoor space for family and other social gatherings.

Scheme Two: Whare Hikitia (elevated)
In recognising the site conditions of the upper North Island rural landscape where there are only small amounts of man-made structures, Scheme 2 offers a minimalist response. The built structure is grouped into smaller stand-alone buildings that house different functions of living; a dining/living module, and bedroom/utility modules. In placing these modules within the landscape in relation to one another, the space in between creates a usable outdoor living area that can be partially covered. Living space that is of small cost! Once again, it is envisioned that these houses also include a carport as auxilliary outdoor space.

DESIGN & RESEARCH SUMMARY

BACK PORCH
- Verandahs, shelter in hot & cold weather to families, esp elderly, babies, toddlers
- Outdoor food prep, sink bench
- Clothesline
-larger rooms at back door are for storage of wet weather gear etc.

OVERALL PLANNING & SPACE CONCEPTS:
Key Principles: siting of dwellings, master planning to include: indoor/outdoor flow, open plan, communal orientation, manuhiri zones, tapu/noa zones, North Orientated & open/accessible , visual barriers between private & public spaces, public spaces at ground level

DINING:
- not normally separated from Living or Kitchen but could flow into Living when necessary, ("nerve centre" around dining table)

MECHANICAL (water supply, waste, energy efficiency):
Passive Solar/Energy efficiency:
-large stud/more insulation, 200mm conc floor slab, 40mm poly slab insulation, eave overhangs, minimize south windows, double glazing, solar hot water systems, rain water

BEDROOMS:
- larger to accommodate 2 or more children/adults/study space/ couples returning home to help parents. Max number 5 bdrms for single dwelling, then semi-detached sleepout with covered connection
- good fire egress

KITCHEN:
- need to accommodate 2 or more people working
- can be divided off from Living areas, sliding doors etc. (during Tangi etc)
- supervision/monitoring of children from (to outside, other internal rooms)

ENTRY / OUTDOOR LIVING:
- Entry verandah/Mahau: covered North Entry off Living, for welcoming, connected to earth/Papatuanuku, and relieving pressure on indoor environment
- Toilet accessed from outside aswell
- Outdoor cooking/prep: wash trough, hangi area
- Decks covered for play area
- Pergola's – permeable with summer coverage by climbing plants

Alternative power supply
- Solar Energy: photovoltaic cells (cost approx $900 per cell, need approx 8 cells per house/small building (run lights, refridgerators, and other appliances), and inverter and storage batteries are also required.

Locations on Marae/wharenui roofs
- Solar hot water cylinders to heat water, built easily by welding steel drum header tank to glass solar trap used to filter water through with small copper pipes & the water collecting pipes to feed it back into the building's hot water reticulation.
- Solar showers for $20
- Solar pads bought from electrical shops $50 to run cell phones and other light elec appliances
- Solar ovens to cook food, solar dehydrators to dry food
- Wind mills for harnessing energy & pumping water, grinding meal, good for exposed sites (wind), built cheaply by making a propeller & using a rewired starter motor to form a generator, energy stored in batteries

LIVING:
- Living/Whanau room 5 x 6m for average whanau/20 people, to have a self contained feel
- Passive solar/active slab heating system, with large carpet squares may be approprate
- Large open living spaces
- Kitchen, lounge, bedrooms all one space?
- Mezzanine provide extra space, multipurpose – office, sleep, teenagers/second living

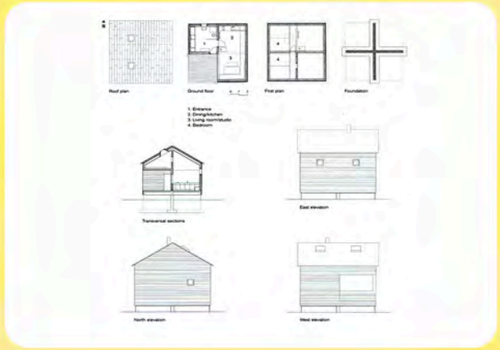
WHARE TAPIRI/SLEEPOUT:
- to provide essential short/long term accommodation, purpose designed.
- to include WC/bathroom facilities, and easy/covered access to main facilities (kitchen, living etc)
- use to screen & contain positive outdoor spaces
- Extra storage/workshop/tool sheds/ancillary buildings for farmers –this could work well with the Whare Tapiri/sleepout idea

CARPORT/GARAGE
- Preference for carports rather than garage, if extra sleep space needed, purpose designed sleepout
-Or provide lined/insulated garage

BATHROOMS:
- WC separate from Shower/bath/vanity & Laundry space
- 1 x WC ideally accessed from outside
- 2 x bathrooms, require at least shub & shower with slide arm, wet area showers sloped to FWG
- semi detached Ablution block favoured for large gatherings

LAUNDRY/LINEN:
- well ventilated, separate from Kitchen, off back porch, good for storage

Information Sources:
Hoskins, R & HNZC; Ki te Hau Kainga, HNZC Design Guide
HNZC, Maori Women's Housing Research Report, c.1980's
Iremonger. C & Scrimgeour. F; Strategy Toolkit for Maori Sustainable Development, Dept of Economics, Waikato University



Outline Specification

This specification sets the standard for the materials and processes of construction. The specification is intended to be read in conjunction with the drawings and other documentation available at this stage.

Materials have been specified in acknowledgment of the processes of construction and conditions of use that these buildings will experience. The objective has been to provide the client - Housing New Zealand Corporation and the residents – with a healthy, comfortable and enjoyable home environment that also can be considered durable and sustainable. This has for this project and will for all low cost projects in the future, be a challenge. In this case the challenge has been greater as the primary structural material is concrete. While concrete has no cost effective match in terms of durability and sustainability indicators, it is a material that requires special skills and equipment to construct effectively and efficiently. The challenge has been to rationalise the construction requirements to keep costs at a manageable level. We feel very strongly that the project details achieve these goals very well.

The project brief calls for a concrete housing scheme that can be built on any number of sites in the Northland and Bay of Plenty rural areas. This leads to presentation of a design proposal that does not include extensive site development. Descriptions of project work beyond the footprint of the building have not been included in this specification, as they cannot be planned for. This also reflects in the attached estimates of cost.

The specification is organised to reflect the two design approaches presented in the drawings. In principle the schemes are not different in the completed house; both feature the main materials of natural finish concrete and timber. Any differences will largely arise from the two approaches, Scheme 1 being a standard flat panel system with the concrete cast on site in the form of tilt panels or cast off site in the precasting yard and freighted to site. Scheme 2 is based on off site prefabrication, to the maximum extent possible. It is envisaged that in most circumstances each 3.6 metre by 7.2 metre module will be constructed in a factory setting before being trucked to site and dropped in place.

The requirements of the New Zealand Building Code and all relevant New Zealand Standards have been borne in mind during the preparation of these sketch plans and specifications. It is important that continued development of the scheme also address the code objectives and specific requirements.

Resource Consent may be required to implement any of these projects.

scheme one
Whare Taunga

Site preparation
Allow to excavate for all footings and foundations. Allow to excavate for all in ground services to and from buildings. Backfill on completion.

Floor slab
Ground floors to be steel reinforced 100 mm concrete slab on grade. Compact sub base and allow 150 min compacted hardfill with sand blinding beneath all slabs. Polythene sheet damp proof course. Allow to cut shrinkage control joints to suit layout shown on plans.

Concrete walls
Concrete walls to be steel reinforced 120 thick precast. At this stage it is not intended to insulate these walls in order to minimise cost and in view of prevailing climate conditions in Northland. To not insulate the exterior walls will enable efficient heat loss at night during the warm periods of the year to release heat gathered during the day. However, as noted in the report from e Cubed Building Workshop Ltd. there may be a risk of cold and condensation if outside temperatures are low. Our strategy has been to increase insulation levels in the timber framed elements forming the exterior envelope of the house to offset heat loss that may occur during the winter months.

During design development and the construction documentation stages it will be important to refine the approach to insulation of the concrete walls in the context of the financial budget. The optimum solution may be very dependent on specific site conditions. Clearly it is paramount that the thermal comfort and performance of the house is to the levels expected and required by law.

Concrete finishes to comply with NZS 3114: Specification for Concrete Surface Finishes with formed surfaces to meet F5 finish requirements and unformed surfaces to achieve U8 finish.

All concrete walls are to remain unpainted on both faces.

Timber framed walls
Lightweight exterior walls to be 100 x 50 framing with R 2.2 insulation batts between.

Exterior cladding to be 9 mm construction plywood fixed to studs over building paper with 60 x 25 timber cover battens at all sheet joins. The planning layout of each building has sought to optimise the use of materials and is based on modules of 1.200 x 2.400 sheets. Allow flashings at all windows, doors and other penetrations.
Interior cladding to be 6 mm construction plywood fixed directly to studs. Allow light arise at sheet joints and screw fixings of nails set below surface.

Lightweight interior walls to be 75 x 50 studs flat with 9 mm construction plywood cladding one face only.

Wet rooms to have 9 mm Hardies Villaboard on timber studs with all fixings and sheet joints stopped. Allow gloss paint finish in these rooms only.

Doors
Exterior doors are to be Tri board or equivalent quality brand hung on 1-½ pair stainless steel butt hinges. Allow paint finish.

Interior doors are also to be painted Tri board.

Hardware
All exterior doors to have mortise latchset and lever handle door furniture. All interior doors to have tubular latchsets and knob handle door furniture. All by Legge Pacific or equal approved.

Allow for miscellaneous hardware such as cabinet pulls, coathooks and rails in wardrobe units and towel rails, all to a basic standard.

Windows and exterior glazed doors
All windows and exterior glazed doors to be domestic grade aluminium frame with square snap-in beads. Allow powder coat finish in selected colour. All windows to be single glazed with thickness and safety features to suit situation. Comply with all relevant New Zealand Standards.

Ceilings & roofs
The roof is to be framed using timber rafters at regular intervals spacing of between 600 – 800. Lay 6 mm MDF as ceiling lining above rafters followed by 75 x 50 purlins on edge with rigid insulation between.

Lay roofing underlay over purlins before fixing 0.4 Colorsteel finish corrugated profile roofing.

Joinery
Allow for the following items of joinery. The design intention is to form modular joinery units to optimize construction cost and to enable residents / owner to customise kitchen layout within the space provided. The construction materials are a laminated plastic bench surface on particleboard on a 16 MDF stained carcase with overlay hinges and basic standard drawer slides.

Proprietary laundry tub and joinery unit.

1 no. storage cupboard to be provided for each bedroom as a wardrobe. This unit is to be constructed from stained16 MDF. 600 x 450 x1800 high

Plumbing
Allow for all plumbing inside house including water supply, and waste/ drainage system to perimeter of building. Allow also for rainwater collection system from roofs. All infrastructure costs beyond the building footprint are not part of this package. These may include

Water supply lines from reticulated source or as collected in tanks on site.
Drainage to reticulated sewer system that may include recycling of gray water on site with other effluent to on site septic system or town system.
Allow the following plumbing fixtures complete with taps and faucets as appropriate to use. Numbers of fittings as shown in the floor plans. Standard of plumbing fittings and tapware to be basic. Where cost effective plumbing can be left exposed to view.

Hand wash basin
Toilet & cistern
shub
Kitchen sink
1 x 135 HWC above laundry tub

Electrical
Meter board and distribution board of appropriate size and capacity to each living unit that is provided with electrical power supply. Cabling to all fittings, switches and outlets. In general, each room to have 2 no. Recessed wall mounted general purpose outlets, 1 no. Ceiling mounted surface mounted light fitting with wall-mounted switch. Allow for basic range light fittings.

Mechanical
Allow 1 no. extract fan in bathroom.
Allow 2 no. lowered vents – no power – in gable ends. Natural ventilation only.

Fire protection
Allow smoke detectors to comply with NZBC approved docs.
Allow 1 no. fire extinguisher in each house.

Site works
Conc. pad at entry door if nothing else is shown.
No other site works to be allowed.
All services outside building foot print to be by separate contract.

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scheme two
Whare Hikitia

Site preparation
Allow to excavate for pile footings. No other excavation should be necessary as one of the design objectives with this scheme that hovers above the site is to touch the earth lightly. The structural engineers will design a pile system that would form the only structural connection to the site and allow terrain of various slopes to be accommodated

All services work outside the building footprint to be carried out by a separate contract.

Concrete Structure
Scheme Two is based primarily on a three dimensional box form similar to the well known Habitat 67 project in Montreal, Quebec and closer to home, the dwellings fabricated by Precast Modular Solutions in Melbourne, Victoria. Both of these precedents have been illustrated earlier in this proposal. The basic form of the units has two concrete walls and a ground floor slab. The design idea has been largely driven by two issues; the objective of being able to relocate the dwellings should the need arise (and therefore the opportunity to prefabricate the units to optimise construction costs) and the objective of using concrete materials in the most effective manner to moderate indoor comfort and energy efficiency.

The concrete box form would have two sides that can be filled in on the other two walls and roof with lightweight construction to allow increased thermal insulation in these areas. Any one dwelling would consist of two or more of the same size module linked by outdoor space. Some of the outdoor spaces would be covered. Proposed module layouts are shown in the drawings, however layouts could be varied within this module. Modules could also be joined to create larger and more traditional house forms. The concrete module is still subject to engineering design but at this point the walls can be assumed to be 120 mm thick with steel reinforcing throughout. It is likely that a slab thickening must be planned for, both to assist in supporting the structure in its final location but more importantly to enable the modules to be carried by a crane in a specially fabricated cradle. By supporting the structure from the underside during the lifting operation some of the stresses at the top of the walls that would normally develop can be avoided.

At this stage it is not intended to insulate these walls in order that costs be minimised and in view of prevailing climate conditions in Northland. To not insulate the exterior walls would enable efficient heat loss at night during the warm periods of the year, releasing heat gathered during the day. However, as noted in the report from e Cubed Building Workshop Ltd. there may be a risk of cold and condensation if outside temperatures are low. Our strategy has been to increase insulation levels in the timber framed elements forming the exterior envelope of the house to offset heat loss that may occur during the winter months. The concrete floor portion of the structure would be insulated using rigid insulation cast into the concrete soffit surface (that would actually be cast face up).

During design development and the construction documentation stages it will be important to refine the approach to insulation of the concrete walls and the entire building in the context of the financial budget. The optimum solution may be highly dependent on specific site conditions. Clearly it is paramount that the thermal comfort and performance of the house is to expected levels and as required by law.

Concrete finishes to comply with NZS 3114: Specification for Concrete Surface Finishes with formed surfaces to meet F5 finish requirements and unformed surfaces to achieve U8 finish.

All concrete walls are to remain unpainted on both faces.

Timber framed walls
Lightweight exterior walls to be 100 x 50 framing with R 2.2 insulation batts between.

Exterior cladding to be 9 mm construction plywood fixed to studs over building paper with 60 x 25 timber cover battens at all sheet joins. The planning layout of each building has sought to optimise the use of materials and is based on modules of 1.200 x 2.400 sheets. Allow flashings at all windows, doors and other penetrations. Interior cladding to be 6 mm construction plywood fixed directly to studs. Allow light arise at sheet joints and screw fixings of nails set below surface.

Lightweight interior walls to be 75 x 50 studs flat with 9 mm construction plywood cladding one face only.

Wet rooms to have 9 mm Hardies Villaboard on timber studs with all fixings and sheet joints stopped. Allow gloss paint finish in these rooms only.

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Exterior doors are to be Tri board or equivalent quality brand hung on 1-½ pair stainless steel butt hinges. Allow paint finish.

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Allow for miscellaneous hardware such as cabinet pulls, coathooks and rails in wardrobe units and towel rails, all to a basic standard.

Windows and exterior glazed doors
All windows and exterior glazed doors to be domestic grade aluminium frame with square snap-in beads. Allow powder coat finish in selected colour. All windows to be single glazed with thickness and safety features to suit situation. Comply with all relevant New Zealand Standards.
Ceilings & roofs
The roof is to be framed using timber rafters at regular intervals spacing of between 600 – 800. Lay 6 mm MDF as ceiling lining above rafters followed by 75 x 50 purlins on edge with rigid insulation between.

Lay roofing underlay over purlins before fixing 0.4 Colorsteel finish corrugated profile roofing.

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Allow for the following items of joinery. The design intention is to form modular joinery units to optimize construction cost and to enable residents / owner to customise kitchen layout within the space provided. The construction materials are a laminated plastic bench surface on particleboard on a 16 MDF stained carcase with overlay hinges and basic standard drawer slides.

Proprietary laundry tub and joinery unit.

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Plumbing
Allow for all plumbing inside house including water supply, and waste/ drainage system to perimeter of building. Allow also for rainwater collection system from roofs. All infrastructure costs beyond the building footprint are not part of this package. These may include

Water supply lines from reticulated source or as collected in tanks on site.
Drainage to reticulated sewer system that may include recycling of gray water on site with other effluent to on site septic system or town system.
Allow the following plumbing fixtures complete with taps and faucets as appropriate to use. Numbers of fittings as shown in the floor plans. Standard of plumbing fittings and tapware to be basic. Where cost effective plumbing can be left exposed to view.

Hand wash basin
Toilet & cistern
shub
Kitchen sink
1 x 135 HWC above laundry tub

Electrical, Mechanical and Fire Protection Services as for Whare Taunga

Site works
Conc. pad at entry door if nothing else is shown.
No other site works to be allowed.
All services outside building foot print to be by separate contract.

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Summary

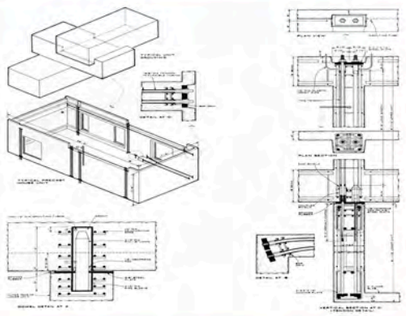
This project presents two sketch design proposals for low income rural housing for the Northland and Bay of Plenty regions. Our initial proposal, included in this document as Scheme One: Whare Taunga, is grounded in the site in the typical fashion of concrete housing in New Zealand. Scheme One presents traditional architectural forms and is proposed to consist of one building, supplemented by a car port for extended outdoor space. Efficiencies have been created by eliminating separate corridor spaces, incorporating these otherwise dead circulation areas into living areas where they can be of greatest use to residents. Although a single scheme was commissioned, as the project developed it appeared that this would be inadequate to respond to the brief and discussions with members of Housing New Zealand Corporation.

A second scheme, to provide for development on multiply-owned Maori land, would require a unique approach using the medium of concrete. For precedent we looked around Australasia as well as further a field. We identified two precedents for concrete housing that is able to be prefabricated in a three dimensional format and perched lightly upon the site. Scheme Two: Whare Hikitia is based on a modular form consisting of a concrete floor and between two and four concrete side walls. The concrete module would be placed upon a series of concrete piles that would be the only portion of the building unable to be salvaged upon removal of the buildings if this becomes necessary. These concrete piles can also accommodate a range of site topographies without requiring modification of the basic module. Houses would contain between two and four such modules to provide the space needed to house a variety of family structures and sizes.

The basis for each design proposal is concrete. The design has sought to optimise the unique qualities of the material, mainly architectural, thermal and structural. In recognition of commonly held perceptions of unpainted concrete we have included areas of unfinished timber framing and plywood. This strategy also allows additional insulation levels to be provided in the roof and exterior walls. We would recommend that as the project is further developed that thermal performance is optimised through computer simulation and modelling, to enhance benefits to residents and to meet the objectives of the New Zealand Building Code. Modelling must take account of specific attributes unable to be planned for at this stage such as specific site orientation and surrounding context.

Two very exciting and appropriate solutions for concrete housing in the rural areas of Northland and the Bay of Plenty are presented in this document. The designs have been informed by research, particularly in the areas of appropriate cultural and social architectural response, and push the boundaries of traditional construction technology in this country. We look forward to seeing the project develop through to implementation and to the opportunity to remain involved during these following stages.

Island Architects Ltd.
December 2005



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