STUDY REPORT

SR 261 (2011)

Physical Characteristics of New Houses

IC Page, MD Curtis

Funded by BRANZ
from the Building Research Levy

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Preface

This is the first of a series of reports on the physical characteristics of new housing. The data was obtained from BRANZ surveys to builders of new detached houses. The purpose of the surveys is to obtain data on new housing which is not available from official sources. This includes the generic type of materials used by building component, and design information such as number of floors, wind zones, envelope risk matrix scores, stud arrangements, prefabrication and efficiency measures. The data is useful for studies in the fields of sustainability, energy efficiency, durability and engineering.

Acknowledgments

This work was funded by the Building Research Levy.

Note

This report is intended for researchers, Government officials and manufacturers.

Physical Characteristics of New Houses

BRANZ Study Report SR 261 [2011]

IC Page, MD Curtis

Abstract

The amount of official data available on the characteristics of new housing is very limited. Building consents data held by Statistics New Zealand provides information on building type, value and floor area aggregated into territorial authorities. This is valuable data, encompassing a complete record of all consents; however, there is no information available on materials used or housing characteristics beyond the floor area. BRANZ began a survey in 1998 to obtain data on materials used in new housing (and other buildings) and has since complied a database of approximately 1200 new houses per year. This report contains results from those surveys on the generic materials used in new housing and some of the other physical characteristics of the houses. The aim is to provide information useful to researchers, Government officials and manufacturers.

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1. INTRODUCTION

Over 1200 new residential units per year are encompassed in the BRANZ New Dwellings Survey. This survey collects a variety of data on materials used in new housing. Using this data, representative results are able to be collected on the incidence and proportions of many different materials. The components and design features analysed are:

- Claddings
- Framing Types
- House Storeys
- Floor Types
- Floor Joists
- Insulation
- Sustainability Features
- Space Heating Appliances
- Wall Stud Arrangements
- Wind Zones
- E2 Risk Scores
- Double Glazing

2. SUMMARY

Data is shown on market share trends for generic materials used in new housing. The survey used to compile the charts began in 1998 but the regional spread and sample size was not sufficient until 2002, so the charts begin from then. The survey was developed mainly for manufacturers and, to preserve confidentiality, the results are shown in generic categories. Not all components/characteristics have been continuously covered since 2002, so some results are for a shorter period.

3. METHOD

Whats On[1] building consent data is used to obtain a sample of new housing for each period. From this sample, builders or designers of new houses from 31 selected territorial authorities are sent our New Dwelling Survey form. Incentives are offered for completion of the form. The 31 territorial authorities are Auckland, Christchurch, Dunedin, Franklin, Far North, Gisborne, Hutt City, Hamilton, Invercargill, Kapiti, Manukau, Marlborough, Napier, New Plymouth, North Shore, Porirua, Palmerston North, Queenstown, Rodney, Southland, Tauranga, Thames-Coromandel, Tasman,

[1] *Whats On Report* (Monthly). TF Stevens & Co Ltd, Auckland, New Zealand.

Waikato, Waipa, Wellington, Waimakariri, Western Bay of Plenty, Whangarei and Waitakere.

Where applicable, results have been weighted based on consent values to allow for regional building activity.

For wind zones, E2 risk scores and double glazing, only recent data has been used. Therefore, the results displayed are an aggregation of the responses that we have received in the last three quarters, i.e. since the December quarter 2010 for each component.

Average floor areas from the past 9 years have been investigated to determine the accuracy of the following results. Figure 1 shows how the average floor area from our sample data matches up against the average floor area from consent data obtained from Statistics New Zealand. Each point on the chart represents one year of data. Our sample has a slight bias towards larger houses, typically about 4% in most years, less in recent years, but up to 9% (in 2007). Reasons for the bias are not known but may be because some smaller territorial authorities are not surveyed and these may tend to have smaller houses (for a list of surveyed territorial authorities see Figure 6).

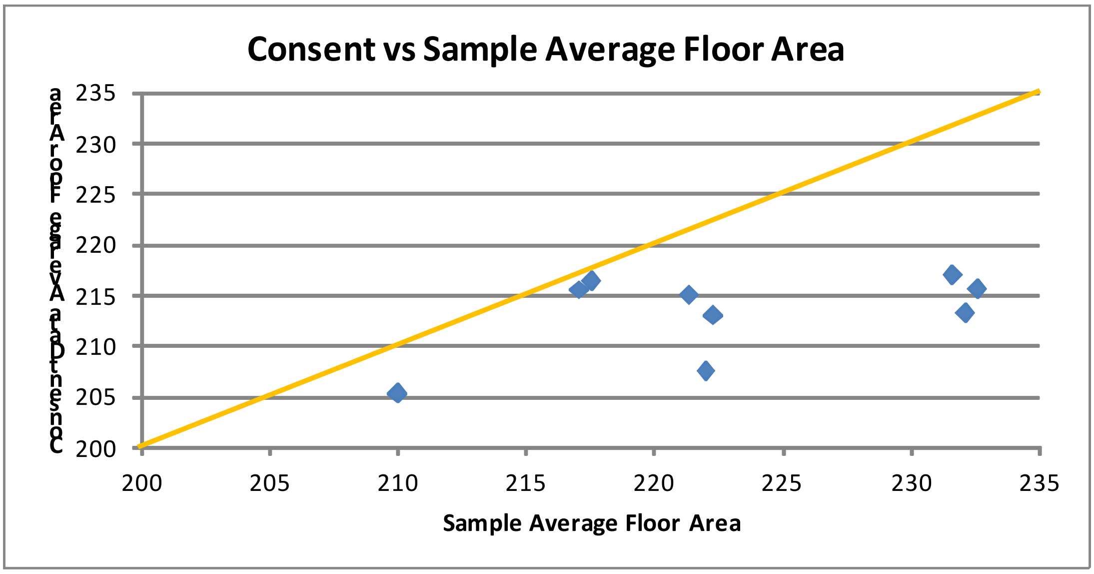

Figure 1 Consent vs Sample Average Floor Area

Figure 2 illustrates the difference between the average consent value and the average survey form value for the houses in our sample. Both follow the same trend throughout the years. The difference between the two is often that builders suggest a lower value in the hope that it will help them obtain a job. Then, once they have the job, the actual cost is sometimes higher. Another reason that may contribute to this difference is that the consent may be applied for before the plan has been finalised, and thus extra costs could be incurred.

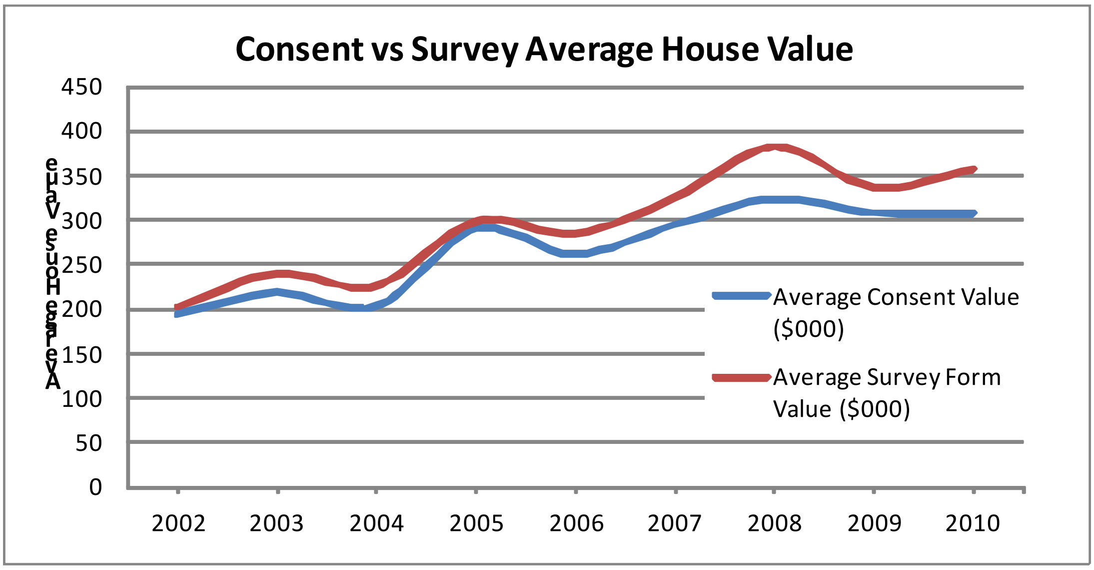

Figure 2 Consent vs Survey Average House Value

4. MAIN RESULTS

Further results are shown in the following charts. The data for these charts is provided in the tables in the appendix.

4.1 Roof Claddings

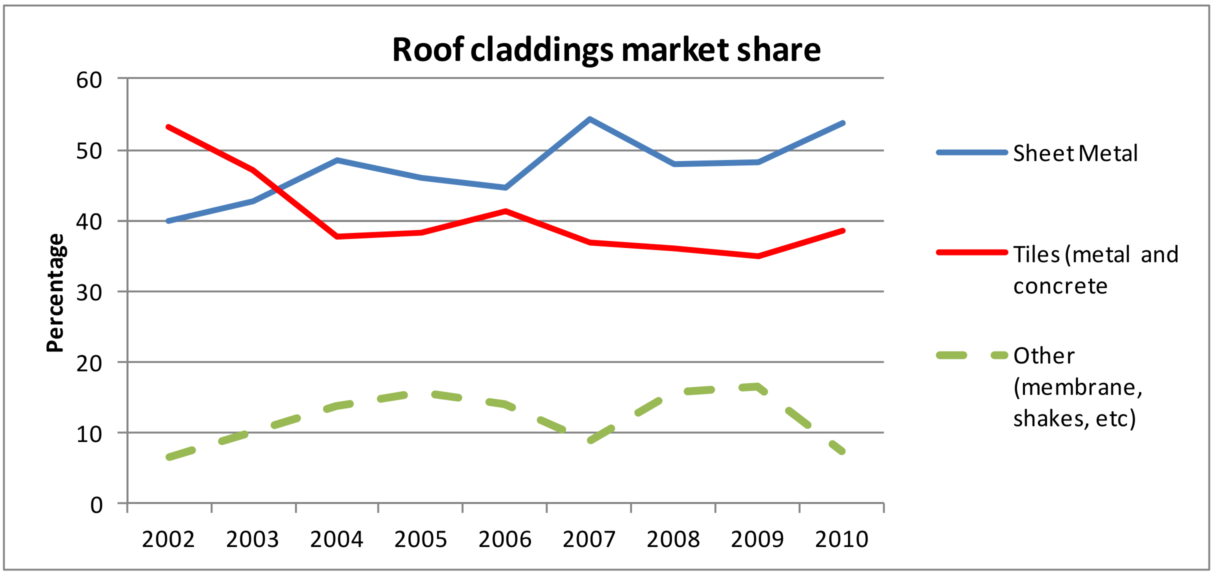

Figure 3 Roof Claddings Market Share

Sheet metal is the dominant roof cladding and is trending upwards. 2005, 2006 and 2008 saw small decreases in the market share for sheet metal. However, overall sheet metal's market share has been increasing.

Tiles are the second-most preferred roof cladding. Combined, metal and concrete tiles hold almost 40% of the market share. Since 2002, concrete tiles have been trending downwards.

4.2 Wall Claddings

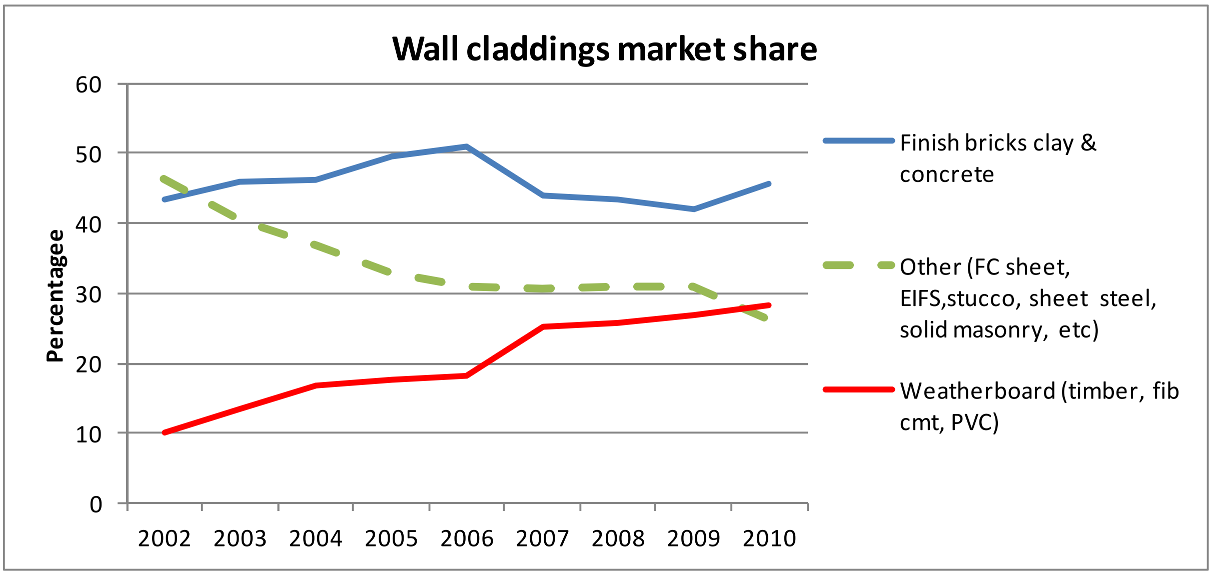

Figure 4 Wall Claddings Market Share

Clay brick is the dominant wall cladding, holding over 40% market share throughout the majority of years covered. 2007 and 2008 saw decreases in the market share for clay brick, but it has since recovered slightly.

The Other category, mainly monolithic type claddings (i.e. sheet fibre cement, EIFS and stucco) have trended downwards after the impact of the leaky homes discovery in the early 2000s.

4.3 Wall Frames

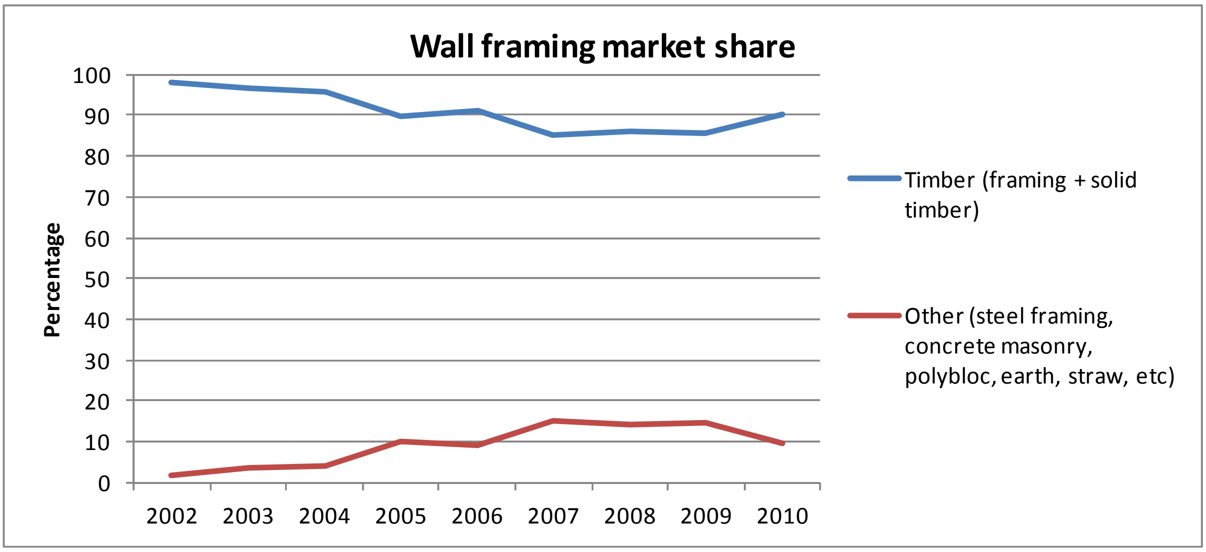

Figure 5 Wall Framings Market Share

The wall framing types are shown in Figure 5. Timber framing is the predominant structural material

There has been slow growth in steel framing and solid timber houses since the mid 2000s. Concrete masonry has been fairly steady at around 2-4% market share during the 2000's.

4.4 House Storeys

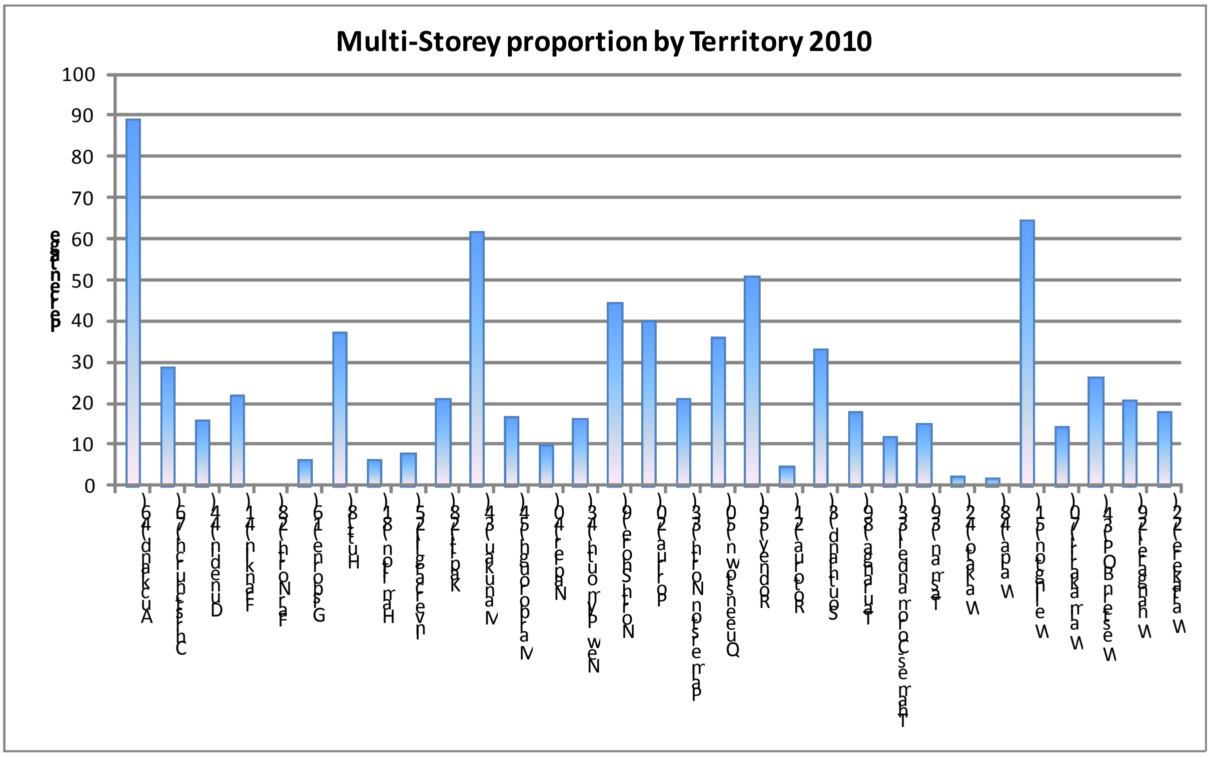

Figure 6 Multi-Storey Proportion by Territory 2010

Almost 90% of new houses surveyed in Auckland were multi-storeyed in 2010. 65% of new houses in Wellington were multi-storey, the second-highest proportion out of the territories surveyed. No new houses that were surveyed from the Far North were multi-storeyed, the only territory sampled to have 0%.

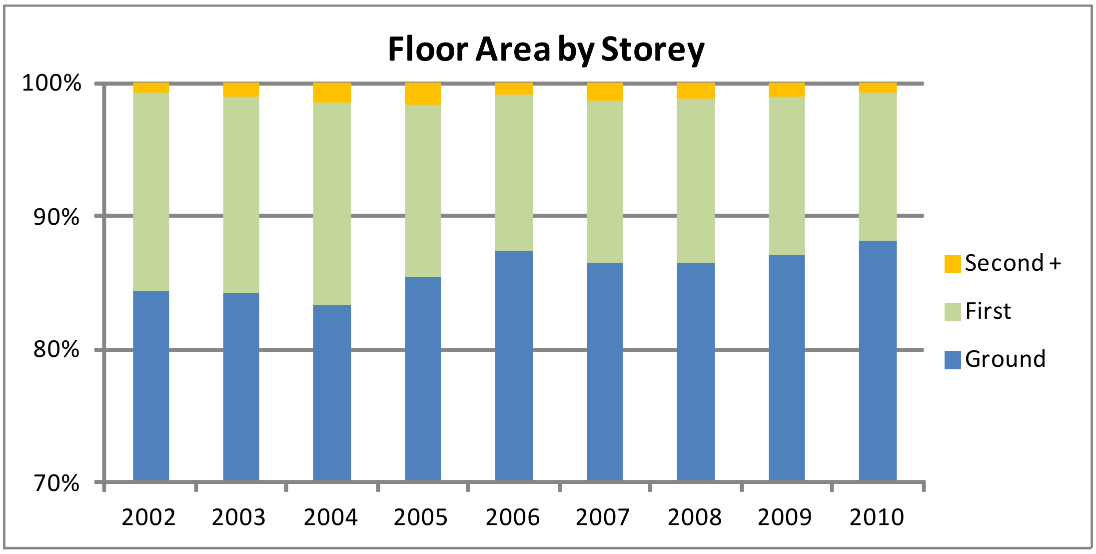

Figure 7 Floor Area by Storey

Single-storey houses are the most common among new houses. Between 2002 and 2004 multi-storeyed houses gained some prominence, however since then, single-storey houses have gained in share, trending towards 90% of new houses. 2004 and 2005 were highs for more than two storeys, with over 1.5% share. However since then, the share appears to be decreasing.

4.5 Flooring

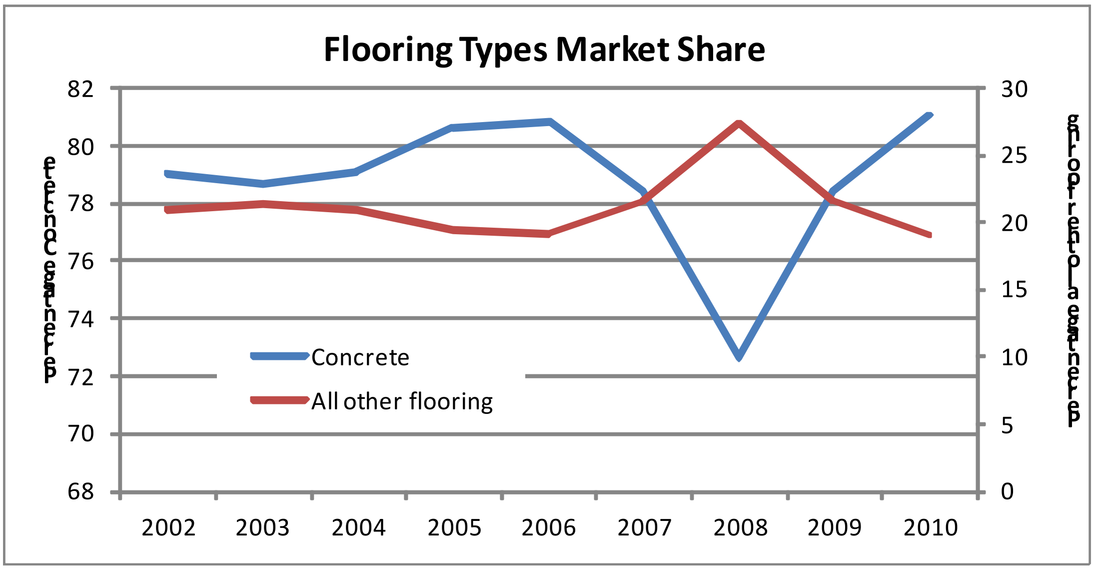

Figure 8 Flooring Types Market Share

Following a 2008 low for concrete of 73% market share, concrete flooring has risen by 8% to its highest share in the surveyed period. The relative mix of concrete and timber, which includes particleboard, plywood and structural strip timber, floors reflects the type of houses being built.

When larger houses are being constructed on small sections the upper floor proportion (i.e. timber floors) increases. Figure 7 illustrates that after 2004, the proportion of area in upper storeys decreases, explaining the increase in concrete flooring between 2004 and 2006. The low concrete flooring market share in 2008 was due to a greater proportion of ground floors being made out of timber than in the other years.

4.6 Floor Joists

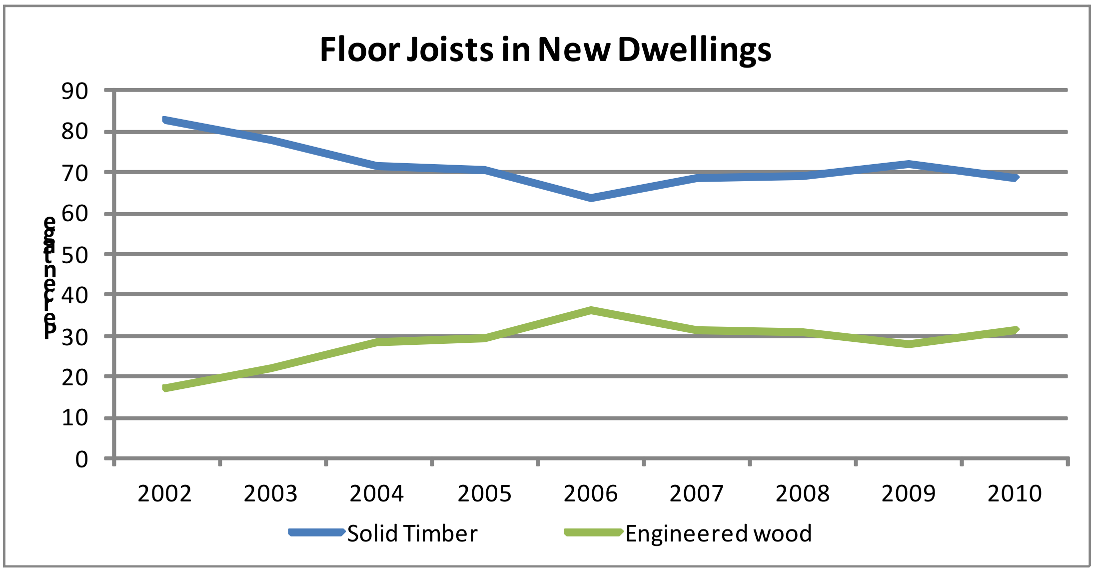

Figure 9 Floor Joists Market Share

Solid timber floor joists are the most common system for timber floors. However, 2010 saw a decrease in share for timber floor joists, with engineered wood increasing in the same period.

Figure 10 Sold Timber Joist Depths Share 2010

250mm was the most common depth for solid timber joists in 2010. Greater than 5% shares were also seen for 150mm, 200mm and 300mm depths.

4.7 Insulation

Wall insulation, ceiling insulation and floor insulation for both concrete slabs and timber floors have been separated in this section.

4.7.1 Wall Insulation

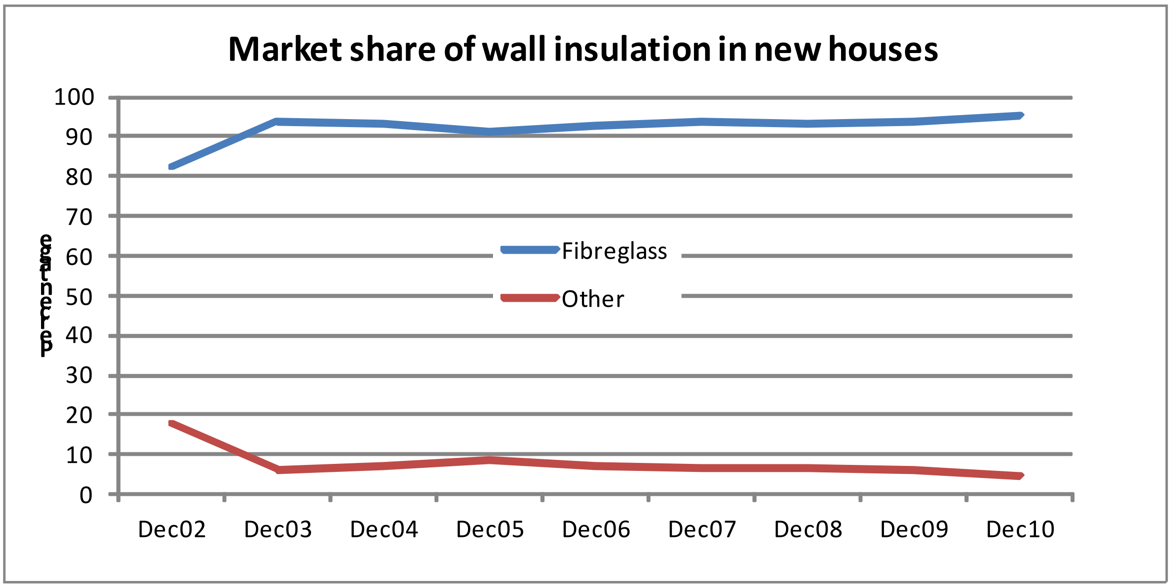

Figure 11 Wall Insulation Market Share

Fibreglass is by far the most popular wall insulation with over 95% market share in 2010. It is also trending upwards. The "other" category is mainly polystyrene and natural wool.

4.7.2 Ceiling Insulation

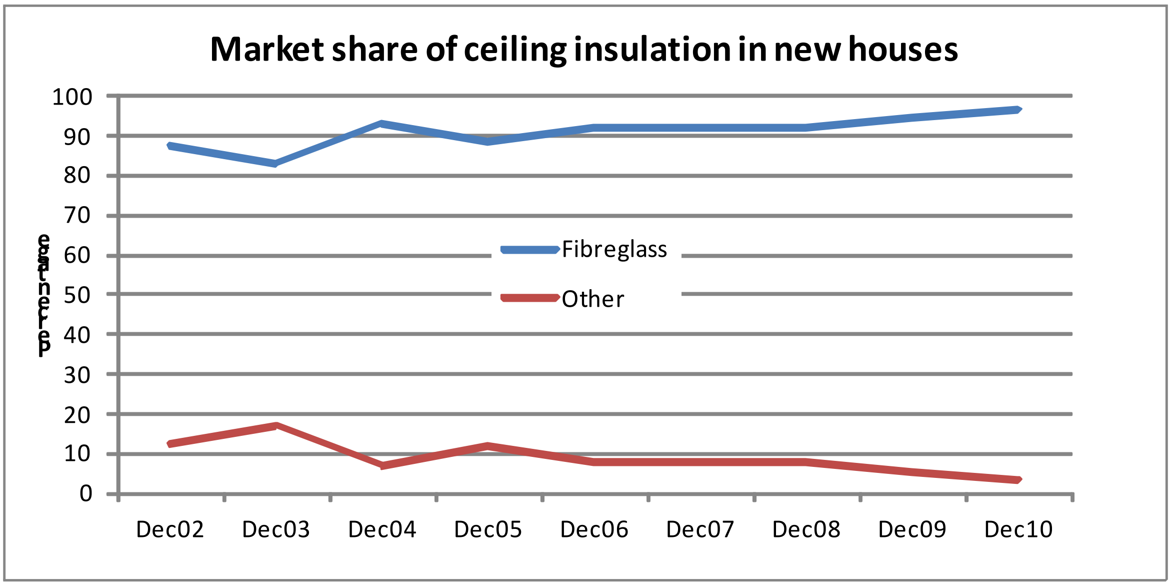

Figure 12 Ceiling Insulation Market Share

As with wall insulation, fibreglass dominates the ceiling insulation market. Polyester has closer to 2% market share and wool is the only other notable insulation material.

4.7.3 Floor Insulation

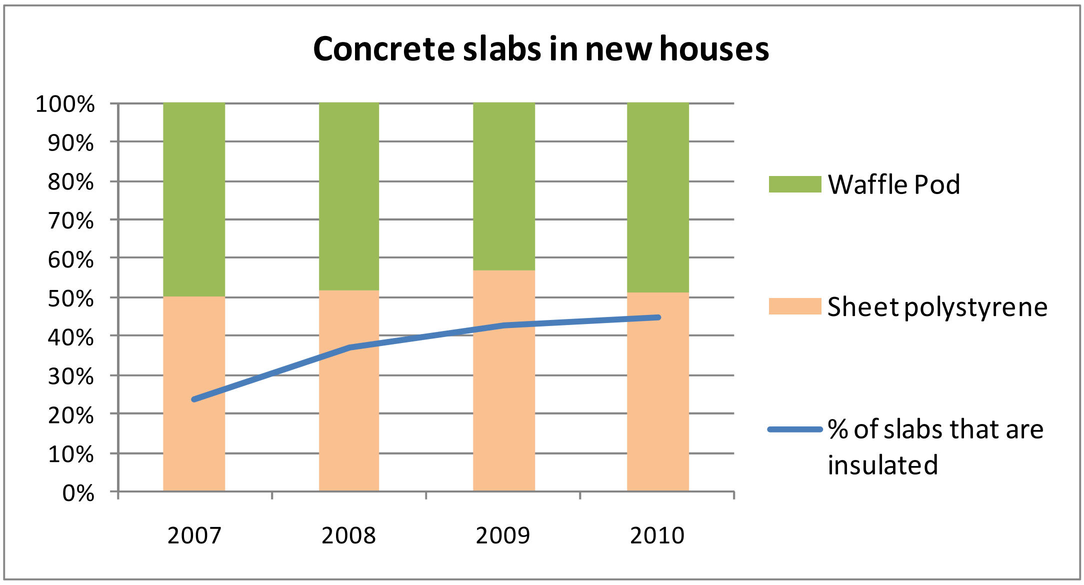

Figure 13 Concrete Floor Insulation Market Share

The percentage of slabs that are insulated has risen steadily and is now about 43%. For those slabs that are insulated, the split is about 50:50 between polystyrene sheet and polystyrene waffle pod type.

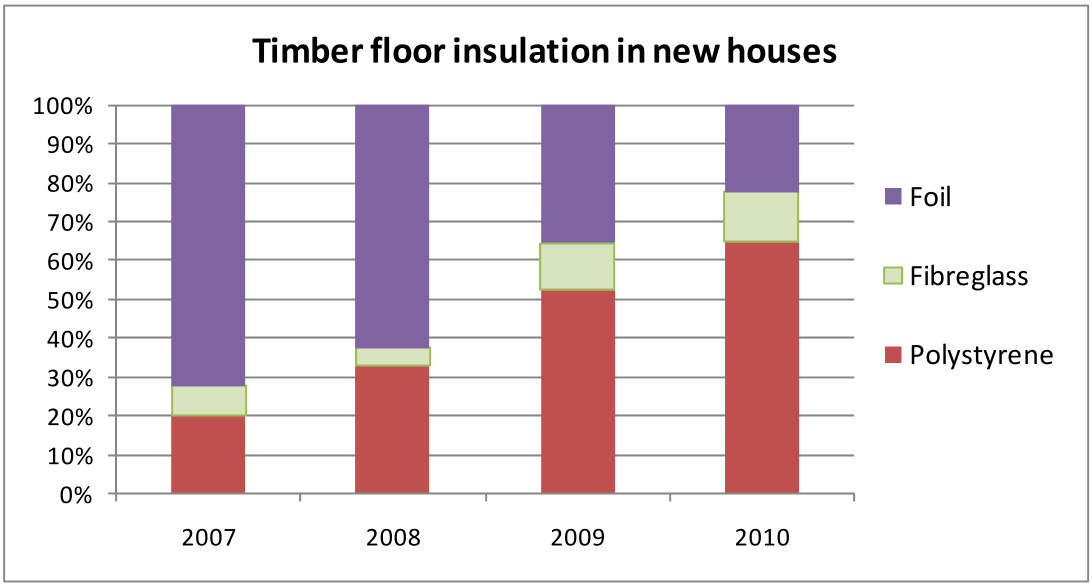

Figure 14 Timber Floor Insulation Market Share

Polystyrene floor insulation has gained significant market share in recent years.

4.8 Green Features

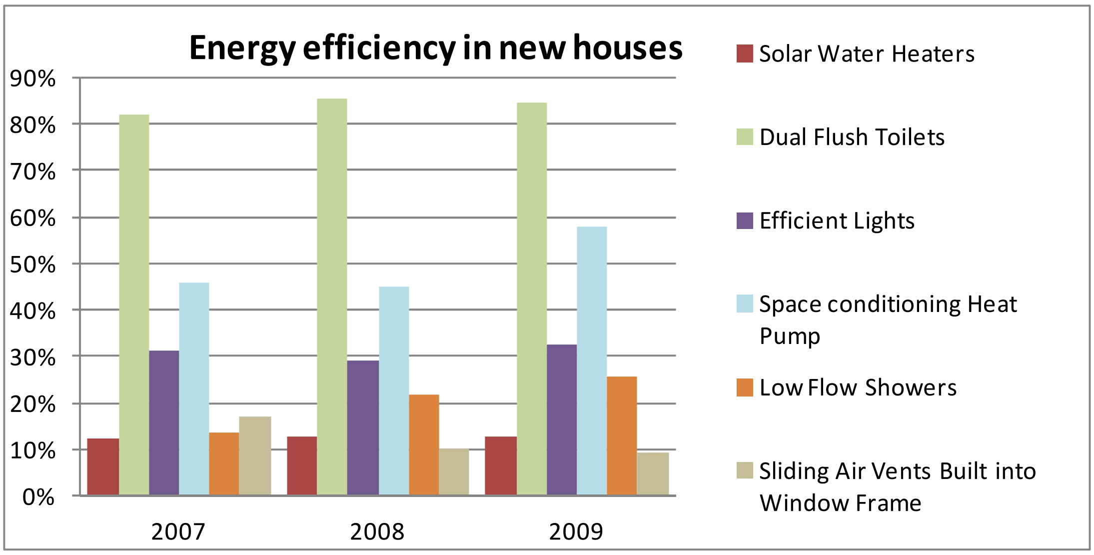

Figure 15 Efficiency Devices in New Housing

The above figure illustrates the percentage of new houses having selected energy efficiency and other sustainability items installed. The most common efficiency item during the survey period was dual flush toilets, installed in over 80% of new houses. The average number of items being installed per house was between 2 and 2.5 for most of the period. Sliding vents built into frames are in approximately 10% of windows according to the survey. However, it is possible some respondents have confused the moisture drainage slits in the frame with sliding ventilation openings and the percentage could be over-stated. The questions on efficiency items were removed from the survey in the March quarter 2010 and therefore more recent data is not available.

4.9 Heating Systems

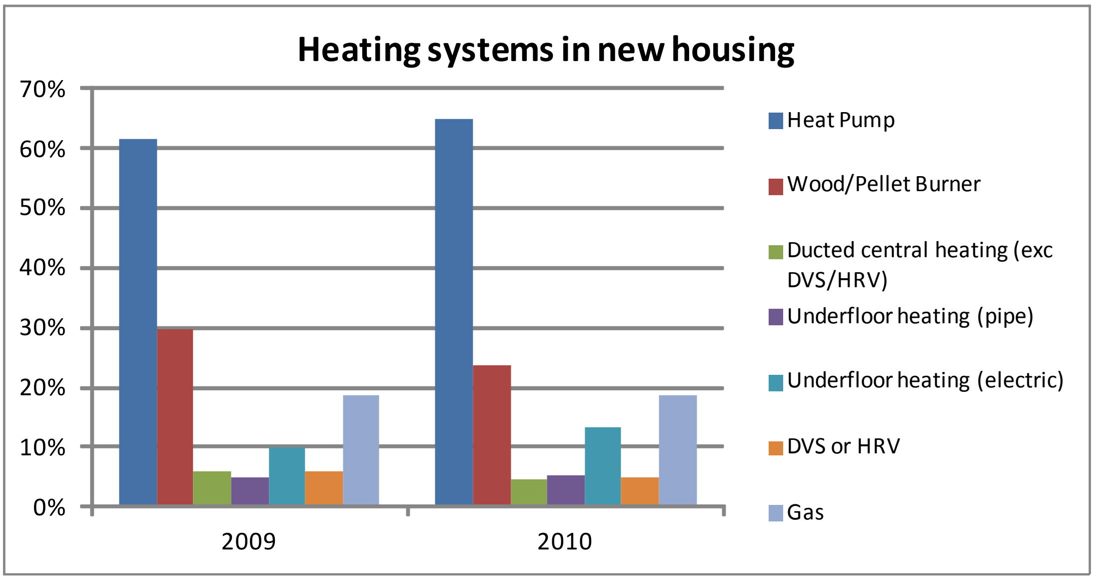

Figure 16 Heating Systems in New Housing

Heat pumps are the preferred heating system in new housing with a 60% market share across the period surveyed. Both gas and wood/pellet burners are the only other heating systems that have been consistently over a 10% share.

4.10 Stud Sizes and Spacing

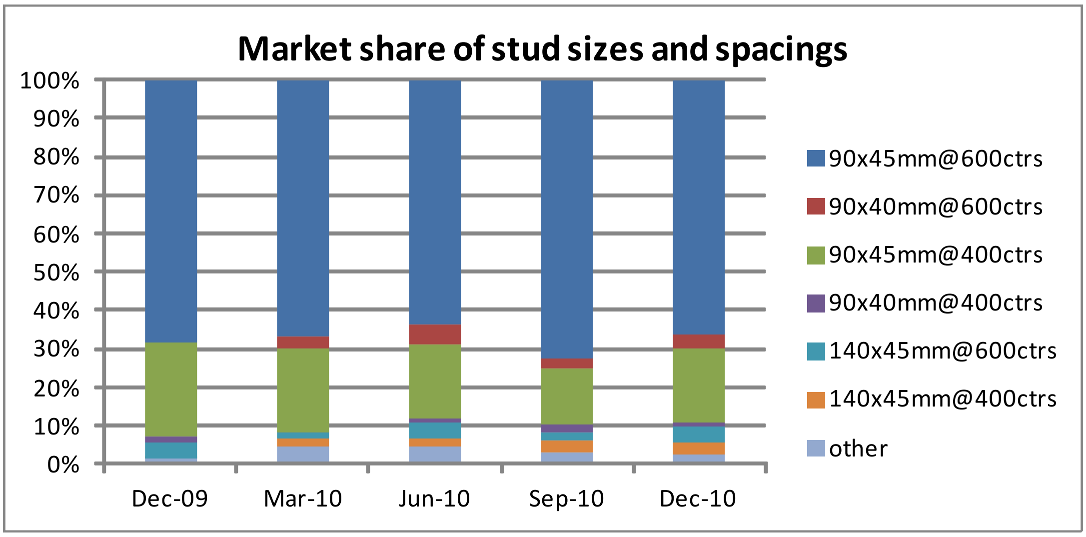

Figure 17 Stud Sizes and Spacing in New Housing

Over the surveyed period, the 90x45mm @ 600 centres stud size and spacing has remained relatively steady at over 65%. The only other stud size and spacing that has over 5% share is 90x40mm @ 400 centres.

4.11 Downlights

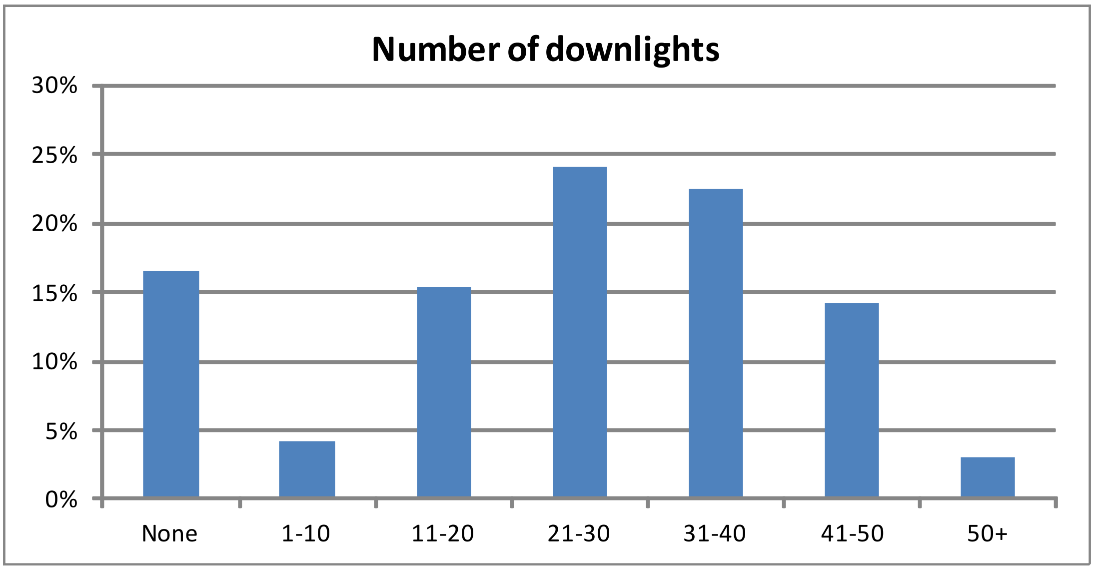

Figure 18 Number of Downlights in New Housing

Figure 18 shows the number of downlights being installed in new housing between February and September 2011. Just over 15% of houses do not have any downlights installed. The greatest proportion is between 21 and 30 downlights.

4.12 Wind Zones

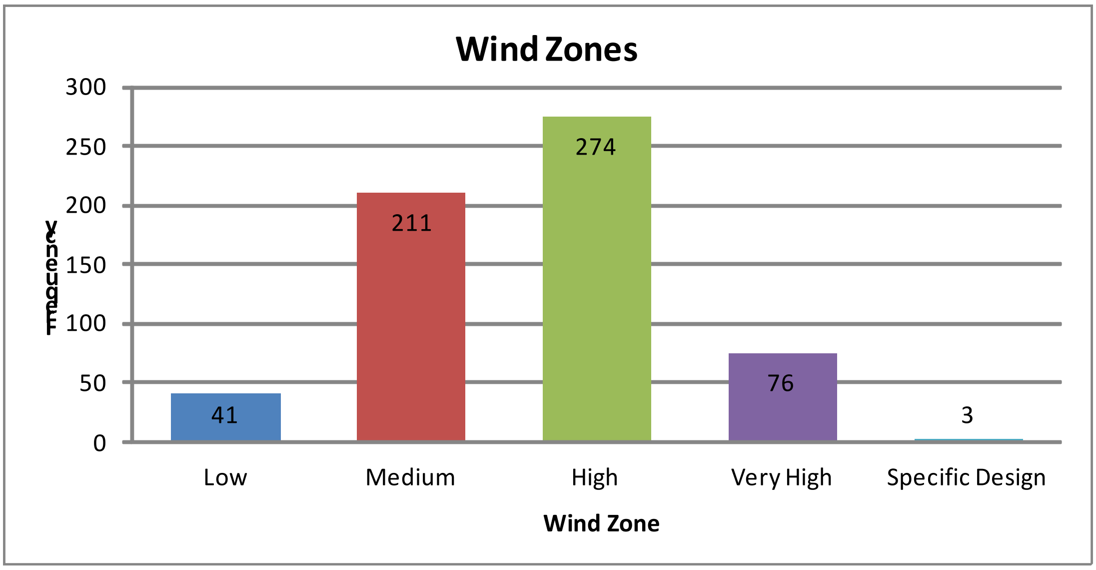

Figure 19 Wind Zones Frequency in New Houses

Wind zone data was collected between September 2010 and June 2011 and the distribution of zones is shown in Figure 19. Note that at the time of the survey the "extra high" wind zone had not been introduced into NZS3604.

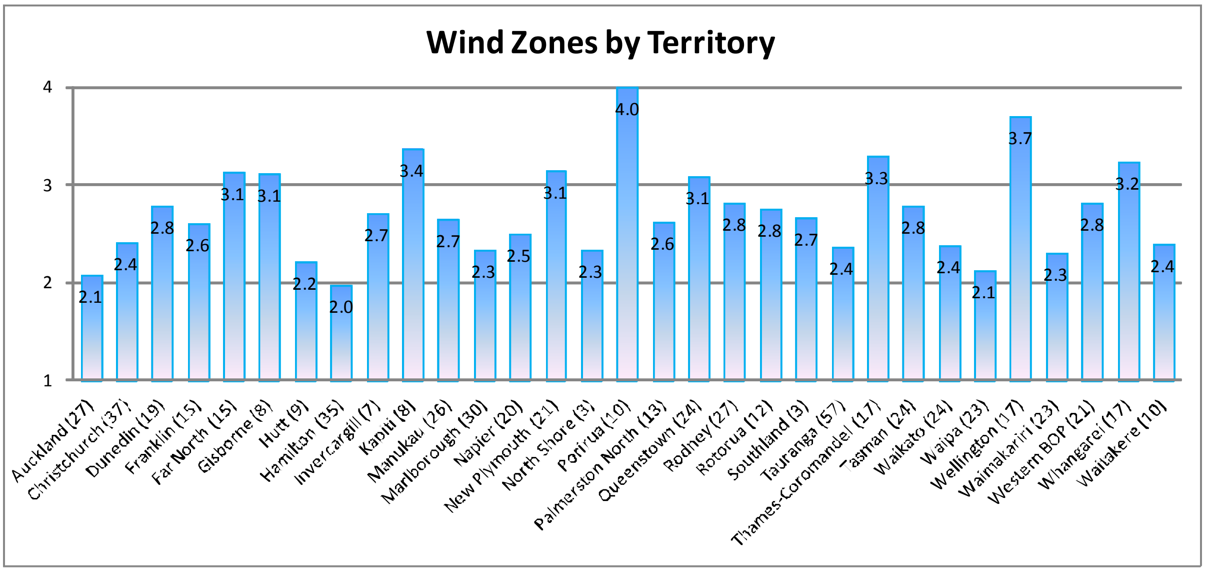

Figure 20 Wind Zones by Territory

The windiest territories from those surveyed were Porirua and Wellington. Low wind zones were assigned a value of 1 and very high wind zones were assigned a value of 4, with the average values shown in Figure 20. The higher the wind zone value, the higher the wind zone of the territory.

The majority of responses stated a medium or high wind zone (see Figure 19). This explains the large grouping of territories with average wind zones between 2 and 3 in Figure 20.

The number of responses received is noted in the brackets after the territory and for an average wind zone of 4 to be achieved, as in Porirua, all of the responses must have stated a very high wind zone. The least windy territory was Hamilton with a wind zone of just under 2, meaning that it is between low and medium.

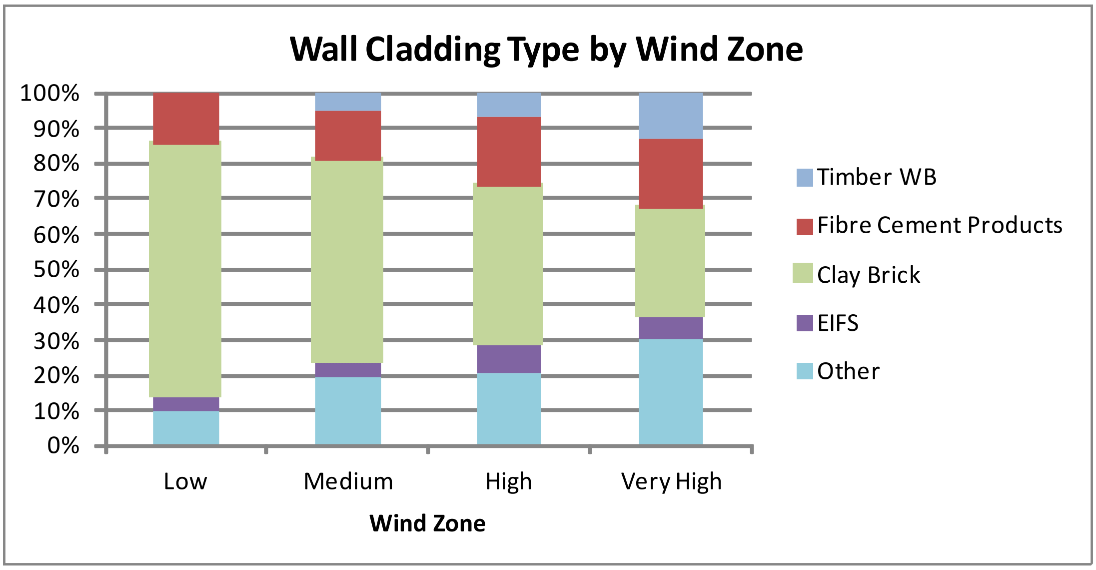

Figure 21 Wall Cladding Type by Wind Zone

Figure 19 shows that there is not a lot of data regarding low and very high wind zones, so data pertaining to the two extremes in Figure 21 should be used with caution. However, there is a definite trend, particularly with the proportion of clay brick wall cladding decreasing in higher wind zones, and both timber weatherboards and “other”, which mainly entails precast slabs, stucco and plaster brick and plywood sheets, increasing.

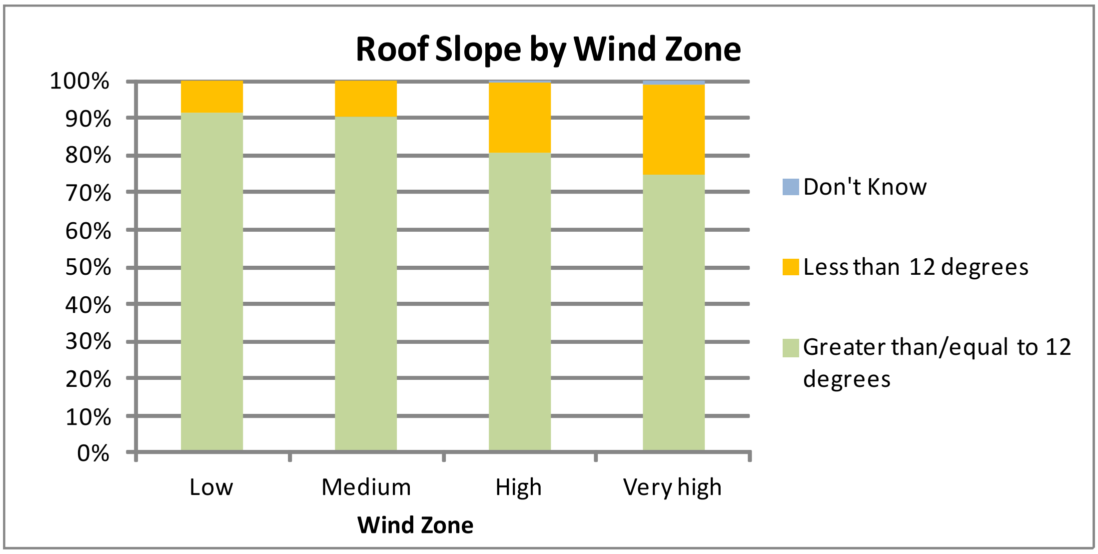

Figure 22 Roof Slope by Wind Zone

The majority of houses have a roof slope of greater than or equal to 12 degrees across the wind zones. However, with greater wind zones comes an increase in proportion of houses with a roof slope of less than 12 degrees.

4.13 E2 Risk Scores

Average risk scores by territorial authority, from the survey returns, are shown in Figure 23. In the New Zealand Building Code E2 the risk score is a function of wind zone, number of storeys, roof/wall intersection, eaves widths, envelope complexity and decks. The BRANZ survey records the first two factors and part of the envelope complexity. An attempt was made to relate the risk score for each house using the wind zone, number of storeys, number of types of cladding and size of house (floor area) in a regression model. The two latter variables were included to represent envelope complexity, the assumption being larger houses are more likely to have complex layouts than smaller houses.

The results are shown in Figure 24 with the actual score plotted against the predicted score from the model. If the model was accurate, the points would lie on the straight line sloping upwards. As there is a large scatter, the model is not very accurate (R-squared = 0.2).

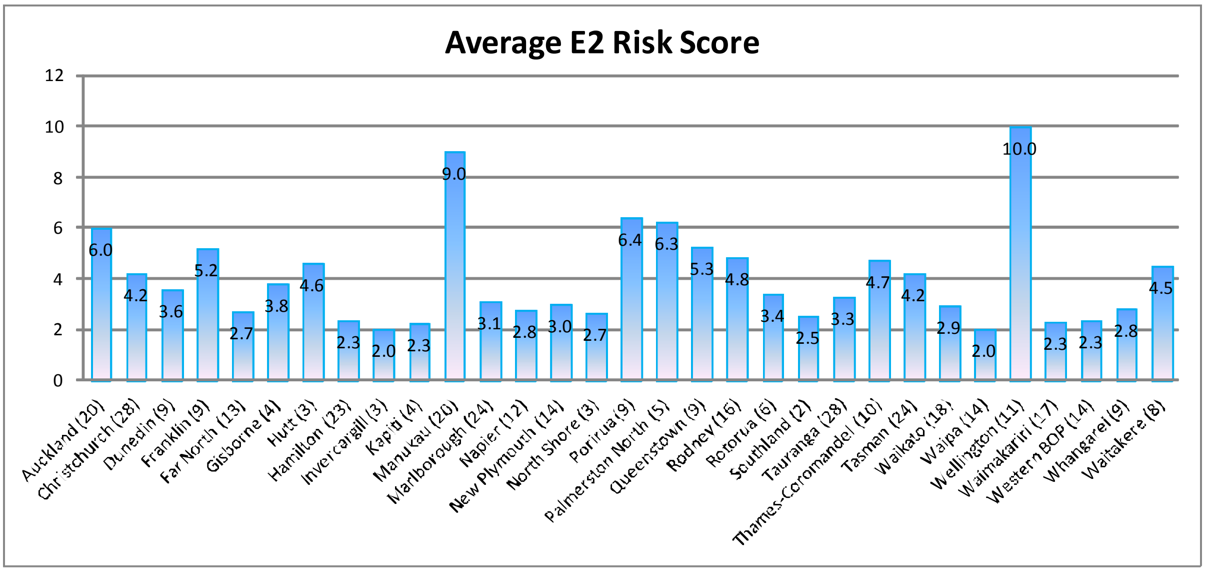

Figure 23 Average E2 Risk Score by Territorial Authority

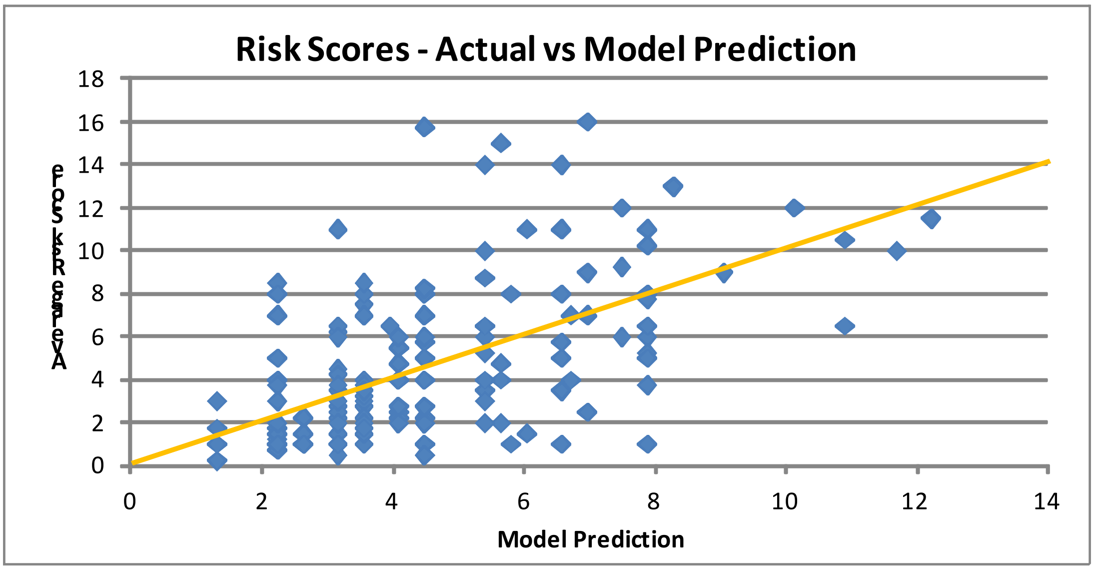

Figure 24 Risk Scores – Actual vs Model Prediction

The individual variables do explain some of the risk score as seen between Figure 25 to Figure 27, with the average risk scores increasing as the three factors increase.

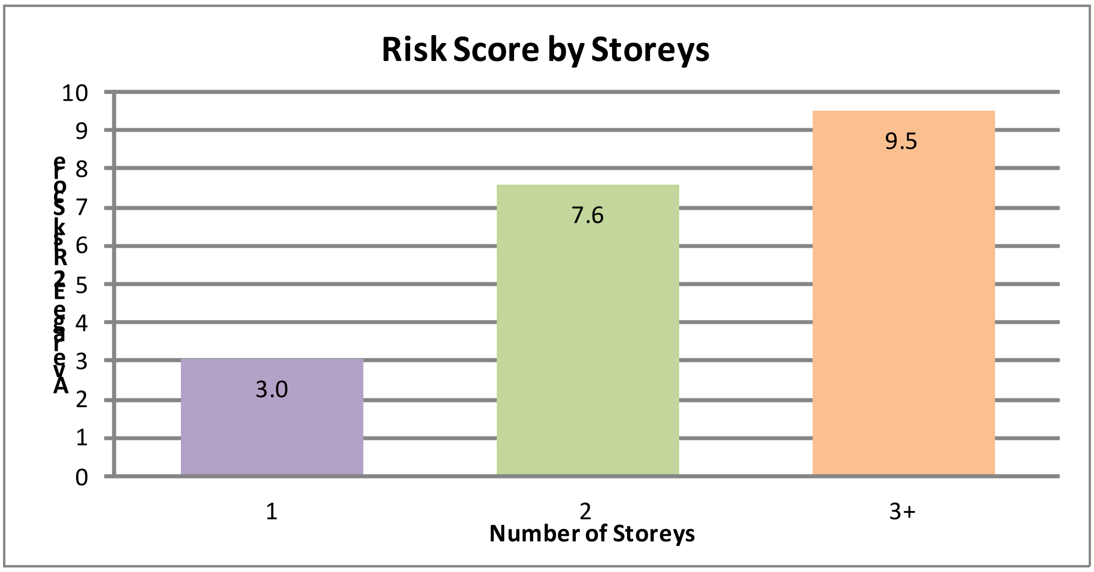

Figure 25 Average E2 Risk Score by Number of Storeys

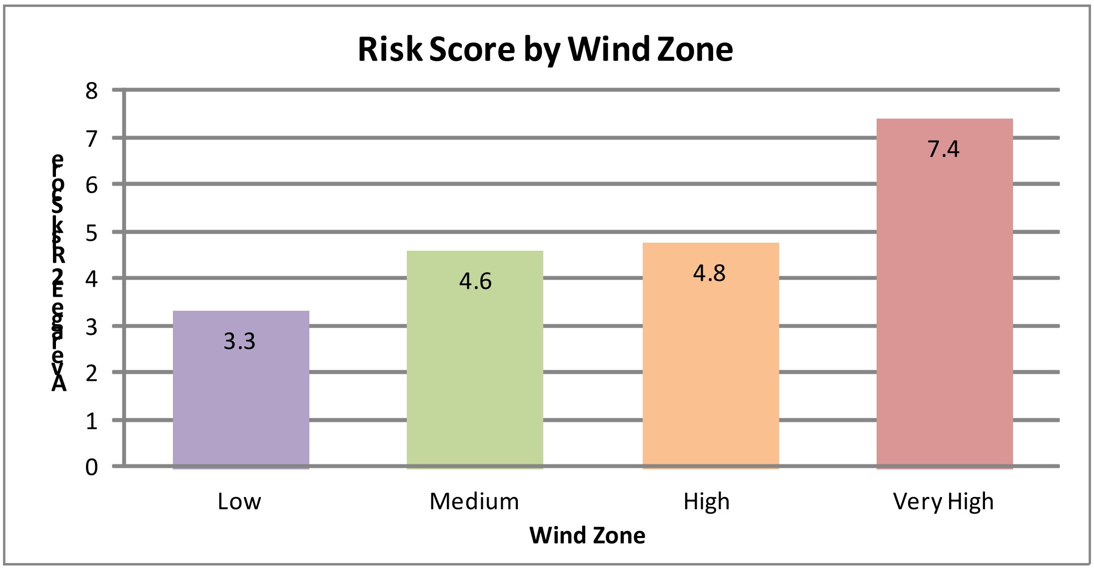

Figure 26 Average E2 Risk Score by Wind Zone

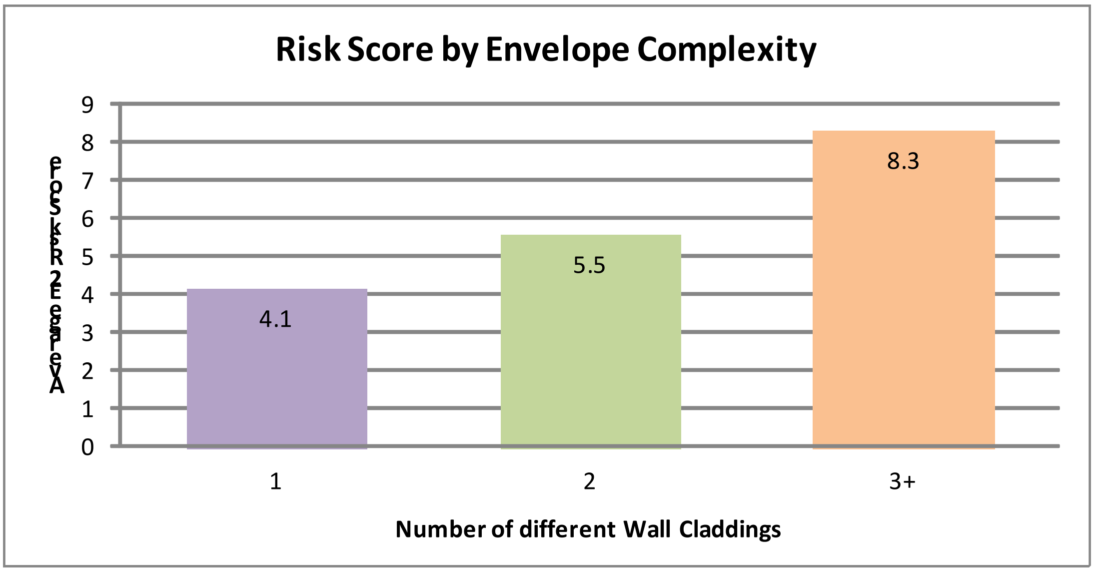

Figure 27 Average E2 Risk Score by Envelope Complexity

4.14 Double Glazing

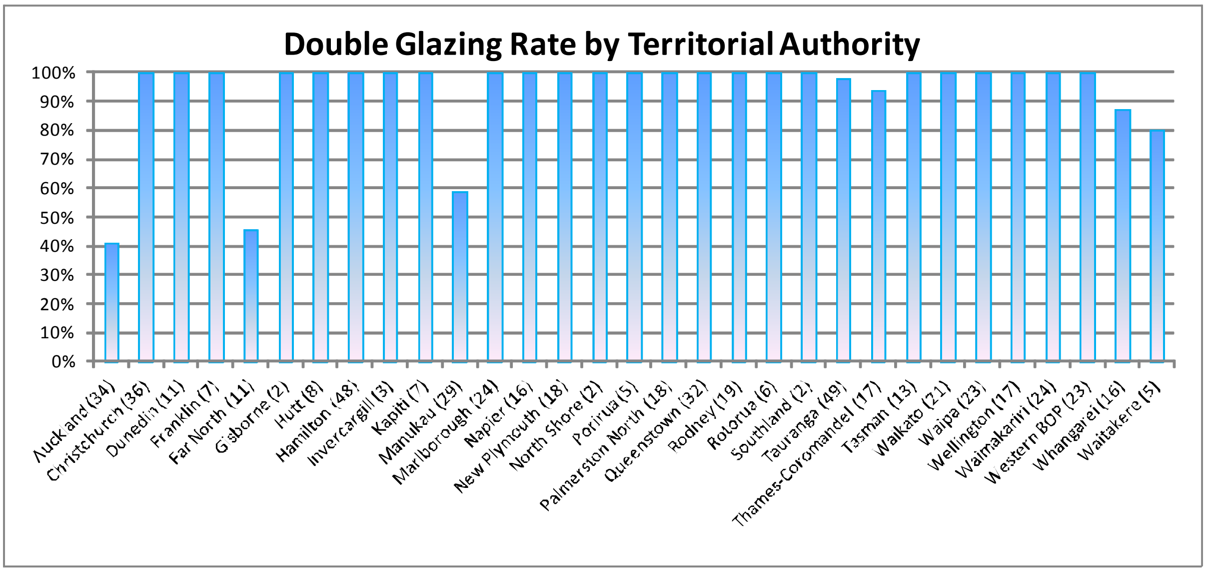

Figure 28 Double Glazing Rate by Territorial Authority

Double glazing rates from those houses surveyed are generally very high throughout the country. The only areas where it is not 100% are in the upper North Island. They are particularly low in Auckland and the Far North, where fewer than 40% of those new houses surveyed had double glazing for the period between September 2010 and June 2011.

The New Zealand Standard 4218:2009 allows for the use of single-glazing in new housing as long as insulation with greater R-Values is used to produce either the same or less heat loss. The appendix has an analysis of the calculation method and shows it is quite difficult to achieve the required thermal performance in houses below about 180sqm in floor area. This is because small houses have a larger envelope to floor area ratio than larger houses and hence need very large amounts of bulk insulation, and/or a small window area, to compensate for the heat losses through the single glazed windows. Furthermore, the appendix shows that for typical houses larger than 180sqm the cost trade-offs between single glazing and more insulation, versus less insulation and double glazing, are in favour of the latter using the calculation method in NZS4218, i.e. single glazing is unlikely to be economic.

The only way it could be economic in Auckland and Manukau is to use a fairly refined design using the modelling method. This is discussed in the appendix, where it was found the amount of compensating bulk insulation, with single glazing, is still excessive and remains uneconomic. Some of the Auckland houses with single glazing are in Mount Wellington and Manukau and it is possible the modellers have used Central Auckland climate records (which are incorrect) rather than the general Auckland records. We conclude it is surprising to see single glazing at all in Auckland outside the CBD, whatever the modelling method that has been used.

4.15 Modelling new house costs

New house values in Christchurch and Tauranga were investigated using houses from the survey to see if there is any relationship with various characteristics of the houses. We looked at the floor area, number of storeys, whether it was a timber or concrete ground floor and the number of claddings as variables. A time variable was also added to distinguish between 2009 and 2010 prices. 115 new houses in Christchurch and 129 in Tauranga were sampled.

Christchurch had a better fit than Tauranga to these variables, with many of the relationships being quite strong for Christchurch and weak in Tauranga, often resulting in the opposite happening (i.e. prices in Tauranga between 2009 and 2010 increased whereas in Christchurch they decreased).

The strongest relationship for the builder's value was the floor area variable. In Christchurch, each square metre of floor area added $1670 to the builder's value of the house and in Tauranga it added $1470. The next strongest relationship was with the number of storeys. In Christchurch, each extra storey added $60,230 whereas in Tauranga it added $58,670. Concrete floors are cheaper than timber floors in Christchurch, where having a concrete floor decreased the cost by $22,000. However in Tauranga, having a concrete floor increased the cost by $4500, although it has a much weaker relationship (i.e. a low t-stat). Extra wall claddings added $13,700 in Christchurch and $9,900 in Tauranga.

Christchurch regression results 2009-2010			Tauranga regression results	
	Coefficients	T-Stat	Coefficients	T-Stat
Intercept	-100.22	-0.67	-103.65	-0.79
Floor Area	1.67	14.34	1.47	16.74
Number of floors	60.23	3.21	58.67	2.87
Timber or Concrete grd floor	21.75	1.30	-4.42	-0.21
Number of claddings	13.74	1.09	9.94	0.83
Year	-9.69	-0.64	1.10	0.08
R squared	0.78		0.74	
Observations n=	115		129	

Table 1 Builder's Value Data

Coefficients and t-Stat data is listed in Table 1. T-stats values over 2.0 are significant at the 95% confidence level, i.e. we can be 95% confident that the coefficients are different from zero. So only the floor area and number of floor parameters are statistically significant. Concrete ground floors were assigned the value 1 and timber ground floors were assigned the value 2.

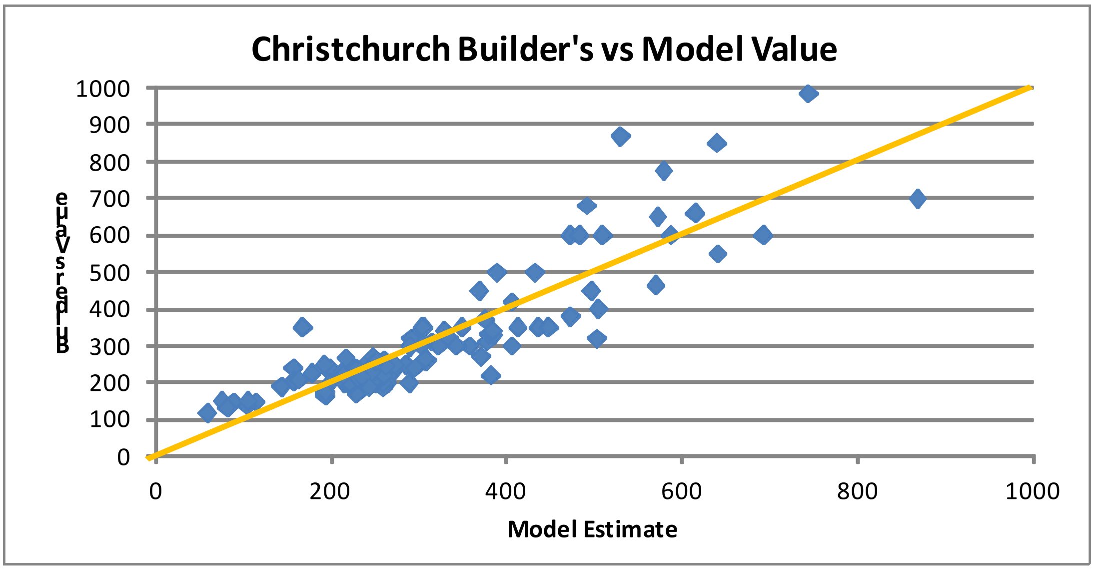

Figure 29 Christchurch House Values

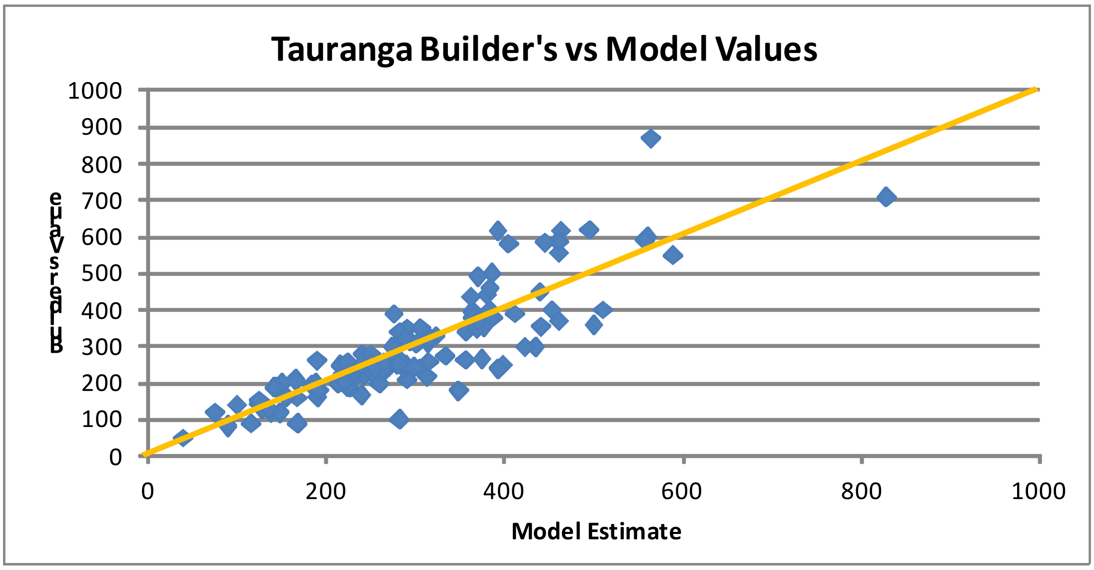

Figure 30 Tauranga House Values

5. CONCLUSIONS

In general, many of the market shares of materials have been relatively steady over the years surveyed. For example, sheet metal roofing and clay brick claddings were the predominate materials over recent years. There are a few exceptions though:

- Concrete structural walls increased their share by 5.5% in 2007 and remained above 10% for the next 2 years before decreasing by 5.5% in 2010.

- The lower proportion of multi-storeyed houses between 2004 and 2006 accounts for the slight increase in concrete share for those years. However, the market share for concrete flooring in 2008 was particularly low due to the larger proportion of timber ground floors picked up by our survey in 2008. Whether this was due to a larger proportion of timber ground floors being built in 2008 than the other years or not is uncertain.
- Solid timber floor joists market share is trending downwards with engineered wood increasing in share.
- The proportion of concrete slabs being insulated is increasing every year.
- Insulation in timber floors has moved towards polystyrene rather than foil.

6. APPENDIX

The appendix contains three items:

- BRANZ New Dwellings Survey details
- Tables of data for the charts
- A cost analysis of insulation and glazing

6.1 BRANZ New Dwellings Survey

This survey has been undertaken since 1998 and was originally developed to obtain data not otherwise available from official or other sources. The main users are building materials manufacturers and the results enable companies to monitor their market share (e.g. claddings and insulation etc). Some questions relate to the layout and design features of new dwellings which are relevant to building officials and researchers, e.g. ground and upper floors, wind zones, envelope risk matrix scores, efficiency measures, heating types, stud sizes and spacings etc. Samples of the forms are shown below. Some questions change from survey to survey but most have remained the same since inception.

It is conducted as a postal survey to the builder identified on the building consent application form and the questions relate to that particular consent. Over 300 returns are received each quarter. The response rate is about 30% and an incentive is offered (Lotto ticket, book voucher or reduced price for BRANZ publications). The main issue is to keep the form as simple and clear as possible and on one page. It is apparent from the density of the form an upper limit on the number of questions has been reached and preferably the form should be simpler to help improve the response rate. At the least, any new questions that might arise from time to time will require the dropping of existing questions. Three survey forms, from between 2006 and 2010, are shown below.

NEW DWELLING

Please give this form to the builder or designer to fill out for the building consent listed over the page.

Number of dwelling units ☐ in this consent. Contract value of work (incl sub-trades) $ ……………. incl GST.

Floor areas Total floor area ________ Sq metres (include attached garage, exclude decks).

	Particleboard	Plywood	Strip timber (not overlay, exclude decks).	Concrete
Ground level	______ Sq metres	______ Sq metres	______ Sq metres	______ Sq metres
First level	______ Sq metres	______ Sq metres	______ Sq metres	______ Sq metres
2nd or more levels	______ Sq metres	______ Sq metres	______ Sq metres	______ Sq metres

Decks (above ground, not concrete patios) (circle one)

Includes a deck ? Yes / No (circle one or more)

Deck area______Sq metres

Deck surface material = radiata/ hardwood/ butyl/ tiles/ other/ pour-on.

Deck substrate = plywood sht/ fibre cement sht/ concrete/ timber joists.

Wall Framing (tick appropriate box)

Radiata ☐ Steel ☐ Douglas fir ☐ Concrete block ☐ Other ☐ (state) ………

Was the wall framing precut or prenailed ? Yes / No (circle one)

Framing timber treatment

	Untreated kiln dry	Untreated wet	H1.2	T1.2 (orange)	H3.1
Tick one or more	☐	☐	☐	☐	☐
State where used (eg outer walls, subfloor, etc)	………..…	………..…	………..…	………..…	………..…

Floor joists

	None	Solid timber	Posistrut	Hybeam (I beam)	Steel	Twinaplate	Origin (I beam)	Other (state)
Tick one or more	☐	☐	☐	☐	☐	☐	☐	☐
Joist depth mm		……..…mm	……....mm	……..…mm	……..…mm	……....mm	……..…mm	……..…mm

Insulation

(tick one or more)	R value of insulation	Pink Batts	Bradford Gold	Premier Fibreglass	Blown FG Rocwool	Greenstuf (polyester)	Other polyester	Treated paper	Wool	Other (state)
Wall insulation	R-	☐	☐	☐	☐	☐	☐	☐	☐	☐
Ceiling insulation	R-	☐	☐	☐	☐	☐	☐	☐	☐	☐

	R value	Expol Warmfeet	Polystyrene panel	Cosy Floor	Sisalation Foil	Other (state)
Floor Insulation	R-	☐	☐	☐	☐	☐ ………………………………………………

Installer (name) ……………………………………………………………………………………

Noise Control (circle one)

Have you installed noise control products? Yes / No What type? ……………………………………

Building wraps

Roof wrap	Flamestop	Thermakraft	Bitumac	GIB underlay	Greencap	Pauloid	Black Paper	Other (state)
	☐	☐	☐	☐	☐	☐	☐	☐

(tick one or more) Wall wrap	Flamestop	Tyvek	Thermakraft coverup	Framegard II	Greenwrap	Fastwrap	Black Paper	Other (state)
	☐	☐	☐	☐	☐	☐	☐	☐

Wall cladding State type (and approx % wall coverage)

Type .... % area................. eg fibre cement sheet, 75% also plywood, solid plaster(min 18mm),

Type .... % area................. clay brick, 15% plaster on polystyrene, concrete

Type .... % area................. cedar 10% block, PVC weatherboard, etc.

If yes to Fibre Cement cladding what is the Manufacturer? (tick one or more) Hardies ☐ BGC ☐ CSR ☐ PRIMA ☐ Other ☐

Fibre Cement Product used as (Circle one or more) Applied texture finish sheet, Flat sheet, FC plank, FC weatherboard/Linea

If solid plaster, what backing? (circle one if solid plaster) fibre cement, plywood, paper, Triple S, block/brick, metal lathe

Roof cladding Type .... (or circle one)

eg metal tiles, prepainted corrugated, other steel profiles, concrete tiles, butyl, asphalt shingles, fibreglass shingles, etc.

Wet wall linings (Tick one or more in each row)

	Formica Aquapanel	Seratone	Hardies Villaboard	Hardiglaze	Standard GIB	GIB Aqualine	Other	(state)
Bathroom	☐	☐	☐	☐	☐	☐	☐	…..….
Laundry	☐	☐	☐	☐	☐	☐	☐	…..….

Is fibre cement sheet flooring underlay used in the bathroom or laundry ? Yes/ No (circle one).

Energy efficiency Tick if any of the following are being installed:

Double glazing	Solar water heaters	Dual flush toilets	Energy efficient lights	Heat pump	Low flow showers	Built-in window vents
☐	☐	☐	☐	☐	☐	☐

Type of Builder How many houses or dwelling units does your company build per year (approx) . ……………….

Construction Delays

If you signed a contract with the owner now, how many weeks before on-site work would start? ……….wks

Thank You. Please fold this form, and freepost it in the return envelope Oct-06

NEW DWELLING

Please give this form to the builder or designer to fill out for the building consent listed over the page.

Number of dwelling units ☐ in this consent. Contract value of work (incl sub-trades) $ ……………. incl GST.

Floor areas Total floor area __________ Sq metres (include attached garage, exclude decks).

	Particleboard	Plywood	Strip timber (not overlay, exclude decks).	Concrete
Ground level	_______ Sq metres	_______ Sq metres	_______ Sq metres	_______ Sq metres
First level	_______ Sq metres	_______ Sq metres	_______ Sq metres	_______ Sq metres
2nd or more levels	_______ Sq metres	_______ Sq metres	_______ Sq metres	_______ Sq metres

If the floor is concrete is it Ribraft or similar (ie polystyrene formers) ? Yes / No (circle one)

If the floor is concrete does it have concrete masonry perimeter foundations for the slab ? Yes / No (circle one)

Wall Framing (tick appropriate box)

Radiata ☐ Steel ☐ Douglas fir ☐ Concrete block ☐ Other ☐ (state) ...……….

Was the wall framing precut or prenailed ? Yes / No (circle one)

Heating Systems Tick one or more

Heat pump ☐ Wood/Pellet burner ☐ Ducted central heating (Not including DVS or HRV) ☐ Underfloor heating (waterpipe) ☐ Underfloor heating (electric) ☐ DVS/HRV ☐ Gas ☐

Floor joists Tick one or more

	None	Solid timber	Posistrut	Hyjoist	Steel	Twinaplate	Origin (I beam)	Laminated veneer lumber	Other (state)	Hyne (I beam)
Tick one or more	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Joist depth		……….mm	……….mm	……….mm	……….mm	……….mm	……..mm	……….mm	……..mm	……..….mm

Insulation (tick one or more)

	R value of insulation	Pink Batts	Bradford Gold	Premier Fibreglass	Blown FG Rocwool	Greenstuf (polyester)	Other polyester	Wool	Other (state)
Wall insulation	R -	☐	☐	☐	☐	☐	☐	☐	☐ ………………..
Ceiling insulation	R -	☐	☐	☐	☐	☐	☐	☐	☐ ………………..

	R value	Expol Warmfeet	Polystyrene Under slab	Cosy Floor	Sisalation Foil	Ribraft Floor	Cupolex	Other (state)
Floor Insulation	R -	☐	☐	☐	☐	☐	☐	☐ …………………………..

Insulation Installer (name) *Please tick……………..* Builder ☐ Other, please specify ☐ ………………………………………………

Noise Control

Have you installed noise control products? (circle one) Yes / No

If so then what type? (Tick one or more boxes)

Pink Batts Silencer ☐ Gib Noiseline ☐ Other Gib Products ☐ Bradford Gold ☐ Pink Batts ☐ Other Specify ☐

Building wraps (tick one or more)

Roof wrap: Flamestop ☐ Thermakraft ☐ Bitumac ☐ Greencap ☐ Pauloid ☐ Black Paper ☐ Other (state) ☐ Diflex 130 ☐ Tekton ☐ Home RAB ☐

Wall wrap: Flamestop ☐ Tyvek ☐ Thermakraft ☐ Framegard ☐ Greenwrap ☐ Fastwrap ☐ Black Paper ☐ Other (state) ☐ Diflex 130 ☐ Tekton ☐ Home RAB ☐

DPC

What DPC products have you installed? Damp-a-thene ☐ Mathiod ☐ Supercourse ☐ Other, specify ☐

Flashing Tapes

What flashing tapes are installed? Weatherseal ☐ Aluband ☐ Tyvek Flexwrap ☐ Protectowrap ☐ Other, specify ☐

Wall cladding State type (and approx % wall coverage)

Type .... % area.................

Type .... % area.................

Type .... % area.................

eg fibre cement sheet, 75%, clay brick, 15%, cedar 10% also plywood, solid plaster(min 18mm), plaster on polystyrene, concrete block, PVC weatherboard, etc.

If Fibre Cement cladding is used, who is the Manufacturer? (tick one or more) Hardies ☐ BGC ☐ CSR ☐ PRIMA ☐ Other ☐ Eterpan ☐

Fibre Cement Product used as (Circle one or more) Applied texture finish sheet, Flat sheet, FC plank, FC weatherboard/Linea

If solid plaster, what backing? (circle one if solid plaster) fibre cement, plywood, paper, Triple S, block/brick, metal lathe

Roof cladding Type .... (or circle one)

eg metal tiles, prepainted corrugated, other steel profiles, concrete tiles, butyl, asphalt shingles, fibreglass shingles, etc.

Windows

Please tick what windows are used Timber ☐ Aluminium ☐ PVC plastic ☐ Steel ☐ Other (state)……………..

Exterior doors

Please tick what exterior doors are used (include entry/exit, french and sliding doors) Timber ☐ Aluminium ☐ Composite (timber and aluminium together) ☐

Fascia

What type of material was used? (tick one) Timber Board ☐ Metal ☐ Other, State ……………………………………………

Wet wall linings (Tick one or more in each row)

	Formica Aquapanel	Seratone	Villaboard	Hardies Hardiglaze	Standard GIB	GIB Aqualine	Other, *specify*	Timber
Bathroom	☐	☐	☐	☐	☐	☐	☐	☐
Laundry	☐	☐	☐	☐	☐	☐	☐	☐

Is fibre cement sheet flooring underlay used in the bathroom or laundry ? Yes/ No (circle one).

Energy efficiency Tick if any of the following are being installed:

None ☐ Solar water heaters ☐ Dual flush toilets ☐ Efficient lights ☐ Energy Heat pump ☐ Low flow showers ☐ Sliding air vents built into window frame ☐

Thank You. Please fold this form, and freepost it in the return envelope Oct-08

NEW DWELLING

Please give this form to the builder or designer to fill out for the building consent listed over the page.

Number of dwelling units ☐ in this consent. Contract value of work (incl sub-trades) $ ……………. incl GST.

Floor areas Total floor area ___________ Sq metres (include attached garage, exclude decks).

	Particleboard	Plywood	Strip timber (not overlay, exclude decks).	Concrete
Ground level	_______ Sq metres	_______ Sq metres	_______ Sq metres	_______ Sq metres
First level	_______ Sq metres	_______ Sq metres	_______ Sq metres	_______ Sq metres
2nd or more levels	_______ Sq metres	_______ Sq metres	_______ Sq metres	_______ Sq metres

Building Envelope Risk Score and Wind Zone

What is the risk score (enter score for EACH elevation) North ☐ West ☐ South ☐ East ☐

What is the wind zone (tick one box) Low ☐ Medium ☐ High ☐ Very High ☐

Wall Framing (tick appropriate box)

Radiata ☐ Steel ☐ Douglas fir ☐ Concrete block ☐ Solid wood ☐ Other ☐ (state) ………………..

Was the wall framing precut or prenailed ? Yes / No (circle one)

Stud size and spacing (tick one or more)

90x45 mm @600ctrs ☐ 90x40 mm @600ctrs ☐ 90x45 mm @400ctrs ☐ 90x40 mm @400ctrs ☐ 140x45 mm @600ctrs ☐ 140x45 mm @400ctrs ☐ Other (please state)________ ☐ ________________

Heating Systems Tick one or more

Heat pump ☐ Wood/Pellet burner ☐ Ducted central heating (Not including DVS or HRV) ☐ Underfloor heating (waterpipe) ☐ Underfloor heating (electric) ☐ DVS/HRV ☐ Gas ☐

Floor joists Tick one or more

None ☐ Solid timber ☐ Posistrut ☐ Hyjoist ☐ Steel ☐ Twinaplate ☐ Hyne (I beam) ☐ lumberworX ☐ Other (state) ☐

Joist depth ……….mm ………..mm ……….mm ……….mm ………..mm ……...mm ………..mm ……..mm

Insulation (tick one or more)

	Insulation R value	Pink Batts	Bradford Gold	Premier Fibreglass	Blown FG Rocwool	Greenstuf (polyester)	Other polyester	Wool	Polystyrene	Other (state)
Wall insulation	R -	☐	☐	☐	☐	☐	☐	☐	☐	………………..
Ceiling insulation	R -	☐	☐	☐	☐	☐	☐	☐	☐	………………..

	Insulation R value	Expol Warmfeet	Polystyrene (NOT polythene) Under slab	Snug Floor	Sisalation Foil	Ribraft Floor	Cupolex	Other (state)
Floor Insulation	R -	☐	☐	☐	☐	☐	☐	☐ …………………………..

Insulation Installer (name) *Please tick……………..* Builder ☐ Other, please specify ☐ ………………………………………………

Noise Control

Have you installed noise control products? **(circle one) Yes / No** If so then what type? (Tick one or more boxes)

Pink Batts Silencer ☐ Gib Noiseline ☐ Other Gib Products ☐ Bradford Gold ☐ Pink Batts ☐ Polyester ☐ Other Specify ☐

Building wraps (tick one or more)

Roof wrap: Flamestop ☐ Thermakraft ☐ Bitumac ☐ CoverTek ☐ Pauloid ☐ Black Paper ☐ Other (state) ☐ Diflex 130 ☐ Tekton ☐

Wall wrap: Flamestop ☐ Tyvek ☐ Thermakraft ☐ Framegard ☐ Home RAB ☐ Fastwrap ☐ Black Paper ☐ Other (state) ☐ Diflex 130 ☐ Tekton ☐

DPC

What DPC products have you installed? Damp-a-thene ☐ Mathiod ☐ Supercourse ☐ Other, specify ☐

Flashing Tapes

What flashing tapes are installed? Weatherseal ☐ Aluband ☐ Tyvek Flexwrap ☐ Protectowrap ☐ Frameflash ☐ Other, specify ☐

Wall cladding State type (and approx % wall coverage)

Type .... % area................. eg fibre cement sheet, 75% also plywood, solid plaster(min 18mm),

Type .... % area................. clay brick, 15% plaster on polystyrene, concrete

Type .... % area................. cedar 10% block, PVC weatherboard, etc.

If Fibre Cement cladding is used, who is the Manufacturer? (tick one or more) Hardies ☐ BGC ☐ CSR ☐ PRIMA ☐ Other ☐ Eterpan ☐

Fibre Cement Product used as (Circle one or more) Applied texture finish sheet, Flat sheet, Linea (16mm), FC plank (7.5mm)

If solid plaster, what backing? (circle one if solid plaster) fibre cement, plywood, paper, Triple S, block/brick, metal lathe

Roof cladding Type .... (or circle one)

eg metal tiles, prepainted corrugated, other steel profiles, concrete tiles, butyl, asphalt shingles, fibreglass shingles, etc.

If roof is metal tiles, specify Manufacturer name...

Is the Majority of the roof slope: (tick one) Greater/equal than 12 degrees ☐ less than 12 degrees ☐ Don't know ☐

Wet wall linings (Tick one or more in each row)

	Formica Aquapanel	Seratone	Villaboard	Hardies Hardiglaze	Standard GIB	GIB Aqualine	Other, *specify*	Timber	Horizon
Bathroom	☐	☐	☐	☐	☐	☐	☐	☐	☐
Laundry	☐	☐	☐	☐	☐	☐	☐	☐	☐

Is fibre cement sheet flooring underlay used in the bathroom or laundry ? Yes/ No (circle one).

Thank You. Please fold this form, and freepost it in the return envelope Oct-10

6.2 Results Tables

The data contained in some of the charts from Figure 3 to Figure 17 is shown below.

Average Floor Area (square metres) Yearly Data 2002-2010									
	2002	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Sample Average Floor Area	210.0	222.0	222.2	231.6	221.3	232.1	232.6	217.5	217.0
Consent Data Average Floor Area (1)	205.4	207.7	213.1	217.1	215.2	213.4	215.8	216.5	215.6
Note: survey average floor area weighted to allow for regional building activity									
(1) Source: Statistics New Zealand									

Table 2 Average Floor Area (square metres)

Average House Value Yearly Data 2002-2010									
	2002	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Average Consent Value ($000)	193.4	218.0	202.6	289.0	260.8	293.4	322.2	306.8	305.7
Average Survey Form Value ($000)	201.8	239.7	225.4	297.7	283.9	324.0	381.6	336.0	355.6
Note: average survey form values are weighted to allow for regional building activity									

Table 3 Average House Value ($000)

Roof Claddings Market Share Yearly Data 2002-2010									
	2002	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Sheet Metal	40.1	42.8	48.4	46.1	44.7	54.2	48.0	48.3	53.8
Tiles (metal and concrete	53.3	47.1	37.7	38.3	41.3	36.9	36.2	35.0	38.6
Other (membrane, shakes, etc)	6.7	10.2	13.9	15.6	14.0	8.8	15.8	16.7	7.6
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Note: percentage weighted to allow for the regional building activity.									

Table 4 Roof Claddings Market Share

Wall Claddings Market Share Yearly Data 2002-2010									
	2002	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Finish bricks clay & concrete	43.5	46.1	46.3	49.5	51.0	44.0	43.5	42.1	45.5
Neatherboard (timber, fib cmt, PVC)	10.0	13.3	16.9	17.7	18.2	25.3	25.7	26.8	28.3
Other (FC sheet, EIFS,stucco, sheet steel, solid masonry, etc)	46.5	40.6	36.8	32.8	30.8	30.7	30.8	31.1	26.2
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Note: percentage weighted to allow for the regional building activity.									

Table 5 Wall Claddings Market Share

Wall Framing Market Share Yearly Data 2002-2010									
	2002	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Timber (framing + solid timber)	98.1	96.5	95.9	89.8	90.9	85.1	86.0	85.4	90.4
masonry, polybloc, earth, straw, etc)	1.9	3.5	4.1	10.2	9.1	14.9	14.0	14.6	9.6
TOTAL	100	100	100	100	100	100	100	100	100
Note: percentage weighted to allow for the regional building activity.									

Table 6 Wall Framings Market Share

Percentage of Floor Area by Storey Yearly Data 2002-2010			
	Ground	First	Second +
2002	84.4	14.8	0.8
2003	84.2	14.7	1.1
2004	83.4	15.1	1.5
2005	85.4	13.0	1.6
2006	87.4	11.8	0.8
2007	86.5	12.2	1.3
2008	86.6	12.3	1.2
2009	87.1	11.9	1.0
2010	88.2	11.1	0.7

Table 7 Percentage of Floor Area by Storey

Flooring Types Market Share Yearly Data 2002-2010									
	2002	2003	2004	2005	2006	2007	2008	2009	2010
Concrete	79.0	78.7	79.1	80.6	80.8	78.4	72.6	78.4	81.0
All other flooring	21.0	21.3	20.9	19.4	19.2	21.6	27.4	21.6	19.0
Note: percentage weighted to allow for the regional building activity.									

Table 8 Flooring Types Market Share

Floor Joists Market Share Yearly Data 2002-2010									
	2002	2003	2004	2005	2006	2007	2008	2009	2010
Solid Timber	82.9	78.1	71.6	70.8	63.8	68.5	69.2	72.0	68.4
Engineered Wood	17.1	21.9	28.4	29.2	36.2	31.5	30.8	28.0	31.6
Note: percentage weighted to allow for the regional building activity.									

Table 9 Floor Joists Market Share

Solid Timber Joist Depths 2010 Data	
100mm	0.5%
150mm	27.4%
200mm	21.6%
250mm	38.5%
300mm	8.7%
350mm	0.0%
400mm	0.0%
450mm	1.4%
Other	1.9%
Note: Other is 500mm (2), 600mm (2) and 900mm (1)	

Table 10 Solid Timber Joist Depths 2010

Wall Insulation Market Share Yearly Data 2002-2010									
	2002	2003	2004	2005	2006	2007	2008	2009	2010
Fibreglass	82.4	93.6	93.0	91.3	92.8	93.5	93.2	93.7	95.4
Other	17.7	6.4	7.0	8.7	7.2	6.5	6.8	6.3	4.6
Note: percentage weighted to allow for the regional building activity.									

Table 11 Wall Insulation Market Share

Ceiling Insulation Market Share Yearly Data 2002-2010									
	2002	2003	2004	2005	2006	2007	2008	2009	2010
Fibreglass	87.4	83.1	93.0	88.3	92.0	91.9	92.2	94.6	96.7
Other	12.6	16.9	7.0	11.7	8.0	8.1	7.8	5.4	3.3
Note: percentage weighted to allow for the regional building activity.									

Table 12 Ceiling Insulation Market Share

Floor Insulation Market Share Yearly Data 2007-2010				
	2007	2008	2009	2010
Concrete Slab				
Waffle Pod	49.6	48.1	43.3	48.9
Sheet Polystyrene	50.4	51.9	56.7	51.1
% insulated	23.8	36.9	42.9	45.0
Timber Floor				
Foil	72.3	62.5	35.5	22.3
Fibreglass	7.6	4.6	12.1	13.1
Polystyrene	20.2	32.9	52.5	64.6
Note: percentage weighted to allow for the regional building activity.				

Table 13 Floor Insulation Market Share

Incidence of Efficiency Devices (percentage) Yearly Data 2007-2009			
	2007	2008	2009
Solar Water Heaters	12.5	12.8	12.7
Dual Flush Toilets	81.9	85.2	84.7
Efficient Lights	31.2	29.1	32.5
Energy Heat Pump	45.8	44.8	57.8
Low Flow Showers	13.5	22.0	25.7
Sliding Air Vents Built into Window Frame	17.0	10.0	9.1

Table 14 Energy Efficiency Items Market Share

Incidence of Heating Systems (percentage) Yearly Data 2009-2010		
	2009	2010
Heat Pump	61.4	64.9
Wood/Pellet Burner	29.9	23.5
Ducted central heating (exc DVS/HRV)	5.8	4.6
Underfloor heating (pipe)	5.0	5.3
Underfloor heating (electric)	10.0	13.3
DVS or HRV	5.8	5.1
Gas	18.7	18.7

Table 15 Heating Systems Market Share

Stud Sizes and Spacings Market Share Quarterly Data Dec-09 - Dec-10					
	Dec-09	Mar-10	Jun-10	Sep-10	Dec-10
90x45mm@600ctrs	68.6	66.5	63.9	72.5	66.5
90x40mm@600ctrs	0.0	3.2	5.2	2.5	3.2
90x45mm@400ctrs	24.0	21.9	18.8	14.6	19.4
90x40mm@400ctrs	1.5	0.2	1.5	2.2	1.2
140x45mm@600ctrs	4.4	1.4	4.0	2.0	4.1
140x45mm@400ctrs	0.2	2.3	1.9	3.2	2.9
other	1.3	4.5	4.8	3.0	2.7
Note: percentage weighted to allow for the regional building activity.					

Table 16 Stud Sizes and Spacings Market Share

Wall Cladding Market Share by Wind Zone December 2010-June 2011				
	Low	Medium	High	Very High
Timber WB	0.0	5.3	6.6	13.2
Fibre Cement Products	14.6	13.9	19.8	19.7
Clay Brick	70.7	56.7	44.3	30.3
EIFS	4.9	4.3	8.8	6.6
Other	9.8	19.7	20.5	30.3

Table 17 Wall Cladding Market Share by Wind Zone

Roof Slope share by Wind Zone December 2010-June 2011				
	Low	Medium	High	Very High
Greater than/Equal to 12°	80.5	87.2	76.6	75.0
Less than 12°	7.3	9.5	17.9	23.7
Don't Know	12.2	3.3	5.5	1.3

Table 18 Roof Slope Share by Wind Zone

6.3 Cost Analysis of Glazing versus Insulation Trade-offs

After September 2008, a revision to Clause H1 Energy Efficiency of the New Zealand Building Code came into force in Climate Zone 1, i.e. the warmer parts of the country. This revision put double glazing in all new housing in the schedule method. The ability to use the calculation method or the modelling method was retained. Most designers use the schedule method, but it was noted in the survey that after the 2008 change some new houses continued with single glazing. This is permitted if it can be demonstrated that the heat losses are no worse than with the schedule method.

The following describes some analyses done using the calculation method for a range of house sizes and either a square or rectangular floor plan. It compares the heat loss in the building with a reference heat loss. Squarer houses and houses with less glazing area compared to wall area will require less extra insulation to compensate for having single glazing than more rectangular or glazed houses.

Figure 31 assumes a single storey square house with a concrete slab on the ground floor with edge insulation behind the brick veneer, masonry veneer wall cladding and a profiled steel roof. For the purpose of this analysis, 30% glazing area has been assumed. The maximum allowable heat loss increases with the area of the house.

The dark red line illustrates the heat loss if this house was single glazed, with extra insulation to the maximum feasible level for slabs and 90mm timber framed walls. The maximum allowable heat loss is higher than the heat loss line at approximately 155 square metres and therefore, houses less than 155 square metres will either have to reduce the amount of glazing or use double glazing to satisfy the schedule method.

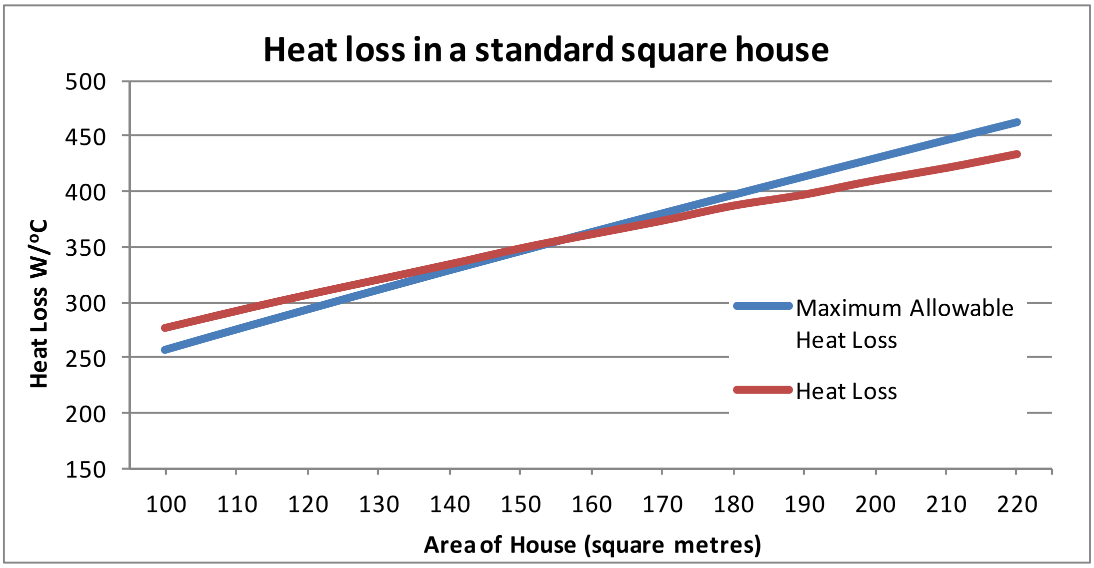

Figure 31 Heat Loss in a Standard Square House Climate Zone 1.

Figure 32 assumes the same as the above. However, instead of a square house, the house is rectangular. The length of the house is assumed to be twice as long as the width. Both the maximum allowable heat loss and heat loss lines are higher as there is now a higher wall-to-floor ratio and thus more glazing.

The minimum area of house required to meet the schedule method is now approximately 175 square metres. All smaller houses will need to reduce the glazing area or use double glazing.

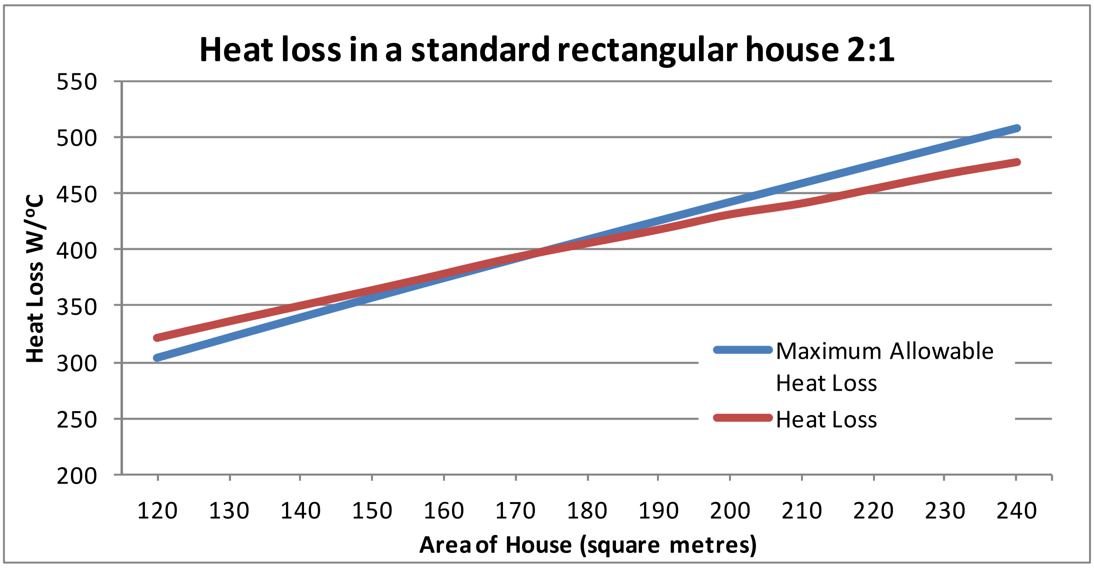

Figure 32 Heat Loss in a Standard Rectangular House Climate Zone 1

These examples indicate it is difficult for typical new housing to avoid double glazing in Climate Zone 1 using the calculation method.

The next part of the analysis entailed examining if the economies of single glazing stack up using the calculation method. Two house sizes were examined, as shown in Table 19.

Table 19 Cost Comparisons of Single vs Double Glazing

Calculation Method:

220 sqm house	Roof		Wall		Floor		Glazing		
HL reference =	$A_{roof} + A_{skylight}$	+	$A_{70\%\ of\ total\ wall\ area}$	+	A_{floor}	+	$A_{30\%\ of\ total\ wall\ area}$		
	2.9		1.9		1.3		0.26		
	fibreglass		fibreglass		nil insul slab				
	R3.2		R2.2		R1.8		double glazing		HL
HL =	220	+	105.7	+	220	+	45.3	=	475
	2.9		1.9		1.3		0.26	Total $	
Insul cost $	3410		1247		0		3625	8282	
Calculatn method	fibreglass		fibreglass		full cover				
Insulation	R4.8		R2.8		50mm EPS		single glazing		HL
HL =	220	+	105.7	+	220	+	45.3	=	475
	4.2		2.2		3.02		0.15	Total $	
Insulation cost$	4840		2220		2860		0	9920	
160 sqm house									
HL reference =	$A_{roof} + A_{skylight}$	+	$A_{75\%\ of\ total\ wall\ area}$	+	A_{floor}	+	$A_{25\%\ of\ total\ wall\ area}$		
	2.9		1.9		1.3		0.26		
	fibreglass		fibreglass		nil insul slab				
	R3.2		R2.2		R1.8		double glaze		
=	160	+	96.6	+	160	+	32.2	=	353
	2.9		1.9		1.3		0.26	Total $	
Insul cost $	2480		1520		0		2576	6576	
Calculatn method	fibreglass		fibreglass		full cover				
Insulation	R5.0		R2.8		100mm EPS		single glaze		
HL =	160	+	113.3	+	160	+	32.2	=	353
	4.35		2.2		3.2		0.15		
Insulation cost$	4000		3172		3360		0	10532	

Roof	Profiled steel -pitched roof, 90mm truss@900ctrs (5%)
Wall	Brick veneer - timber framed 100mm frame, studs 600, dwangs 800 (14%)
Floor	Slab on Ground - Edge insulation behind brick veneer.

Schedule Method: Climate Zone 1

Roof	R 2.9
Wall	R 1.9
Floor	R 1.3
Windows and Glazing	R 0.26
Skylights (none)	R 0.26

With single glazing a large amount of bulk insulation is needed to achieve the required heat loss value in both the 200sqm and 160sqm houses. In both houses the single glazed arrangement costs more than the double glazing arrangement. Hence, we conclude single glazing is likely to be uneconomic in Climate Zone 1 using the calculation method.

Finally we investigated the modelling method to ensure that the houses without double glazing, particularly those in Auckland, Manukau and Waitakere, do comply with the building code. We started with a basic and favourable house design in ALF3.2 to determine if it would comply without double glazing in Auckland. Even with a favourable design, extra insulation and decreased window sizes on all sides of the house bar the northern side, we were unable to get the Building Performance Index (BPI) below the 1.55 kWh/(m^2 . °C month) required to comply with the Energy Efficiency Clause H1.

However, the houses we surveyed were not increasing the level of insulation considerably. R-Values of 2.2 for the wall insulation and 3.2 for the ceiling insulation including an insulated concrete slab were standard for the houses surveyed without double glazing.

In an attempt to discover how these houses were complying we looked at ALF3.1. The same house design was input into ALF3.1 and located in Central Auckland. A calculation is available to establish the BPI using ALF3.1. However, it is explicitly stated that "Once the new version is available, ALF3.1 (2000) should not be used for BPI calculations and the method below must NOT be used". Using this method, a BPI of approximately 0.4 is obtained. This is well below the 1.55 needed.

Without increasing the insulation to higher levels than those stated in the survey responses it seems impossible to achieve the required BPI. Also, the houses that are not double glazed do not appear to be in Central Auckland. This is particularly the case for houses in Manukau and Waitakere, but also those located in the former territorial authority of Auckland City appear to be mostly in Mount Wellington rather than Central Auckland.

ALF3.1 has since been removed from the BRANZ website.