

STUDY REPORT

SR 316 (2014)

New housing condition – A preliminary assessment

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Preface

This is the first of two reports prepared during research into the condition of new detached houses. The aim is to inspect houses under construction for workmanship, compliance, components causing problems and to identify whether there are design and construction issues that are likely to cause future problems in house performance.

The first stage, reported here, is to development an inspection methodology and identify the range of potential issues that need further examination. Some preliminary results on defects are reported. Later work, to be reported in 2015, will more accurately quantify the extent of issues and problems using a larger sample of houses.

Acknowledgments

This work was funded by the Building Research Levy.

Note

This report is intended for council inspectors, designers, builders and central government officials.

New housing condition – a preliminary assessment

BRANZ Study Report SR 316

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Abstract

There are anecdotal reports that new housing is being constructed with compliance defects that means completed buildings do not meet Building Code performance requirements. In particular, there are risks associated with clauses B1 Structure, E2 External Moisture, and H1 Energy Efficiency, despite the experiences of leaky homes and the associated changes to weather-tightness performance requirements. This project aims to quantify the extent of any compliance issues, to assess “quality” of construction and to better understand the problems builders face in producing high standard work. The first part of the project is to develop an inspection method and obtain a preliminary assessment of workmanship and design issues, and this is the subject of this report. The second stage, to be completed in 2015, is to report on the findings coming out of the full sample of 200 houses.

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1. INTRODUCTION

Anecdotal evidence suggests there are significant quality and non-compliance problems with new housing and this project attempts to quantify the extent of the problem. It is a two year project and this report is for the first year where methods for investigating the issue have been explored. The aim is to recommend what further investigations are needed and to assess how effective these investigations are likely to be for identifying problem areas.

The main approach was to undertake inspections of houses under construction and to identify by component, firstly, code compliance, and secondly, quality of work. The secondary approach was a postal survey of new home builders asking about problems they have encountered in building their houses.

2. SUMMARY

The main findings for the preliminary sample are:

A total of 38 pre-lining and 23 pre-purchase inspections have been done, and there is sufficient evidence to indicate problem areas in workmanship and compliance.

Further inspections up to the numbers originally proposed (200 houses in total, over 2 years) are likely to be worthwhile in determining the extent of defects in typical new housing.

Pre-lining inspections indicate that approximately 75% of houses have code non-compliance (NC) defects, mainly related to excess cut outs in framing, lack or misplaced holding down bolts, and inadequately fixed windows. The average number of these defects was 1.4 per house.

These inspections also found almost all houses had minor gaps or compressed insulation in places due to cabling and pipes, and all houses lacked any insulation at corners of the walls.

Pre-purchase inspections (i.e. completed houses) indicate 91% of new houses have NC defects, mainly related to flashings at openings, penetrations of the wall cladding, and problems with the roof cladding. The average number of these NC issues per house was 2.8.

Quality was assessed by counting finishing defects such as poor paint finishes, damaged or poorly fitting trim, and cracks in linings. An average of 2.0 quality issues were found per house and 87% of inspected houses had quality defects.

To supplement on-site inspections new house builders were surveyed by post (as part of the regular BRANZ New Dwellings Survey) on their experience of construction problems over the past year. Roof and wall flashing details caused problems for over half of all builders.

3. MAIN RESULTS

3.1 On-site inspections

Two types of inspection were undertaken – pre-lining and pre-purchase.

The **pre-lining inspection** covered the interior only and checked the frame, flooring, windows, flooring, insulation, pipes and cabling, and connectors. The check was against acceptable solutions in the building code.

An overall assessment of workmanship was made on a five point scale ranging from very good to poor. Figure 1 shows a scatter chart of results for the 36 houses in the sample. The vertical axis is a count of the number of defects in a house, including code compliance defects and amenity or quality type defects. Generally houses with more defects were rated lower in overall workmanship, as is to be expected. The most common defects were incorrectly fixed window joinery, poorly fitting insulation, and straps and nogs sitting proud of the framing.

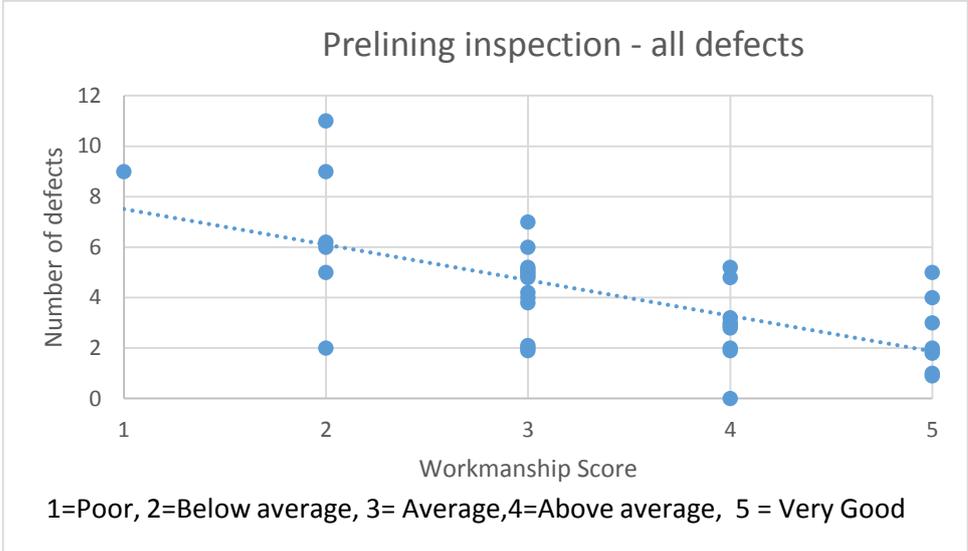


Figure 1 Pre-lining inspection defects v workmanship score

Figure 2 shows the same data but for code compliance defects only. These defects relate to the frame and connectors and the defects counted were inadequate window fixing and air seals, large cut-outs in frames, inadequate holding down bolts, and penetrations not sealed to the wrap correctly. Other defects including misaligned studs and nogs, compressed/missing insulation, and particleboard flooring in wet areas were counted as “quality” type defects and not included in the compliance defects. The reason was the work has been done, but not to a completely satisfactory standard, affecting the performance or finish so it is counted as a quality defect rather than affecting code compliance.

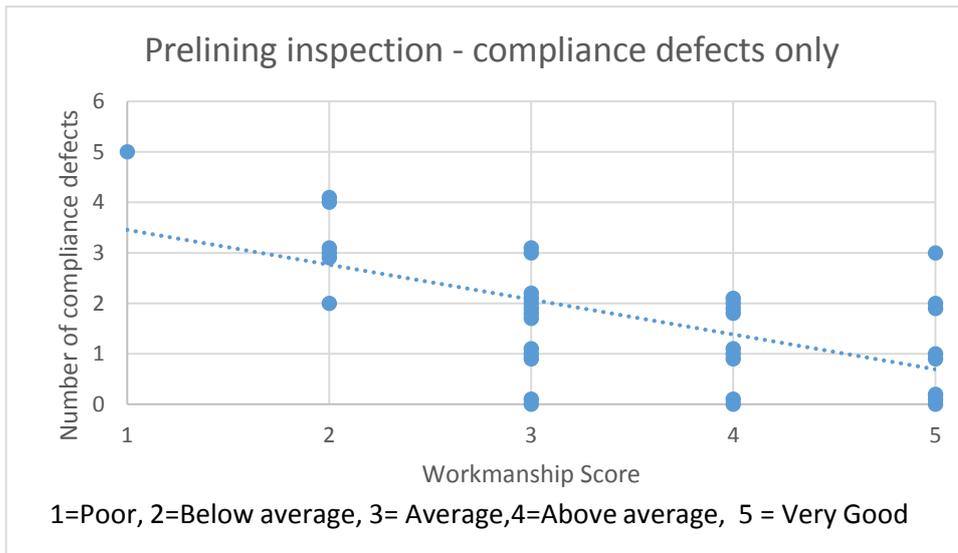


Figure 2 Pre-lining inspection defects – compliance defects only

The **pre-purchase inspection** results are shown in Figure 3, Figure 4, and Figure 5.

Figure 3 shows a scatter chart of results for the houses inspected. The vertical axis is a count of the number of defects in a house, including code compliance defects and amenity or quality type defects. Generally houses with more defects were rated lower in overall workmanship although the link was not as strong as for the pre-lining inspections.

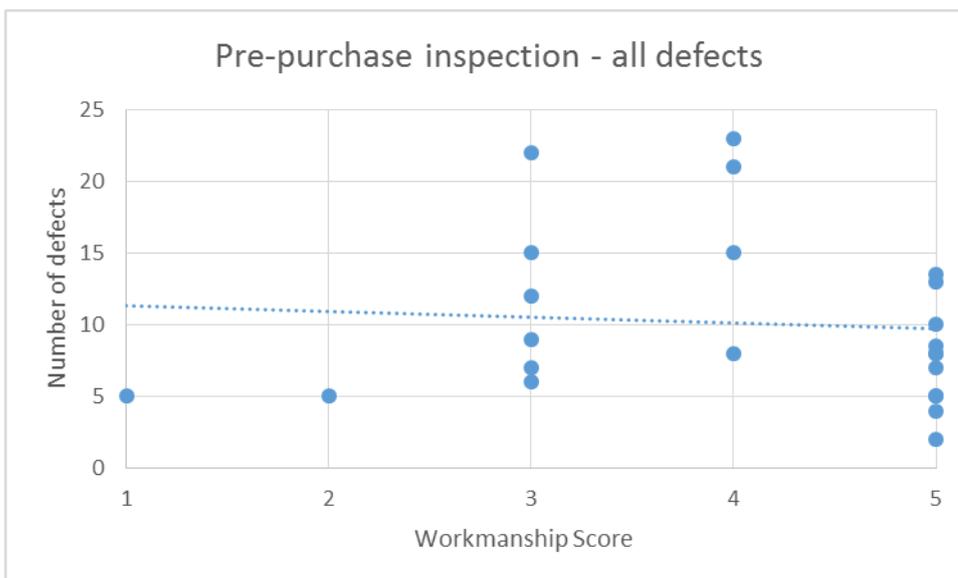


Figure 3 Pre-purchase inspection defects v workmanship score

Figure 4 shows a scatter chart of code compliance defects on the vertical axis, against total defects on the horizontal axis. The two are strongly related, but houses with smaller numbers of compliance defects also tend to have smaller numbers of *additional* quality defects. For instance, houses with three total defects in total averaged 1.5 compliance defects and 1.5 quality defects. Houses with four total defects averaged around 2.1 compliance defects and 1.9 quality defects.



Figure 4 Pre-purchase inspection defects – Compliance v all defects

Figure 5 shows the mix of main compliance and quality defects. The most common are wall flashings and penetration defects, cracked linings, and wall cladding defects (cracks/damage, loose bricks/ mortar, inadequate ground clearance to cladding). The defects counted as code compliance issues are wall flashings/ penetrations, exterior cladding cracks and loose bricks, and damaged roof cladding and flashing defects. The other defects in Figure 5 are considered to be quality type defects.

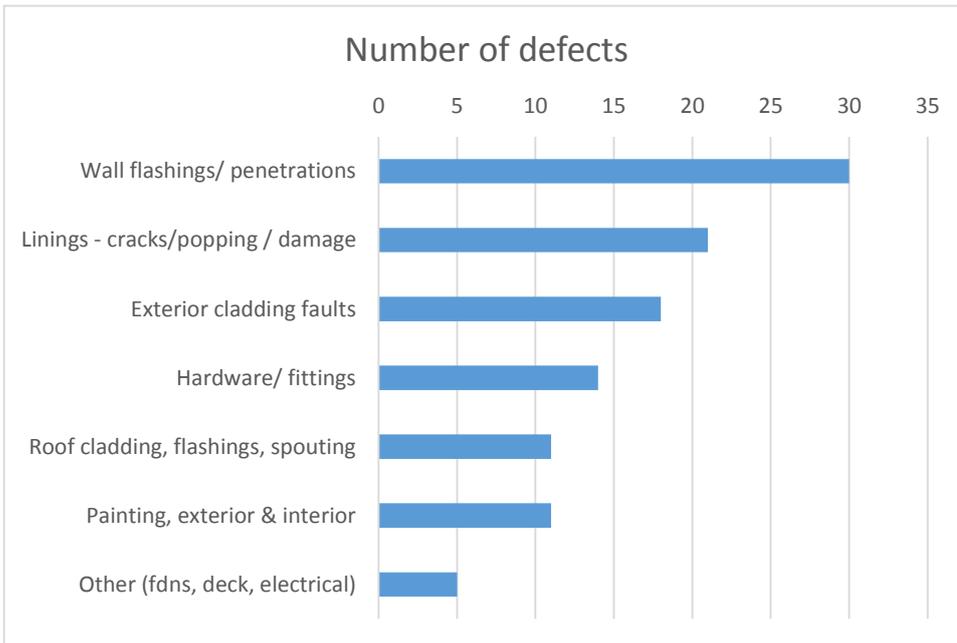


Figure 5 Pre-purchase inspection defects – Types of defects by number

3.2 Postal survey of builders

In addition to on-site inspection a postal survey was sent to builders asking about their problem areas in constructing new houses, see Figure 9 in the appendix. A list of problems was provided and respondents ticked those they have experienced in the last year on their housing projects. See Figure 6 for the results.

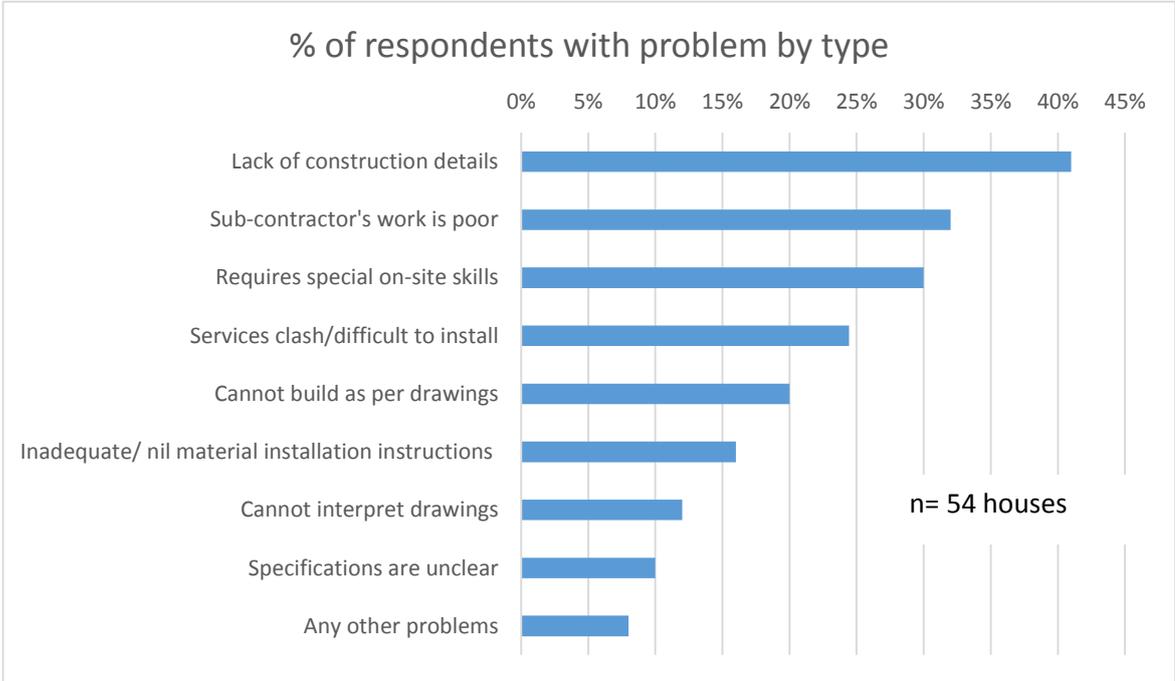


Figure 6 Problems areas by frequency

Over 40% of respondents had issues with lack of construction details. The results by component are in Figure 7 and indicate the difficult or problem areas are roof and wall flashings (i.e. window and door openings), with over 55% of respondents having issues.

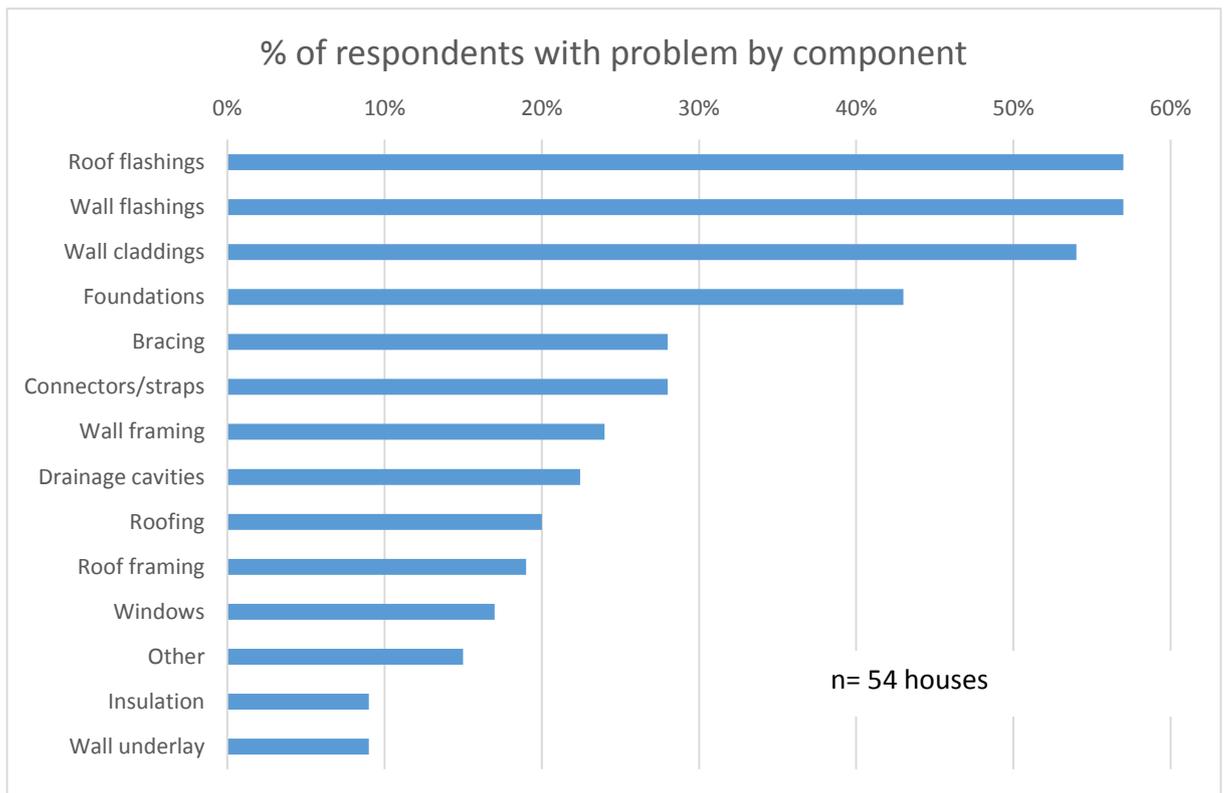


Figure 7 Problem areas by component

The most mentioned problem areas, flashings and wall claddings, are similar in ranking to those from the house inspections. The postal survey asked for builder's experience over a year and it shows that over 50% of builders had problems with these components over that time.

4. INSPECTION METHODOLOGY

A house inspection company, Realsure Ltd, was commissioned to inspect houses at two stages of construction. The first was an inspection at pre-lining when the floor, frame, wrap, windows/ doors and initial work on plumbing and electrical were inspected, defects and compliant work recorded, and photos taken of areas of interest, both good and bad. Moisture readings were also taken of the frame and were used to help the builder determine the timing of the lining work. Realsure agreed with some building companies to do these inspections. Realsure also persuaded a few councils to provide the timing of the pre-lining inspections so they could arrange with the builder to visit the site before lining. The same houses were inspected later on completion.

In addition, a different set of new houses had a pre-purchase inspection only, which covered all components. The regions chosen for inspection were Auckland, Hamilton, Christchurch, Tauranga and Wellington.¹ The basis for the inspection was the NZ Standard 4306:2005 Residential Property Inspection. It has survey sheets which are used for recording a mix of workmanship and house specification and amenity aspects.

For both inspections, the inspectors recorded an overall assessment of the quality of workmanship. This assessment was based on their experience in inspecting houses over many years.

¹ No properties were inspected in Wellington or Tauranga in Year One of the project.

5. DISCUSSION

A number of questions arise from the methodology. These are discussed below.

5.1 Is the sample likely to be representative of all new houses?

To some extent the sample is self-selected since builders have to agree to be inspected. Some builders that have experienced difficulty in their construction may be reluctant to allow inspection, whereas well-performing builders may be proud to show off their workmanship. This will bias the sample.

However, discussions with Realsure indicate the houses cover a range of types from standard to executive type construction and some are poor in quality indeed, indicating the sample is covering the full range. As an added check, the inspectors are recording floor areas, which will be one way to compare the sample against the population of new housing by region from complete building consent data.

5.2 Are they inspectors performing adequately?

The Realsure experience is mainly in pre-purchase inspections using the NZ standard 4306 Residential Property Inspections. This document is commonly used on existing houses but is suitable for new housing. Inspectors need to know details of NZS3604, and the Acceptable Solutions in clause E2 and H1 to inspect for 100% compliance. But it is unlikely they know all the details, for example when and what types of connectors are needed on lintels to studs, spacing of holding down bolts, spacing of window nailing, exact ground clearances to claddings, turn-ups on head flashings, etc. Also, since there are only at most 2 inspections per house, faults in foundations and the wall cavity and wrap will not be observable.

So the inspectors will mainly pick up obvious defects such as damaged/ cut wall frames and trusses, missing insulation, missing flashings, roof and wall cladding defects, and loose connectors. However, those areas available for observation do cover the main source of defects, and defects are generally apparent to a reasonably knowledgeable and observant inspector.

The inspectors were asked to give an overall rating for workmanship on a 1 to 5 scale with 1= poor, 2= below average, 3= average, 4= above average and 5= good. Figure 1 and Figure 2 show the number of defects against their workmanship score. The trend is downward from left to right, as expected but even with a good workmanship score there are still a significant number of defects in some houses. This suggests there may need to be refinement in scoring overall workmanship. Further investigations are needed in how the inspectors assess the workmanship score.

5.3 What components are we not inspecting?

The two main areas lacking inspection are the foundations, and the exterior after framing and before cladding, including wall underlay, flexible flashing tapes, cavity battens and sill support bars. Also, the ends of flashings for upturn are not observable at the final inspection. On one site adjacent to a house inspected, poor foundation preparation was observed, involving lack of compaction in 150mm layers, as required by NZS3604. The frequency of defects in fill compaction, and other unobservable components, is not known.

5.4 General observations

Almost all of the pre-lining inspections found gaps and/or compression in the insulation in both walls and ceilings. This will degrade the expected performance of the insulation. Unless there are frequent gaps this has not been scored as a code compliance defect.

A significant number of houses have packing on studs, or have been straightened as per NZS3604, to achieve an even surface for the linings. This indicates that timber being supplied for some houses is only just meeting the straightness criteria of NZS 3602 and that the quality is not as good as could be expected.

Generally, windows were fixed to the framing using single nails. Most builders are not aware of the recent changes to window reveal fixing details in Clause E2/AS1 of the building code requiring paired fixings at specified spacings (see clause 9.1.10.8. of AS1).

Some houses with four or more butting studs (supporting steel beams for example) are required by the council inspectors to have horizontal straps to tie the studs together because the inspector cannot see the nails joining the interior studs to each other within the assembly. But in many cases these straps are not used and presumably the assumption by the inspector is that there is adequate nailing.

Installing larger windows is difficult for builders due to weight. Some window suppliers install the glazing separately but not all suppliers are prepared to do this. There may be hidden damage to the window frame during installation with the heavier windows.

At this stage there do not appear to be any systemic failures in new house construction on the scale of the leaky homes failures. The issues identified so far relate to components such as claddings, flashings and windows, which are probably amenable to improvement through education and better enforcement.

There would be value in doing inspections of foundations, and of the exterior walls after wrap, battens, and flashing tapes before cladding. It is recommended that on some houses the pre-lining inspection is swapped with either of a foundation or pre-wall cladding inspection. This would entail a similar workload for the inspectors but would cover a larger number of components across the whole sample.

Discussions were held with one of the Realsure inspectors. He was not aware of any consistent trends in workmanship that could cause problems in structural integrity, durability or weathertightness. Where defects do arise in these areas they are generally isolated. Major failures in the future, if they occur, are likely to be due to combination of factors, much as happened with leaky buildings.

6. APPENDIX

This appendix contains:

- Details of defects obtained from the pre-lining inspections.
- The survey form sent to buildings as part of the regular New Dwellings Survey.

bow wall	cut frames	Proud straps/bolts/plate	Poor joist support	Bottom plate HDs	penetrations	Wet area floor not treated	Insulation (comp, loose)	Loose blocking/ squeaks, protr	Roof underlay	Wiring/ plumbing close to surf	DPC	Window/ door sealing	Window/ door fixing	Other	Total
x	x	x	x										x		5
x	x	x			x							x		x	6
				x			x			x		x			4
				x		x		x		x		x			5
		x										x			2
	x				x	x		x				x			5
x		x	x			x						x		x	6
x															1
x		x				x						x			4
x	x			x				x				x		x	6
														x	1
x	x	x		x	x		x	x	x	x			x		11
			x				x	x							3
	x	x			x							x			4
					x							x			2
		x						x				x		x	3
			x					x							2
															0
x	x	x		x	x		x	x				x		x	9
	x							x							2
								x						x	2
							x								1
							x					x	x		3
		x					x					x	x	x	5
							x					x	x		3
		x		x			x						x		4
x							x						x		3
x		x					x					x	x		5
x		x					x					x	x		5
				x			x	x				x		x	5
												x	x		2
							x	x							2
x							x	x				x	x		5
x	x	x					x	x				x	x		7
							x						x		2
							x						x		2
x		x					x	x					x		5
x		x	x	x			x	x				x	x	x	9
															ave
15	9	17	3	8	6	4	19	17	1	3	1	14	25	10	4.0
															med
															4

Figure 8 Defects by house inspected – pre-lining inspections.

Figure 9 Survey form posted to builders

Problem areas in new housing construction																
BRANZ is interested in getting your views on problem areas in housing construction generally, not only this house but other projects you have done.																
Component	Foundations	Wall Framing	Roof framing	Bracing	Windows	Roofing	Insulation	Wall underlay	Drainage cavities	Wall Claddings	Wall flashings	Roof flashings	Connectors/ straps	Other (state)	No problems in my experience	
Problem areas	tick boxes that are applicable in your experience in the last year														
Lack of construction details	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Cannot intepret drawings	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Cannot build as per drawings	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Requires special on-site skills	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Sub-contractor's work is poor (1)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Material installation instructions are inadequate / not provided.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Specifications are unclear	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Services clash/ difficult to install	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Any other problems? (state	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
.....																
Thank you. Please fold with New Dwelling Survey and return to BRANZ. (1) What sub contractor?.....																
We will add another lotto ticket or voucher for this completed form.																