STUDY REPORT

SR 335 (2015)

New house construction quality survey 2014

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Preface

This is the second of two reports on the inspection of new houses. The aim of the inspections is to ascertain the quality of construction, problem areas for the builder including adequacy of construction details, building complexity, and any building code compliance issues.

Acknowledgments

This work was funded by the Building Research Levy.

Note

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

New house construction quality survey 2014

BRANZ Study Report SR 335

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Abstract

There are cost and time pressures on builders to complete their projects, particularly at present due to high demand levels. During rising demand building companies find it difficult to contract staff with adequate skills and quality of work often declines. Designers and building inspectors are also under pressure during high demand. For designers this may result in less than complete drawing details to guide the builder. For the council inspectors the high workload may leave inadequate time to carry out inspections. This project has found failings in work of all three sectors. Designers have not always supplied sufficient details. Some builders have failed to follow the details provided, quality of finish is poor in some cases, and there are compliance failures. For inspectors some compliance issues have been missed partly due to lack of knowledge and partly due to work covered up due to some areas not inspected. This report quantifies the incidence of all these failures and discusses the remedies required for better outcomes.

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1. INTRODUCTION

This project inspected over 200 new detached houses at various stages of construction. These were at post-wall underlay, pre-lining, and at the final council inspection. The first stage of this work was discussed in the BRANZ Study Report 316 in 2014. It reported on the development of the inspection method and identification of issues to explore. It also had some preliminary results from the start of the survey.

This report is for the completed survey. The aim was to assess the quality of work, problems that the builder experienced, and the extent of code compliance of the work. The inspections were carried out in Auckland, Tauranga, Hamilton, Wellington and Christchurch. The inspection firm Realsure Ltd undertook the on-site work. They arranged with the councils to be notified when work was ready for inspections, what type and the location. Realsure approached the builder, explained the project and obtained agreement to inspect. BRANZ carried out the analysis from the on-site reports provided by Realsure.

2. EXECUTIVE SUMMARY

The main findings are:

- On-site inspections of houses under construction found a number of defects which were classified into two groups, namely, building code compliance defects, and quality or appearance defects.
- Most houses inspected had one or more defects of both types. Compliance defects are the more serious because they potentially affect the durability and performance of the house. It is arbitrarily assumed the presence of four or more compliance defects is likely to indicate serious concerns about that house. Approximately 8% of new houses are considered likely to be in this category.
- The incidence of quality defects averaged over four per house. They typically related to interior surface finish defects. Many of these defects are likely to be observed by the new owner whom, in most cases, will ask the builder to repair them. Other work by BRANZ indicates the call-back rate is very high for new housing. (Curtis 2015a)
- Separate to the on-site inspection a postal survey of a different sample of builders was done on issues they have with constructing quality houses. This found their main problem was inadequate detailing, in particular roof and wall flashings and connectors, which affected over 40% of builders over the previous year. Difficulty in obtaining workers with adequate skills was also a major issue affect about 35% of builders.
- Building Code Authority (BCA) inspectors in areas of high demand may on occasions be limited in time to carry out inspections. This can affect checking to ensure all the details are built as drawn. This view is based on the Realsure observations of the time allowed and extent of council's inspections for some houses. Additional staff could be seconded from BCA with lower workloads to help out in BCAs experiencing high demand.
- BCAs could assist builders to construct a compliant house by specifying a minimum level of detail required in consent documentation. The amount of detail required may vary depending on the BCA's experience with the builder.
- There are anecdotal reports from two sources that some project supervisors in group building companies were responsible for up to 20 houses at one time. This is believed by the author to be excessive. They should have a lower workload, the ratio dependant

on the skills of the workforce, to ensure adequate guidance and checking of the workmanship. This is the responsibility of building firm owners whom in some cases need to be much more concerned about the quality of the work produced by their workforce.

3. RESULTS

3.1 On-site-inspections

Three types of inspection were carried out: post-underlay inspection (wall), the pre-lining stage, and the final inspection. The post-underlay inspection included the wall underlay, cavity battens, and the installation of flashing tape to openings, flashings and underlay penetrations. Pre-lining inspections including framing, installation of straps and fixings, window installation, services and insulation. The final inspection included roof and wall cladding, spouting, exterior and interior paint, flashing, linings and trim.

The incidence of defects found in the inspections is shown in Figure 1 for all three inspection types. The blue bars are quality type or aesthetic defects and the red bars are building code compliance defects. The percentages are calculated using the number of houses inspected for that particular type of defect. A total of 225 inspections were done (112 final, 49 post-underlay and 64 pre-lining). There is a quite high incidence of defects, between 10% and 65% of all houses.

The most common compliance defect related to the fixing of the windows to the frame. It appears many builders are not aware of the 2011 amendment to the fixing requirements as set out in E2/AS1 clause 9.1.10.8.

A variety of flashing defects were found including wrong clearances, no slope or inadequate kick-out, no stop ends, flashing too short, poor joints, and damaged flashings. Just one of these defects at an opening or roof junction could cause water damage, and the high incidence of these defects is a concern. There is some leeway with flashings because the cavity system is believed to be quite robust in terms of water management. However poor flashings combined with loose underlay on an exposed weather face could cause moisture problems. To be conservative it was decided to class any flashing defect as a potential problem area even with good underlay.

Some of defects shown in Figure 1 could be classed in either of the two categories, compliance or quality. For example, an insulation fit defect arises when the insulation is cut incorrectly leaving gaps or causing compression at the edges. Almost always it is the latter and this does affect performance. However it was decided to classify this as a quality issue because the insulation is still performing a useful function even when it is not operating optimally.

Bowed wall frames were found in about 40% of house inspections. In most cases it was only just over the 5mm per 2.4m stud height that is allowed in NZS3604, and was for one or two walls only. This may cause appearance problems. However in a few cases it was well over the 5mm on some of the walls. This could be a structural hazard, though it has been shown in the chart as an aesthetic or quality defect. This also raises the issue of quality of timber framing in general, with anecdotal reports from older builders saying that more frame straightening is done now than in the past.

Loose wall or roof underlay could cause weather-tightness problems. When it is sufficiently loose and extensive then wicking of water can occur between the cladding, flexible underlay and insulation. It was decided to class it as a compliance defect because where it occurred it was generally on more than one place on the envelope.

A fuller description of each defect is in the appendix, including a discussion of why they are classified as a compliance or a quality/aesthetic defect.

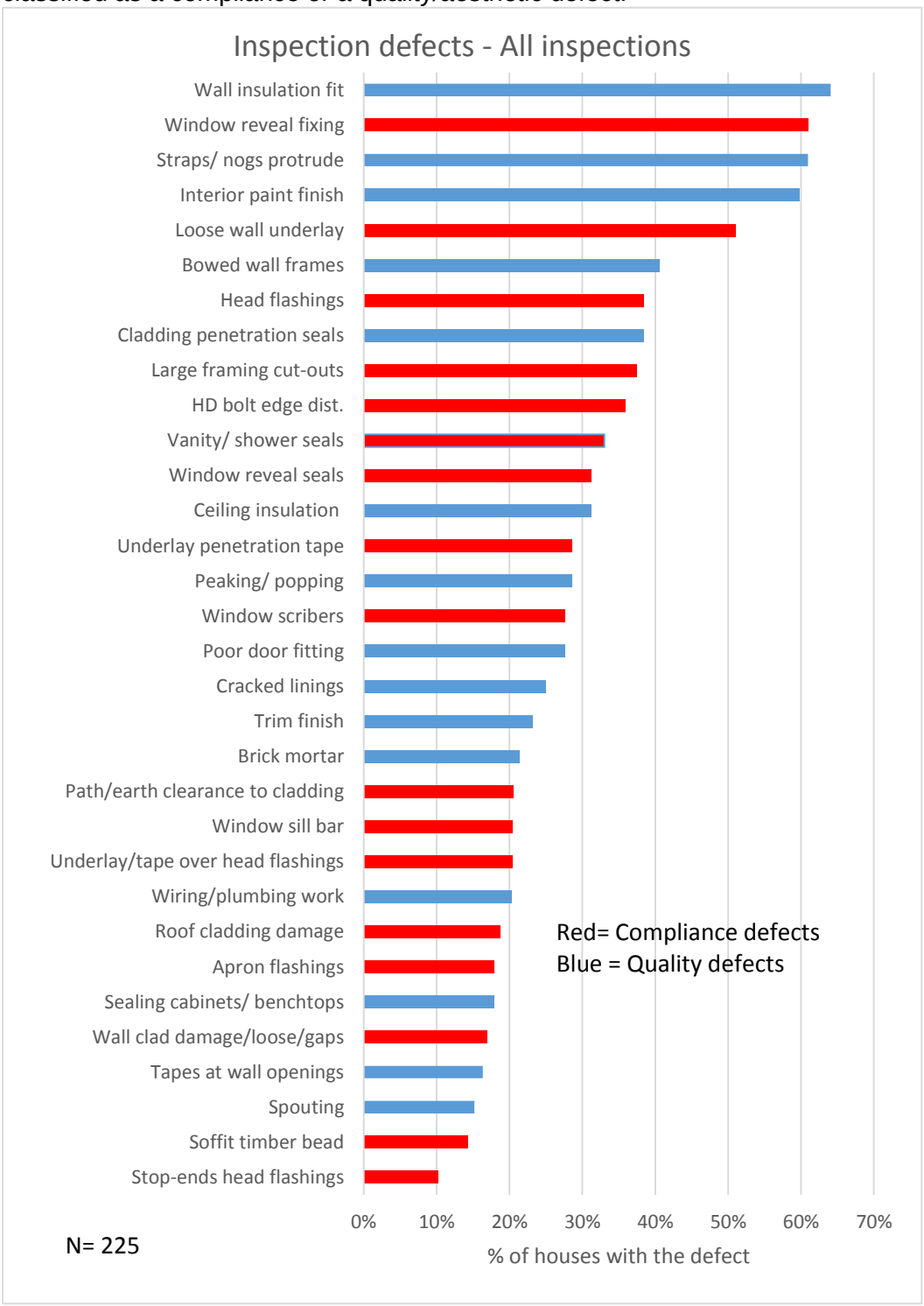


Figure 1 Defect incidences from all inspections

3.2 How serious are the compliance defects?

To obtain a better feel for serious defects the number of compliance defects per house was analysed as shown in Figure 2 to Figure 4. Many of these defects are completely visible for one inspection only. For example, the assembly for wall flashings and cavity battens are visible only at the post-wrap stage. Insulation and services cabling are visible at the pre-lining stage. The final inspections check the linings, paint finishes and cladding details. Wall and roof flashings are also checked in the finals mainly for their positioning on claddings.

Realsure inspections took place both before and after the council inspector had visited. So many of the defects observed, particularly at post-underlay and pre-lining will be remedied. This is less likely at finals because many are difficult to repair, or may be difficult to see (e.g. after removal of scaffolding). Also some defects may not be picked-up by the BCA inspectors due to time pressures and incomplete knowledge.

It was intended to inspect the same house at different stages of construction but the time and logistics of this proved difficult so almost all inspections are on a house that had not been inspected previously by Realsure Ltd.

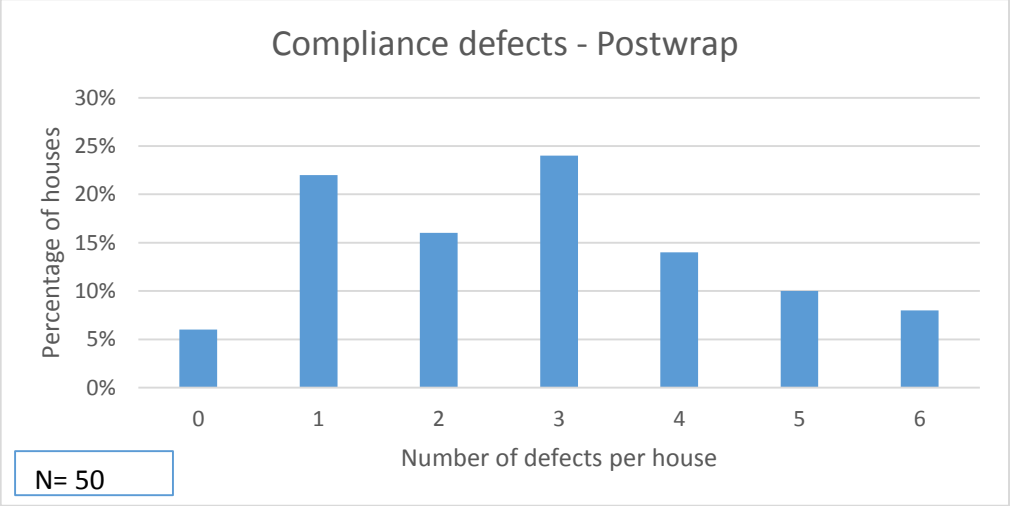


Figure 2 Compliance defects post underlay

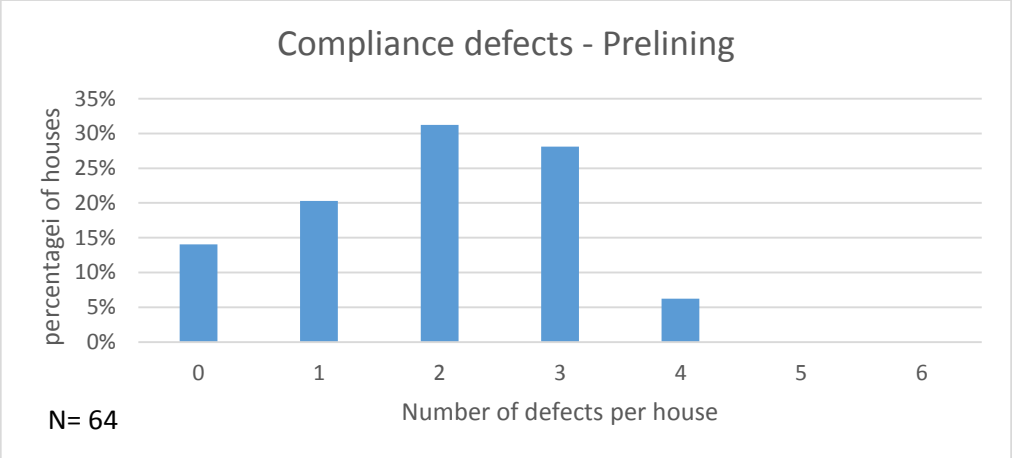


Figure 3 Compliance defects pre-lining

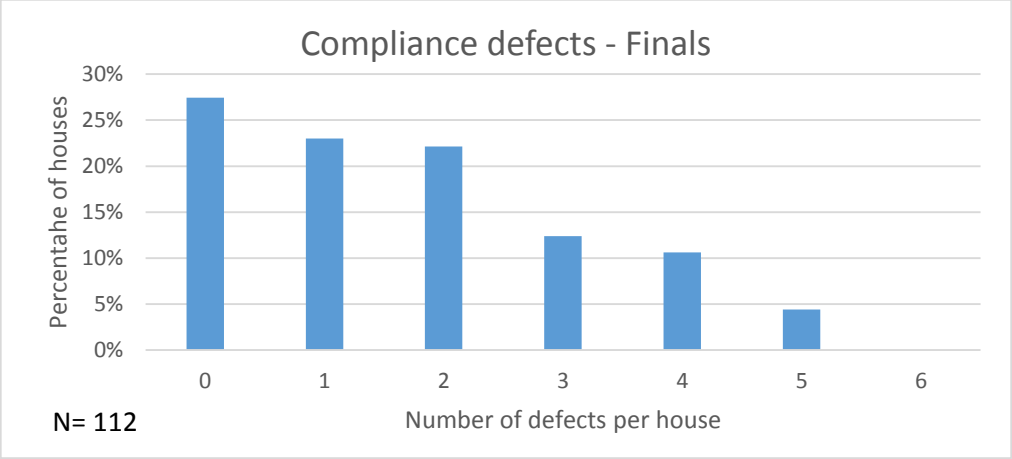


Figure 4 Compliance defects final inspection

The three stages of inspections indicate a quite high level of compliance problems. There are between 6% and 27% of new houses with no defect, depending on the type of inspection (i.e. post-underlay, pre-lining, and final). We could assume a house with one or two defects is able to survive with minimal damage, though that depends somewhat on the actual defect. There are between 16% and 30% of houses with one to two defects, depending on the type of inspection.

The three staged inspections are mainly inspecting different components in each, and we need to adjust for the different sample size in each inspection type. This is done in Table 1 where the numbers are derived from the percentages in the previous charts for each of the three inspection types.

The table shows the average number of compliance defects across all three inspection types is 2.2. It indicates about 18% of new houses have no defects, and about 40% have one or two defects. 23% of houses have three compliance defects, and 19% with four or more defects. Figure 5 has the same information in pie chart form. We somewhat arbitrarily assume four or more defects is indicative of serious compliance issues, and in particular poor workmanship.

As noted above some post-wrap and pre-lining defects recorded by Realsure will likely be remedied. So the 19% share of houses with four or more compliance defects is an upper limit. A more realistic measure is from the finals inspections because earlier defects picked up in the council inspections would have been remedied. The final inspection has a rate of about 15% of houses with four or more compliance defects. We assume, perhaps optimistically, half of these are remedied before occupancy leaving a compliance defect rate of about 8%.

There were 27 houses in the total sample (post-underlay, pre-lining and final inspections) with four or more compliance defects. To get a better feel for these houses their full range of defects, compliance and quality defects, are shown below. The compliance defects are in bold print.

Table 1 Scaling-up for the different inspection types

Expected number of compliance defects per 1000 houses.					
Number of	Number of defects if each inspection sample is 333				
defects per house	Post-wrap	Pre-lining	Final	Total	%
0	20	47	115	182	18%
1	73	68	11	152	15%
2	53	104	93	250	25%
3	80	94	52	225	23%
4	47	21	44	112	11%
5	33	0	19	52	5%
6	27	0	0	27	3%
	333	333	333	999	100%
2.2	= Average number of compliance defects all inspections				

Figure 5 All inspections compliance defects

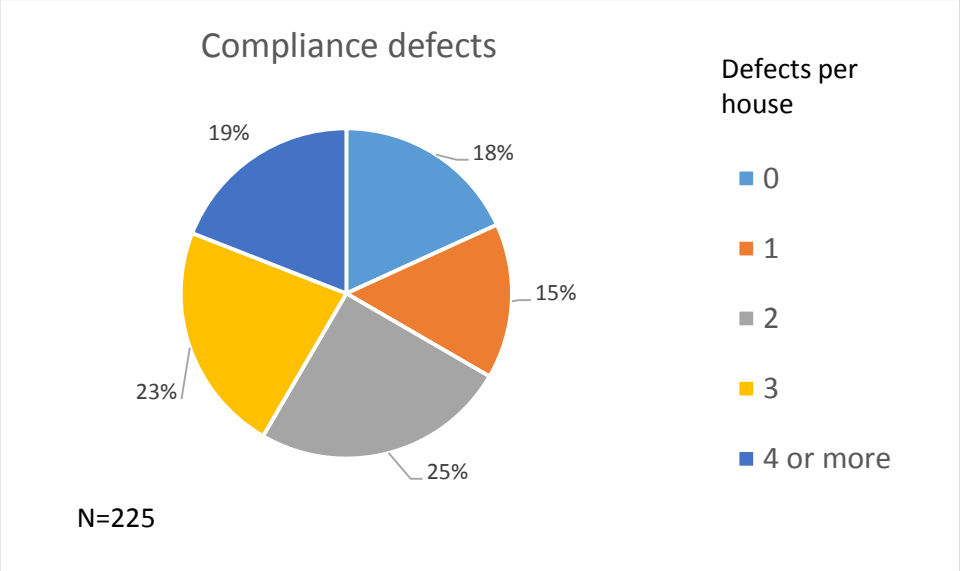


Table 2 is the score sheet for post-underlay inspections, Table 3 is for pre-lining inspections, and Table 4 is for final inspections, all for houses where four or more compliance defects were found. In most houses the quality defects are as numerous as the compliance defects (i.e. the total number of defects are approximately twice the compliance defects). This indicates that that houses with several compliance defects also have a similar number of quality type defects. So using compliance only defects as a guide to performance is a reliable method for assessing overall workmanship. Generally poor workmanship is the reason. In some houses with compliance issues the quality of finish is quite good but the builder has been let-down by lack of skills, knowledge, or poor drawing details to correctly construct the critical components.

Table 2 Defect sheets for houses with four or more compliance defects at Post-underlay inspection.

	House inspection number																
POST UNDERLAY INSPECTIONS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
Wrap /tape over head flashing	x	x	x	x	x												5
Head timber bead soffit						x	x	x		x							4
Upturn end of head flashing		x	x	x													3
Roof/wall flashing details	x									x					x	x	5
Flashing meter box										x	x						2
Window open corner/sill tapes									x		x		x				3
Loose underlay			x	x	x	x		x	x	x	x	x	x	x	x	x	13
Vertical window seals loose/ incorrect			x			x		x									3
Cladding window junction			x	x													2
Sill bar faults						x				x	x	x				x	5
Bowed wall		x	x	x	x							x	x			x	7
Cut frames			x	x							x						4
Proud straps/bolts/plate		x	x	x	x	x		x	x	x	x	x	x	x	x	x	15
Poor joist support floor/ roof								x					x				2
Bottom plate HDs	x				x			x	x					x	x		6
Underlay penetrations taped	x						x		x			x	x	x	x	x	8
Insulation (corners, comp, loose)					x		x	x	x	x	x	x					7
Loose blocking/ protrudes					x						x	x				x	4
Wiring/ plumbing close to surface			x						x								2
Window/ door sealing		x	x	x		x	x		x			x	x	x		x	10
Window/ door fixing	x	x		x	x		x	x	x		x	x	x	x	x	x	13
Other			x	x	x	x		x	x	x	x	x	x	x	x	x	13
Other 2			x	x		x				x	x			X		x	7
Total defects	5	6	12	11	9	8	5	9	10	9	11	10	9	8	7	11	
Compliance defect totals	5	4	6	7	4	4	4	5	5	4	4	4	5	6	5	6	

Table 3 Defect sheets for houses with four or more compliance defects at Pre-lining inspection.

	House inspection number				
PRELINING INSPECTIONS	17	18	19	20	Total
Bowed wall	x	x	x	x	4
Cut frames	x	x	x		3
Proud straps/bolts/plate	x	x	x	x	4
Poor joist support				x	1
Bottom plate HDs	x	x	x	x	4
Wall underlay penetrations	x	x			2
Insulation (compressed, gaps)	x	x	x	x	4
Loose blocking/ ,protrudes	x	x		x	3
Roof underlay	x				1
Wiring/ plumbing close to surface	x				1
DPC missing	x				1
Window/ door sealing		x	x	x	3
Window/ door fixing	x		x	x	4
Other		x	x	x	3
Total defects	11	9	8	9	
Compliance defect totals	5	5	5	4	

Table 4 Defect sheets for houses with four or more compliance defects at Final inspection.

	House inspection number							
FINAL INSPECTIONS	21	22	23	24	25	26	27	Total
Lining cracks							x	1
Door ill-fit /striker					x			1
Roof fixing overtight, missing, rusty				x				1
Lining damaged		x				x		2
Lining stopping							x	1
Mortar/ paint splatter							x	1
Paint drips/scuff, unfinish					x			2
Trim damage					x			1
Shower leak		x	x		x		x	4
Popping, peaking					x		x	2
Downlight insulation			x	x		x	x	4
Plumbing					x			1
Exterior door	x				x			2
Sill flashings, flat sill				x				1
Apron flashings			x	x	x	x	x	5
Head flashings	x	x	x	x			x	5
Valley flashing				x				1
Window scribers	x	x	x	x	x	x		6
Roof clad damage				x	x			2
Wall clad damage				x			x	2
Wall clad paint						x		1
Wind/clad gaps, not sq,scribers				x	x	x	x	4
No DPC timber to concrete				x				1
Fascia details	x	x						2
Mortar block/brk				x	x		x	3
Monolithic clad cracks	x							1
Fixings to wall clad	x	x						2
Penetratns wall clad	x	x		x				3
Path wall clad clearance	x	x				x		3
Ground wall clad clearance	x	x			x			3
Garage door/jamb						x		1
Deck			x	x				2
Roof wrap touch insul						x		1
Other					x	x	x	3
Total defects	9	9	6	14	14	10	12	
Compliance defect totals	5	5	4	4	5	4	4	

3.3 Quality and appearance defects

These are defined as all defects not classified as compliance defects and are shown in. Figure 6. The average number per house is 4.2 and there was only 8% of houses with no quality defects.

Figure 6 Quality defects at final inspection

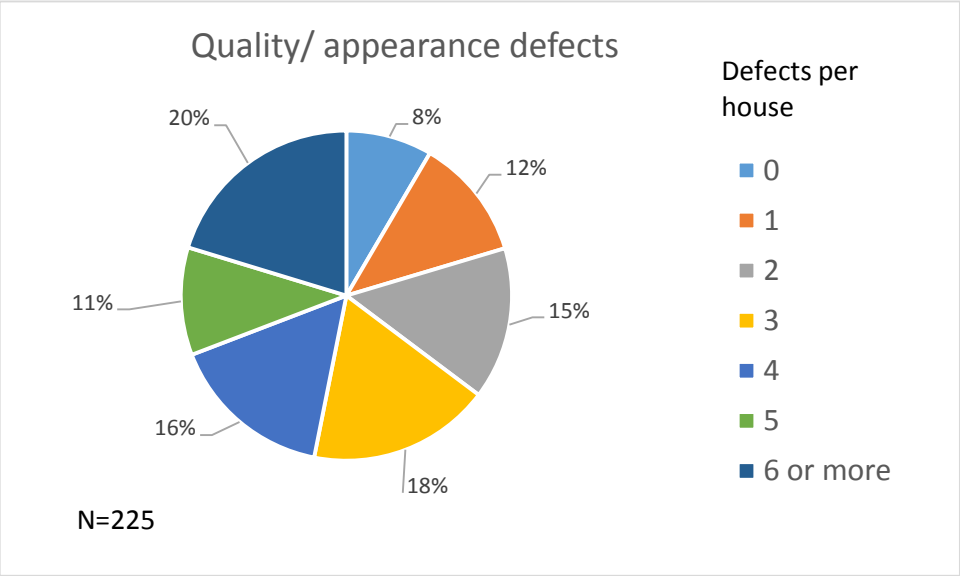
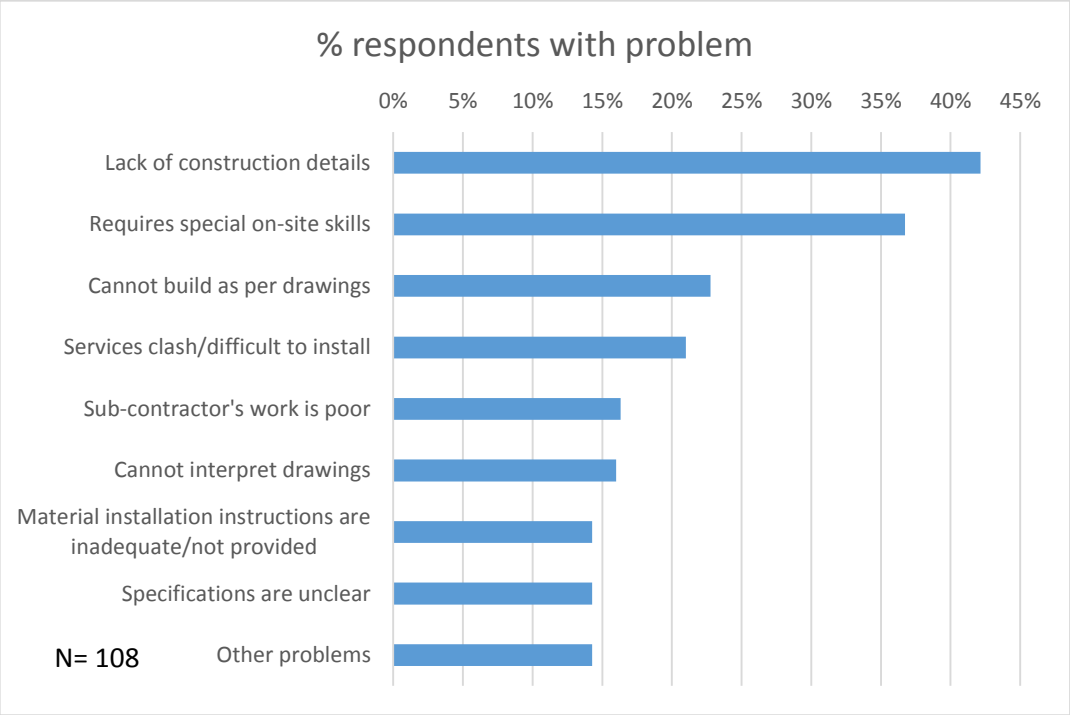


Figure 1 shows these quality defects included interior and exterior paint finish, ceiling insulation, popping of fixings in plasterboard, poor trim work, ill-fitting cupboards, and cracked linings. Other inspection types (apart from the final inspection) also indicate wall insulation installation is poor, and some walls are not straight or have protruding straps and nogs which affect the surface finish.

3.4 Survey of the problems builders face in producing good work

Separately from the site inspections a different group of builders were surveyed on the problems and issues they have in producing quality work in new housing. It was a postal survey to over 600 builders, and 108 responses were received. They were asked to tick-box any problems encountered over the last year in their work, and the survey sheet is in the appendix in Table 7. The problems are shown below in Figure 7.

Figure 7 Types and incidence of problems experienced by builders.



The top three issues relate to lack of buildable details on the drawings, and lack of appropriate skills. Over 40% of builders have experienced lack of details at least once in the past year. The responses may indicate a lack of knowledge about where to find details, e.g. E2/AS1 and NZS3604 or inability to translate the drawings into what needs to be done on-site. So the top three items in the chart could partly be caused by insufficient skills of the workforce, rather than insufficient detail being provided on the drawings or available from other sources.

The survey also asked on which part of the house the problems arose. The components and results are shown in Table 5. The components most affected are foundations, wall claddings, wall flashings, and roof flashing.

Table 5 Builders survey of problems they have experienced in new housing construction

Builder's survey - Problem areas															
							Number of responses by component								
Problem areas	Foundns	Wall framing	Roof framing	Bracing	Windows	Roofing	Insulatn	Wall underlay	Drainage cavities	Wall cladding	Wall flashings	Roof flashings	Connectors /straps	Other	Total
Lack of construction details	11	4	7	3	2	3	2	2	1	12	16	18	10	2	93
Cannot interpret drawings	5	2	3	0	2	1	0	0	0	4	3	2	4	1	27
Cannot build as per drawings	6	6	9	1	4	2	0	0	1	4	9	10	3	0	55
Requires special on-site skills	14	7	7	6	7	10	3	4	6	14	13	16	5	2	114
Sub-contractor's work is poor	11	6	3	2	5	9	3	0	2	9	6	6	4	5	71
No/Poor material installation info	3	0	1	1	4	0	2	0	3	5	5	2	2	2	30
Specifications are unclear	3	1	2	1	3	1	1	1	1	1	3	3	3	1	25
Services clash/difficult to install	5	2	1	1	2	0	1	0	4	4	1	2	2	5	30
Any other problems	3	3	2	1	1	1	2	2	2	2	3	1	3	5	31
Total	61	31	35	16	30	27	14	9	20	55	59	60	36	23	

Table 5 indicates that lack of on-site skills and poor construction details are the main problem area for this groups of builders. The shading is from red and orange having the most responses to dark green having the least number. The components most affected are foundations, wall claddings and roof and wall flashings.

The survey had space for builders to write general comments about problem areas, and 32 comments were received. These are summarised in Table 6. The most common comment related to dealing with councils, including getting approvals and arranging inspections. Skills were also a major issue. Seven of the builders commented they had no problems in producing quality work, and they outlined the reasons. They mainly relate to good management and thinking pro-actively.

Table 6 Builders general comments

General comments from builders.	
Councils / regulations	Nine comments including:
	Time delays (approvals, inspections)
	Requesting information beyond the drawings.
	Standards and solutions are too complex.
Skills	Seven comments
	Lack of skills, cannot read plans
	Unable to install new systems and products.
	Some LBP have poor skills.
	Wage expectations do not match skills level.
Designs/ designers.	Four comments
	Not enougth details, need more cross sections
	Flashings and connectors are poorly detailed
	Does not consult or use builders suggestions for changes.
	Flashings detailing and installation is a constant problem.
Sub-contractors.	Three comments.
	Poor skills
	Time delays appearing on-site
	Earthworks contractors are unskilled
H&S	Two comments.
	New requirements are costly and time onerous.
No problems	Seven comments
	Keep tight control on subbies and designer details
	40 yrs experience makes projects go smoothly
	Management is crucial
	Familarity with standards and approved solutions
	Managing problems from the client's perspective

4. DISCUSSION

4.1 Types of houses inspected.

The majority of the houses inspected were from the larger builders and were generally in the medium cost range, rather than expensive one-off designs. The inspectors commented that generally the few expensive one-offs they inspected were better quality and had fewer compliance defects. This is assumed to be because they had more experienced builders doing the work and the supervision was better. Their drawings were more detailed as well, and usually the designer was available to clarify details as required for the builder.

About 70% of all new housing is from the group builders and is in the medium cost range (per comm Curtis 2015a, $1650/sqm, average size 185 sqm). So it is concluded that this project is relevant to the majority of new detached housing constructed in 2014. However, over this same period we know that multi-unit construction was approximately 20% of new dwellings, and these were not inspected. BRANZ has received anecdotal reports that quality on multi-units is of concern. The reason given is project management companies employ sub-contractors to do all this work, usually at fixed rates which are not "generous". Also, design of multi-units is often more complex than for detached housing. If these assumptions are correct then their defects levels on low-rise multi-units could be higher than found in this project for detached housing. Comparative on-site inspections are needed to check this.

Construction techniques and management skills differ for multi-unit construction, compared to detached housing, particularly at higher storeys. Multi-units as a share of new housing in Auckland is expected to increase to 40% of the next few years (Page 2013). It is not known whether designers and builders are adapting adequately to this new scale of construction. Research into this aspect is also needed.

4.1.1 Types of inspections

Three types of inspection were done to cover critical stages of construction. The main component that was not inspected was the foundations. The reason for this omission is that this stage was thought to be straight forward to construct particularly with slab construction on near flat sites, where specialists layout the foundations and install waffle pods. These systems have over 50% share, and concrete slab in general over 90% share (per comm, Curtis 2015b). However, the inspectors commented on two houses where the slab foundation preparation appeared to be inadequate, including insufficient hardfill, and inadequate bulk fill compaction at a slab corner. Also slab layout was obviously incorrect in some houses with both over and under-dimensions relative to the wall cladding. The may be some problems with foundations on new housing, and this supposition is supported by the builder's postal survey which found quite a high level of problems in foundations, see Table 5. Any future surveys should consider whether foundation inspections are needed.

4.1.2 Timing of inspections

The Realsure Ltd inspectors were in liaison with the BCA inspectors for notice of which inspections were ready. The Realsure inspector would then contact the builder and arrange to visit as soon as possible. Generally that would be the same day or the next, and could be on either side of the BCA inspector's visit. Many of the defects in the post-underlay and the pre-lining inspections that Realsure noted would have been remedied due to the BCA inspector notifying the builder. So the charts in this report over-estimate the actual incidence of defects that are not remedied. However, the fact that a quite high incidence of compliance defects are being built is of concern, even when some of these are fixed after the BCA inspector had pointed these out. Also, defects in the final inspections are less likely to be repaired, as discussed above in section 3.2.

4.2 Drawing details

A sample of 21 houses at post-underlay stage were checked by Realsure Ltd for drawings details. The Realsure inspectors were advised in 11 cases that no plans were on-site at the time of their inspection. The workmen on-site said the supervisor keeps them in his vehicle and visits each site approximately twice a day. This may be sufficient most of the time but it is suspected on occasion the workers lack the detailed drawings when needed and build incorrectly. For the other 10 cases with plans on-site, the Realsure inspectors found in five cases the plans were not followed correctly or specific details were totally ignored. These omissions were mainly for connections, battens and flashing details. Also another three of the plans were not well detailed. Only two houses out of the 10 where drawings were inspected had good details and good workmanship. Lack of time in this project disallowed further investigations into the adequacy, or otherwise, of the drawings. A bigger sample is needed to assess whether this apparent inability to provide and follow specific details is wide spread.

4.3 Incidence of compliance defects.

Almost all houses inspected had one or more defects. There were two houses with no defects, one each at the post-underlay and pre-lining stages. The average number of defects for the three inspections was 2.2 compliance defects. Whether the compliance issues go on to cause deterioration of the structure and envelop depends on the particular circumstances. These include the extent and location of the defect, and the weather face of the building with the defect and its exposure to the elements.

The average number of compliance defects may appear to be quite low. But we would not expect any compliance defects to appear in a well designed and built house. So it is concerning that almost all houses had one or more of these defects. The number with four or more compliance defects, which is suggested as the threshold for serious concern, is 15% in the final inspections. Some of these will be remedied and it is “guesstimated” that half remain, i.e. 8% of new houses have a “serious” compliance problem. It is not certain these defects will go on to cause physical damage of the building envelope, but the potential for this exists. Even houses with one or two compliance defects could potentially have significant physical damage over time, depending on the type of defect.

It is known that some houses have four or more defects after the issue of the code compliance certificate (CCC) since many of the Realsure inspections were done after work was completed for the CCC. The defects include head flashings, poor fixing of windows, loose flexible underlay facilitating moisture transfer across the exterior envelope, and window jamb sealing. Also included are underlay penetration taping, large cut-outs in the timber frame, and frame holding-down bolts in the wrong place. These all potentially could result in physical damage to the building.

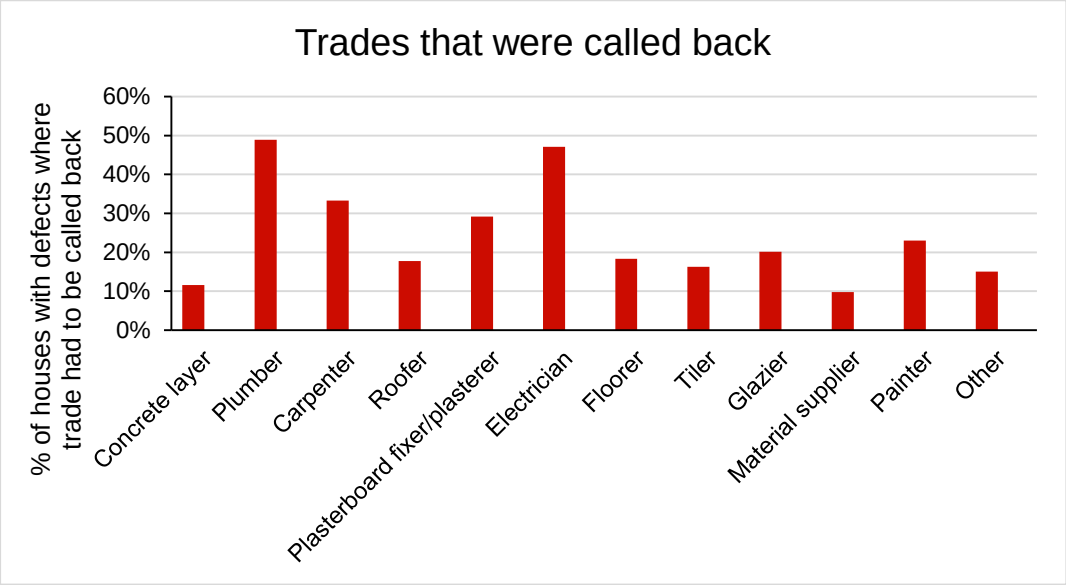
4.4 Quality issues.

BRANZ has anecdotal reports and has done formal surveys indicating that new homeowners very often need to call back their builders to repair defects. The BRANZ New Home Owners Satisfaction Survey (Curtis 2015) has been recording these defects for a number of years now. The latest finds that 81% of new owners had call-backs. The types of defects were recorded by trade, see Figure 8. The most common trades called-back were plumbers and electricians, followed by carpenters (doors, trim, cabinets, etc.), plasterer (linings) and the painters. These are all related to aesthetics, and fixtures and fittings. Any structural or weather-tight defects would generally be hidden or unknown by the owner. However 18% of the call–backs

(equivalent to 15% of all new houses) were for the roofer. This is in agreement with the Realsure inspections which found 18% of houses had roof cladding defects.

Expectations of owners can be misplaced, especially regarding finishes, and quality is often subjective. There is a need for designers and builders to discuss what can be achieved in the level of finish and fittings, and the cost associated with the various levels. It is hoped the guide to quality for new housing that Ministry of Business, Innovation and Employment (MBIE) is developing will aid owners to better understand what finishes are achievable and what to expect from their builder. This guide is shortly to be published by MBIE.

Figure 8 New home owners survey 2014



Despite the high call-backs new owners were generally happy with the quality of their new home. 88% of respondents reported being at least fairly satisfied with the overall quality (on a scale of 1 to 5, where 4= fairly satisfied) of their home. This was the aspect with the highest level of satisfaction achieved in the latest survey, though this is down from 91% in the 2013 survey.

New home owners were least happy with:

- The fixing of defects after first occupancy
- The level of communication from their builder, and
- The service provided by their builder after they moved in.

28% of respondents rated their builder's fixing of defects after first occupancy as fairly poor or worse (score 1 or 2). This is slightly worse than the result for 2013.

The high satisfaction of owners is not a reason to ignore the compliance defects revealed by this project. Owners expect the structural and weathertightness aspects of a house to be to code level. They are unable to check these aspects and rely on the industry to do its job. This inspection survey has indicated the industry as a whole is not always performing to the expected standard.

4.5 Builders survey

A separate builder's survey was done, and received 108 responses. It asked about the types of problems they have encountered in building quality housing over the previous year. Lack of

construction details was the top problem, with 42% of builders ticking this box. It is not certain if this truly reflects poor design, or lack of builder's ability to interpret the drawings and to find appropriate details in NZS3604. If it is the former then there may be issues at the consent approval stage. Not able to build as per the drawings was the third ranked problem and could mean either lack of skills or incorrect details.

The second ranked problem, shortage of specific skills, suggests that some of problems reported as lack of lack of drawing details could be inadequate skills. The skills problem is also evident in the Realsure Ltd inspections as workmanship defects in a number of areas.

4.6 The value chain

It is the responsibility of all industry sectors to produce compliant and quality new housing. Manufacturers need to ensure they make fit-for-purpose materials and systems. Designers need to provide adequate and workable details. Builders need to build to the drawings and the relevant standards and have adequate skills. BCA inspectors need to have training and time to adequately check the work.

All sectors are important but usually success or failure in quality and compliance is with the builder. If the drawings are not adequate the builder should insist on an appropriate level of detail. The business owner need to ensure the licenced building practioner (LBP) responsible for the sign-offs of the work has adequate time to supervise, and that he/she is supported in their request for adequate documentation from the designer.

Having said that, there is a need for adequate resource in BCAs to check drawings and specifications at the consent application stage. Builders should be able to rely on consent documents being correct.

Delivery of the complete package is an industry issue and pressure on resources applies to all segments during the boom-bust cycle that occurs in the industry. It relies on all parties acting conscientiously, cooperatively, and with the aim to produce a quality job. Builders are liable for compliance defects discovered within 10 years of construction under the Building Act 2004. Other parties such as designers may also be found liable. However build and design firms fail and liquidate over time and may not be in existence for redress by the owner. In these cases councils often remain the main source of financial redress in the event of failure. This gives a strong incentive for BCAs to ensure compliance at the consent application stage and during construction. Councils need to be adequately resourced to do this.

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5. RECOMMENDATIONS

Designers need to ensure they produce sufficient detail suitable for the level of complexity of the job. This needs to be explained to the client so that designers are adequately paid to produce a compliant and quality set of documents.

BCAs need to ensure the documentation provided at consent application time is complete. Further, BCAs should consider what is a minimum level of detailing needed in the consent documents for the workforce to produce a compliant house. The amount of detail may need to vary depending the skills of the builder and his workforce, and the complexity of the job.

In regions of high demand building inspectors need to be given sufficient time to check documentation and carry out inspections. To this end BCAs should monitor whether the

inspectorate is sufficiently resourced. A possible solution is to obtain temporary resource from BCAs with lower workloads.

Builders should ensure all their workforce has at least a basic knowledge NZS 3604 and E2/AS1, and arrange training on where to find the details set out in these documents. In particular builders need to keep up-to-date with amendments to these documents.

The supervising builders (LBPs) need to ensure building work is compliant and to accepted quality standards. Construction Company owners need to support the LBPs in this by ensuring their supervisory load is not excessive, and they should support LBPs when they require appropriate details from designers.

BRANZ should carry out further survey work on checking the adequacy of drawing details and to what extent the workforce is able to follow and built to these details.

BRANZ should carry out a scoping survey on multi-units to investigate whether compliance and quality issues are likely to be wide-spread.

BRANZ should consider repeating the new house construction condition survey within 5 years.

6. REFERENCES

NZS 3604:2011 Timber-framed buildings. Standards New Zealand.
NZ Building Code Acceptable Solution E2/AS1
Curtis M (2015a). New homeowners satisfaction survey 2014. Study Report #338, Building Research Association of New Zealand.
Curtis M (2015b). Physical characteristics of new houses 2014. Study Report #330, Building Research Association of New Zealand.
Page I (2013) Auckland housing forecasts and the Unitary Plan. Study Report #295, Building Research Association of New Zealand.

7. APPENDIX

7.1 Types of defect

7.1.1 Compliance defects

Head flashings –No end stops or upturn. Upturn too small. Flashing length too short not sufficiently covering window frame at ends. Inadequate slopes to flashing faces (less than 15 degrees). Gap between flashing and cladding is too small (less than 5mm). Flashing is in two pieces with nil or poor junction seal. All these are weather-tightness issues.

Window fixing – Reveals not fixed at required spacings as per E2/AS1 clause 9.1.10.8 Amendment 5 August 2011, and is a structural issue.

Wall underlay – Too loose. Torn and not taped. Cut short at bottom. Inadequate overlaps. Spacing between straps more than 300mm when studs over 450mm centres, or nil straps. Straps installed vertically instead of horizontally. All these faults could enable insulation to touch the cladding, causing wicking of moisture. Insulation pushing out wrap excessively was found to be uncommon, but it is a potential compliance issue.

Frame cut-outs – Cut-out is larger than NZS3604 allows and not reinforced. Mainly in top and bottom plates. A structural issue.

HD bolts – Holding down bolts in the floor slab are too close to the slab edge. Generally several of these were observed in houses with this defect. Isolated 1 or 2 HD bolts close to the edge may be OK from a structural viewpoint but several of these raises compliance issues.

Vanity, shower wall seals – not sealed, or poor sealing with potential moisture problems. Could eventually cause structure problems.

Window reveal seals – The gap between the window jamb and framing is too large or too small for the pef backing rod and foam seal. No pef rod was used. There are gaps in the foam seal. These cause the air barrier to not work as designed and is a water penetration issue.

Wall underlay penetrations – pipes, cables through the wall are not correctly sealed to the underlay. This needs to be done well for the drained cavity to work properly.

Window scribers – gaps at weatherboard scribers. Scribers should be cut correctly, and if not the gaps should have sealant. This is a possible point of entry for moisture.

Path/earth clearance to claddings – clearance from the bottom of cladding to bare earth or the concrete path/ driveway is less than specified in NZS 3604 and E2/AS1.

Window sill bars – for windows wider than 600mm in cavity construction, inadequate fixing of bars to the frame, or the bar is absent.

Underlay/tape on overhead flashing upstands – missing.

Roof cladding damage – dents, scratched coatings, too short at gutters, screws not tight or over-tight. Rib profile roofing ends are not closed at gutters.

Apron flashings – at roof-wall junctions on upper storeys the kick-out dimensions is too short. The upstand dimension is too short. Also includes the apex flashing lead edge not profiled to cladding. These are weather-tightness issues.

Wall cladding damage – split boards, loose bricks/ masonry, poor joints allowing moisture entry.

Tapes at wall openings – tapes to the framing are missing, not to E2/AS1, or poorly done.

Soffit timber beading – no beading at the junction of the soffit with the top of the wall cladding or where the window frame touches the soffit. There is a potential moisture entry problem, though the junction is usually protected from the weather by the eaves.

Stop-ends/ head flashing caps -missing stop-ends or caps, or not behind cladding.

7.1.2 Quality defects

Insulation – The fit between studs and nogs is too tight or too loose. Excessive compression at pipe and electrical cables. No wall frame junction insulation (especially corners). Compression and nil insulation at corners occurs on almost all houses. Compression or gaps is usually not extensive, hence this defect is classed as a quality issue rather than compliance.

Protruding straps and nogs - Straps at top and bottom plates and at lintels are not recessed. The nogs not flush with studs. There are different plate and stud sizes. These defects may cause problems with the linings finish.

Paint finish – Inadequate number of coats. Rough finish. Drips and runs.

Frames not straight. The bow exceeds the 5mm over 2.4m length allowed in NZS3604. Includes top and bottom plates. Generally isolated to 1-2 walls hence classed as quality issue rather than a compliance issue.

Wall cladding penetration sealing - Screw fixing of downpipes and lights to cladding without compression washers. Pipes lack escutcheons to protect the silicon sealant. These are assumed to not cause weather-tightness problems because all inspected houses had drained and vented cavities. But they do allow moisture deterioration of the claddings in isolated places in the long-term. This is considered a quality issue.

Insulation over downlights – partial or complete cover of downlights. These were not uncovered by the inspector to check their rating. Visible downlights in the photos had rating labels, and often the insulation around the light was untidy, i.e. poorly or excessively cut. The inspectors did not know the fire rating for the insulation and hence it is impossible to say if covered downlights were a hazard. In general the fire hazard from downlights is believed to be low, based on NZ Fire Service records. This defect was classed as a quality defect because the main issue observed was the excessive gaps around the downlights.

Peaking and popping – Plasterboard linings finish is marred by nails popping. Very little peaking was observed (two houses only).

Poor door fitting installations – mainly cupboards and wardrobes, rather than passageway or exterior doors.

Cracked linings - mainly at window corners.

Trim finish – junctions poorly done. Damage to floor trim. Paint repairs needed.

Brick mortar – too thick in places causing a poor appearance. Bricks/ blocks overlapping concrete slab by >2cm were classed as a compliance issue.

Wiring/ plumbing work – holes in framing for the services are too close to the surface – when plasterboard is fixed the screws/ nails could penetrate the services. Cut-outs for switches are over-large and a small gap is visible on one side.

Sealing cabinets/ benchtops – Nil or poor sealing to the walls – may cause moisture problems to the linings.

Spouting – poor quality junctions, gradients too shallow. Downpipes too short at base entry to sump.

7.1.3 Photos of typical defects

These photos are mainly of compliance defects, but some relate only to quality defects.

Over-cutting of weatherboard for the flashing. No stop-end was visible behind the cladding. Weatherboard is split.

Poor junction of the flashing allowing moisture entry. Bottom edge of cladding needs painting.

No stop-end on head flashing

No sealing at the end of the head flashings

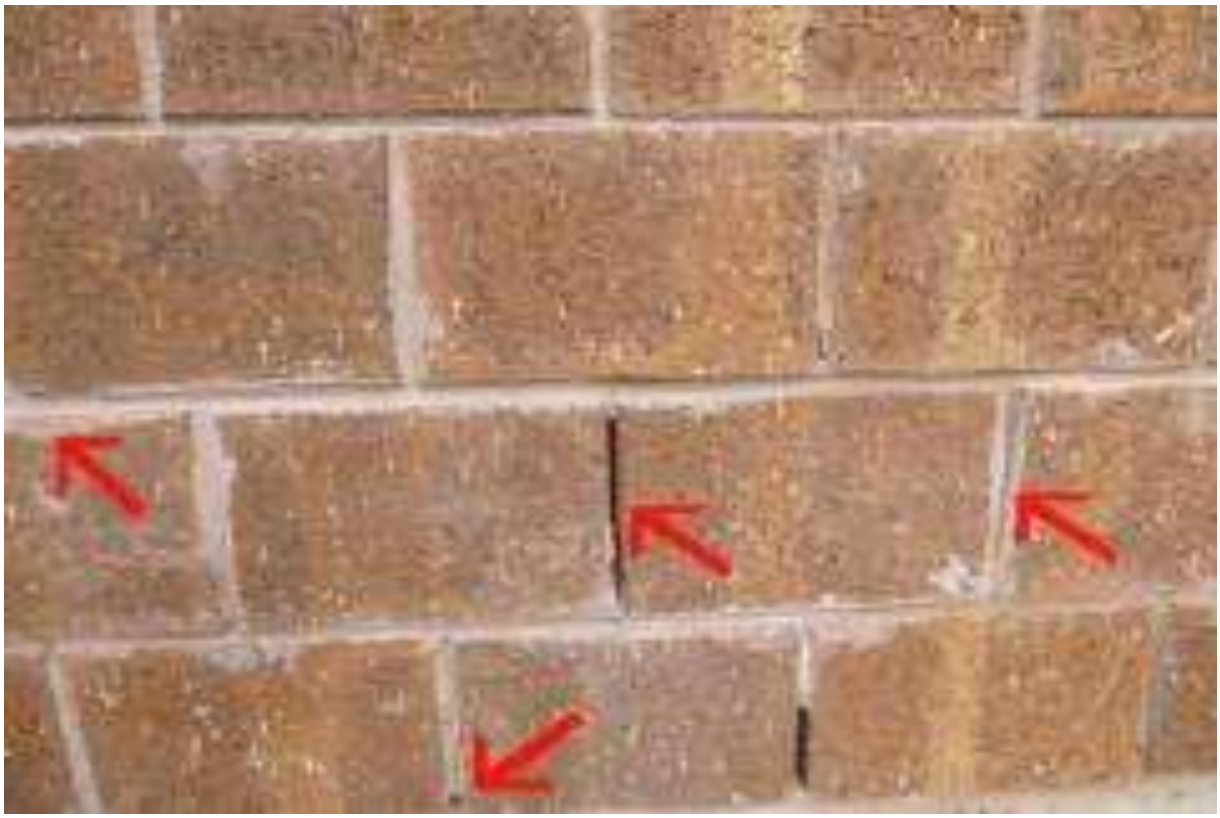
Inadequate clearance between cladding and head flashing

Head flashing does not cover scriber, unpainted and poorly cut scriber.

Poor weatherboard junction potentially allowing moisture penetration.

Window frame should to be firm against timber fillet at the window bottom.

Gaps between the window frame and the cladding



Missing mortar and poor finish

Apron flashing incomplete at corner with exposed timber.

Inadequate clearance between the cladding and to the apron flashing

No weep holes in brick cladding on the lintel. Downpipe needs a spreader at the bottom.

No sealing of hole on vertical corrugated sheet steel.

Underside of scriber is not painted.

Loose underlay

No bead between soffit and window frame

Un-reinforced top plate cut-out.

Loose clay brick.

Cracked masonry block.

Over 5mm bow in the stud.

Lintel strap is incorrectly positioned.

Poor sealing between the shower frame and the plasterboard.

Shower lining with gaps around the pipe inlet

No seal at sink-wall junction.

Poor finishing in toilet area.

Ill-fitting cupboard door

Inadequate fixing of window jamb to framing

A large cut-out which the builder said would be repaired (but repairs are unlikely to be adequate due to the geometry). Appears to be a bracing wall re HD bolts.

Untidy workmanship at the fascia junction.

Sealant around penetrations should have an escutcheon to protect the sealant.

No sealing of the pipe cladding penetration.

Excessive clearance. Downlight has a CA 135 mark so rated insulation could abut the can.

Poor foundation work, or alternatively blocks should have been cut to fit the slab.

Holding down bolt is too close to the edge of the slab.

7.2 Builders survey

A postal survey was sent to 700 builders and 108 returns were received. The survey form is in Table 7.

Table 7 Builders survey form of problems/ issues in producing quality houses

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	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Cannot intepret drawings	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Cannot build as per drawings	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Requires special on-site skills	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Sub-contractor's work is poor (1)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Material installation instructions are inadequate / not provided.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Specifications are unclear	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Services clash/ difficult to install	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Any other problems? (state	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

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.