BRANZ

Study Report

SR438 [2019]

Perspectives on the use of structural engineered wood products and adhesives in New Zealand: Results of an industry survey

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Funded from the Building Research Levy

The work reported here was funded by BRANZ from the Building Research Levy.

ISSN: 1179-6197

Preface

This report forms one part of the BRANZ research project QR01521 Structural Adhesives.

Acknowledgements

The authors thank all of the survey participants for their contribution to this work and in particular those who provided more detailed feedback from follow-up conversations via telephone. Nick Brunsdon assisted with survey design. We also thank the engineered wood product manufacturers who provided comments and data for this report, including the Engineered Wood Products Association of Australasia (EWPAA) who supplied the data in Figure 9.

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Reference

Nicholson, C. L. & Walsh, A. (2019). *Perspectives on the use of structural engineered wood products and adhesives in New Zealand: Results of an industry survey*. BRANZ Study Report SR438. Judgeford, New Zealand: BRANZ Ltd.

Abstract

This report summarises the results of an industry survey asking practitioners about their experience with structural engineered wood products (EWPs) and adhesives. EWPs are used extensively in construction overseas and are gaining increased interest in New Zealand. The aim of this survey was to understand practitioners' attitudes towards EWPs and their experience of using them. A total of 276 people responded to the survey, of which seven provided more in-depth feedback after follow-up telephone interviews. While the limited study size is recognised, some consistent themes emerged from the survey responses. These included that EWPs are widely used, that their use is likely to continue to trend upwards and that they are generally viewed positively by the building sector. More information provided by manufacturers of EWPs about their long-term performance and durability would assist with further increasing practitioner understanding and confidence in these products.

Keywords

Engineered wood products, EWPs, structural adhesives, laminated veneer lumber, LVL, glued laminated timber, glulam, cross-laminated timber, CLT, structural insulated panels, SIPs.

Contents

Figures

1. Introduction

Engineered wood products (EWPs) are used extensively in construction overseas. These products are gaining increased interest and market share in New Zealand, although quantitative data around their usage is lacking. The adhesives used in EWPs are critical to maintaining their integrity, and BRANZ is currently undertaking research to investigate the long-term durability of polyurethane-based structural adhesives in EWPs. Polyurethanes have a shorter history of use compared with conventional phenolic or resorcinol-based adhesives for structural applications in the New Zealand building industry.

The aim of this study was to complement the structural adhesives research by carrying out an industry survey asking building practitioners in the New Zealand construction industry about their experience with EWPs. The survey gathered information about practitioners' use of EWPs to attempt to understand how extensively they are being used now and likely future trends. This study report summarises the survey results and presents some very limited quantitative findings around EWP and adhesives usage.

For the purposes of this survey, an EWP was defined as a laminated product containing a structural adhesive. Structural insulated panels were also included in this survey as some utilise adhesives as an integral component. The focus of the survey was therefore on the following products:

- **Cross-laminated timber (CLT):** large-scale prefabricated solid wood panels produced by stacking layers of kiln-dried lumber boards bonded with adhesive.
- **Laminated veneer lumber (LVL):** structural composite lumber produced by bonding thin wood veneers together with adhesive.
- **Glued laminated timber (glulam):** structural timber produced by bonding layers of dimensioned timber together with adhesive.
- **Structural insulated panels (SIPs):** composite panels composed of an insulating foam core sandwiched between two structural facings that may be made of wood or other materials. The core and facings may or may not be bonded together with adhesive.

An invitation to complete the survey was emailed directly to 6,863 recipients (6,775 building professionals from the BRANZ database and 88 building companies identified through a web search who were thought likely to be using EWPs). Building specifiers and those involved in building approvals were not targeted as potential participants. A link to the survey was shared via several industry channels, including newsletters and social media. A total of 276 responses were received, representing a response rate of approximately 4%, which, while low, is in line with other BRANZ surveys. Seven participants provided additional feedback via telephone interviews.

After the survey results were collated, industry members representing EWP manufacturers were invited to comment on the findings. This feedback is shown in separate blue text boxes.

Appendix A lists the survey questions.

2. Current use of EWPs

Respondents were asked initial questions around whether they had been involved in construction projects that used EWPs. In instances where respondents hadn't ever used EWPs, they were then asked whether they planned to in the future. Respondents were not asked whether they had responsibility for specifying EWPs, but some commented to say they did not.

These were the key findings:

- Most respondents (85%, 234) had been involved in construction projects using EWPs (Figure 1). Some respondents added comments about how they had used EWPs. Examples included lintels, beams, rafters, floor joists and posts.
- 21 respondents (53%) who hadn't used EWPs said they planned to in the future (Figure 2).
- Of the 42 (15%) that hadn't used EWPs, 29 (71%) said it was because they hadn't had an opportunity to do so. One respondent commented that it was because they had been unsuccessful with the quote (Figure 3).

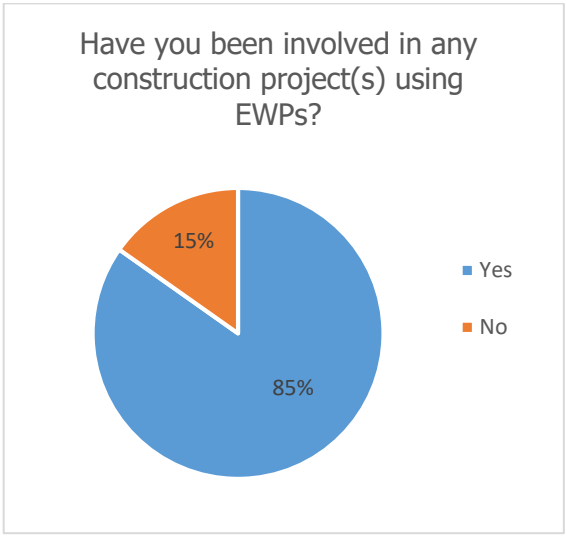

Figure 1. Current use of EWPs.

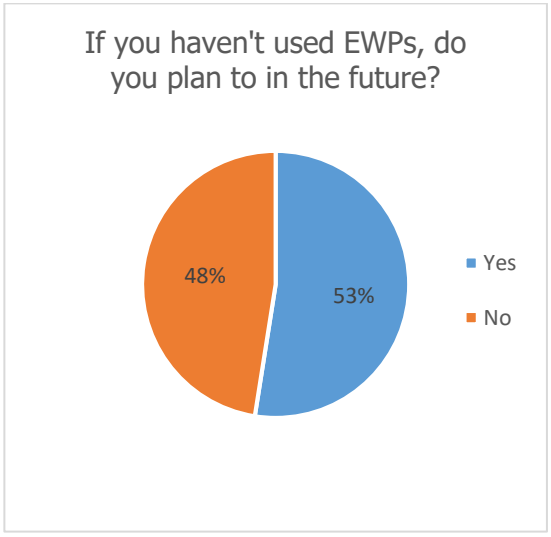

Figure 2. Planned future use of EWPs.

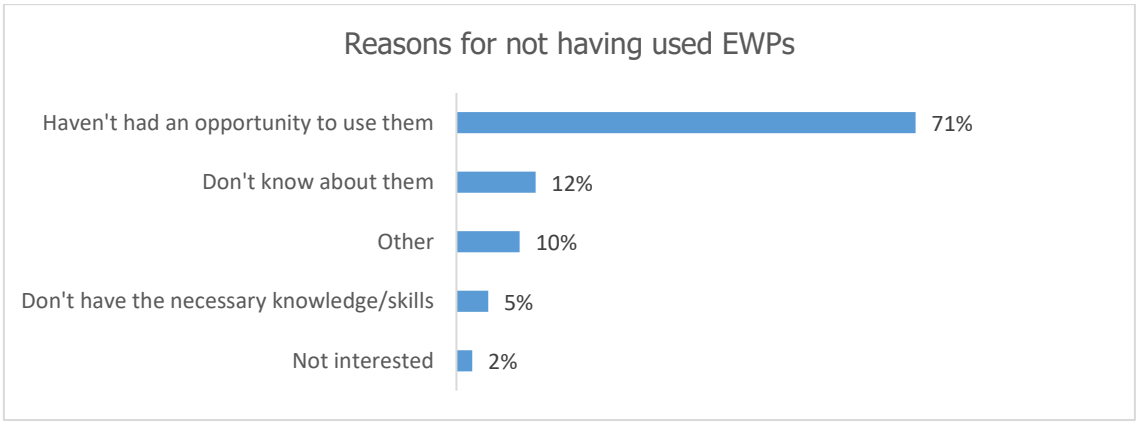

Figure 3. Reasons for not having used EWPs.

About 90% of the survey participants had therefore already used or intended to use EWPs in future construction. Only 10% of respondents either hadn't used EWPs or didn't ever intend to in the future. This suggests a very high interest in using EWPs but could also reflect survey bias, as those people already interested or knowledgeable about EWPs would be more likely to respond to a survey about EWPs.

Many different perspectives were expressed in the follow-up interviews. One respondent commented that their interest in EWPs was mostly personal rather than professional. They believed that timber construction had benefits from both an environmental and a human perspective. They would like to see more EWPs being used and see the market grow in New Zealand.

Another respondent said they were a big fan of investigating and using materials that lifted the standards of New Zealand buildings. Even though the New Zealand Building Code sets the minimum requirements a building must meet, people were so price conscious that they did not even build to the minimum. As a result, this respondent believed that the average New Zealand house was substandard. The respondent felt that New Zealand had made progress on using better materials, especially following the Christchurch earthquakes, and that things could only get better. They commented that many prominent building companies were supportive of engineered timber.

Another comment was the belief that people were keen to see new products, although it was noted that EWPs have been used overseas for decades so are not technically 'new'. The feeling was that more education about the products and how they performed was needed before some people would feel more comfortable using them.

An obstacle to using EWPs that was cited was mindset. One respondent said that people's attitudes in New Zealand tended to be: "We've always done it this way so why would we change?"

One respondent said there were unknowns about how EWPs performed because their use in New Zealand is in its infancy. As a natural product, their performance could be unpredictable, and they could react with their environment in possibly undesirable ways. For an EWP to be a material that stood the test of time, they believed that care had to be taken to consider all aspects of its performance, including fire and reaction to moisture as well as structural performance.

Another comment was that there had been a big push worldwide to build bigger and taller with EWPs, but the New Zealand industry first needed to ensure there was enough experience and evidence of the products' performance before doing the same. This respondent was a big supporter of EWPs but believed the industry should proceed with caution and use them carefully. The last thing they wanted was for the industry to forge ahead without enough care and then expose people to risks that put them off using EWPs again.

3. Which EWPs are being used and on which building types?

To better understand which EWPs were being used and how, respondents were asked how often they used EWPs (Figure 4).

LVL and glulam were used most often –198 respondents (94%) were using LVL either frequently (50%) or sometimes (44%). SIPs were used least – only eight respondents (4%) said they used SIPs frequently, but most had never used them (64%, 134).

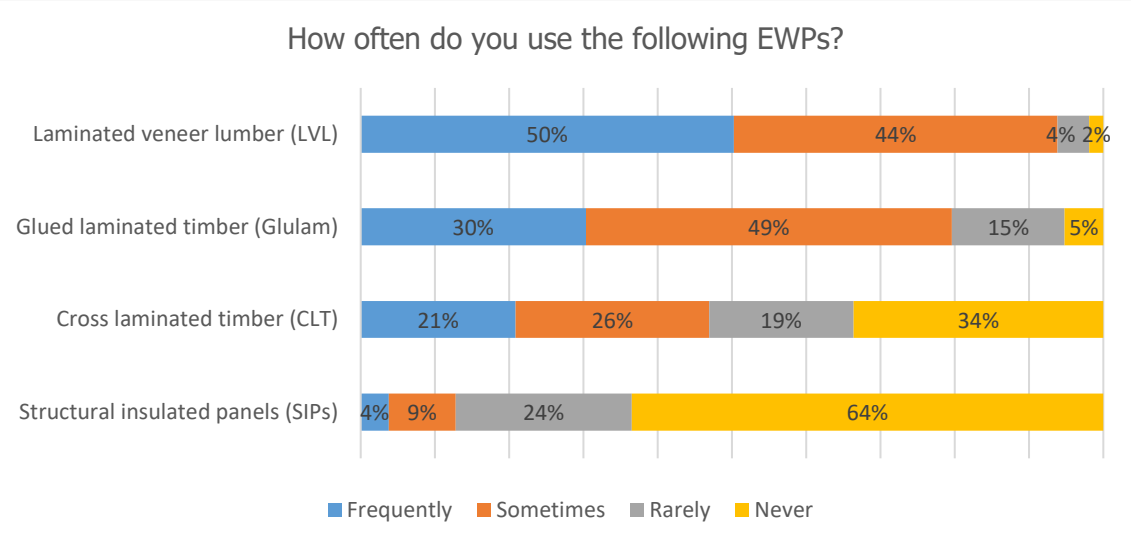

Figure 4. Frequency of EWP use.

Figure 5 shows that the most common type of work done by survey participants with EWPs was on residential stand-alone buildings (85%, 180).

More than two-fifths had used EWPs on commercial building projects (42%, 88), and a quarter had used EWPs on residential multi-unit projects (25%, 53). Examples of other uses included educational facilities (4), aged care facilities (2), farm buildings (2), healthcare facilities (2) and industrial (2).

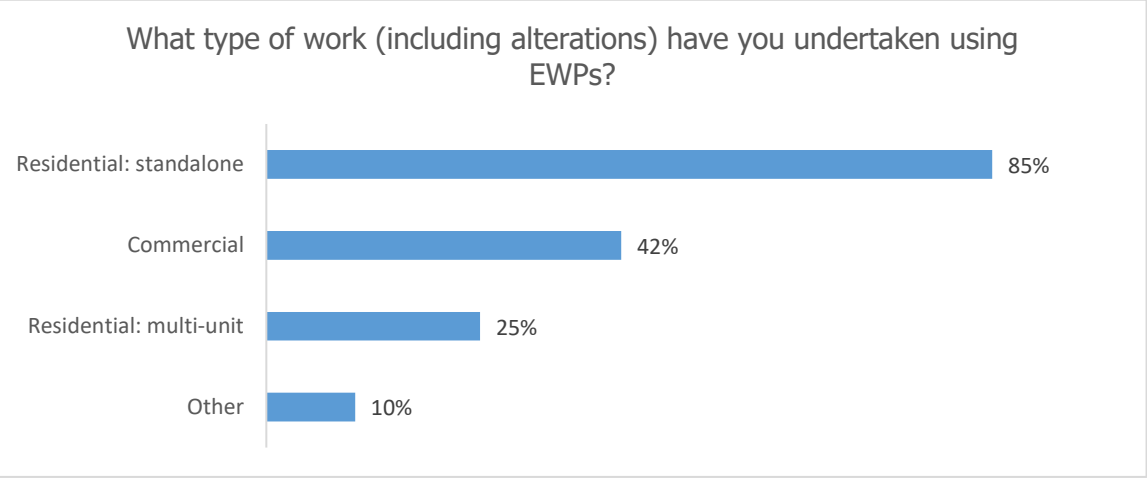

Figure 5. Type of work done using EWPs.

A common theme among respondents was that the dimensional stability of EWPs was seen as being a major factor in why they preferred using these products over solid timber.

For example, one respondent said that a benefit of EWPs was that they "stabilised pine", which could otherwise be unstable when grown in New Zealand conditions. This sentiment was echoed by another respondent who commented that radiata pine was not dimensionally stable and often warped or cupped, forcing them on a previous building project to use solid timber to replace many of the studs due to dimensional instability.

LVL was cited as not being as dimensionally affected as solid timber if it got wet during construction before the building was weathertight. This respondent added that the product always arrived straight and was stronger than solid timber. In a similar vein, one survey participant liked using EWPs more than traditional timber because it resulted in straighter and more durable buildings.

One respondent, however, had a less positive experience of using EWPs in the form of LVL beams, I-joists and laminated beams. They had experienced some manufacturing issues with LVL rafters that varied in tolerances.

One respondent took an opportunity to use SIPs when a client approached them to build a sleepout in Wanaka. They had been looking at alternative construction methods for many years, driven to find energy-efficient solutions that promoted healthy indoor environments. They said that the Building Code was the minimum needed for compliance, but the industry should be trying to do better because traditional stick construction was not good enough. They said exceeding the minimum was not much more expensive when long-term running costs were considered. They wanted to help bring awareness of using alternative products and improving the quality of buildings.

Another respondent believed SIPs to be a good product, especially for homes in colder climates such as Queenstown, due to the inherent high level of insulation.

Variations in tolerance are a sum of three distinct parts: (1) manufacturing tolerances, e.g. differences in tolerances between timber and steel connections, (2) site tolerances, i.e. how accurately a building is constructed and (3) environmental factors, such as moisture absorption causing swelling. Good detailing during the design phase and appropriate onsite handling can minimise adverse effects and with the positive uptake of digital fabrication in recent years, variations in tolerance are likely to become less and less of an issue.

Swelling and cupping due to changes in moisture are generally more pronounced in LVL than sawn timber. Straightness, twist, bow and machined tolerances, however, are much better for LVL. (EWP industry feedback)

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4. Perceptions of structural adhesives

Structural adhesives are used in EWPs to join layers or veneers and are critical for the long-term performance and durability of the product. Respondents were asked if they were aware that different EWPs contain different adhesive types.

Two-thirds of respondents (66%, 139) were aware that there were different types of adhesives in EWPs. Of these, three (1%) commented that they knew there were different types but not what they were.

They were then questioned about their perception of structural adhesives in relation to their performance, environmental impact and cost. The survey results are shown in Figure 6.

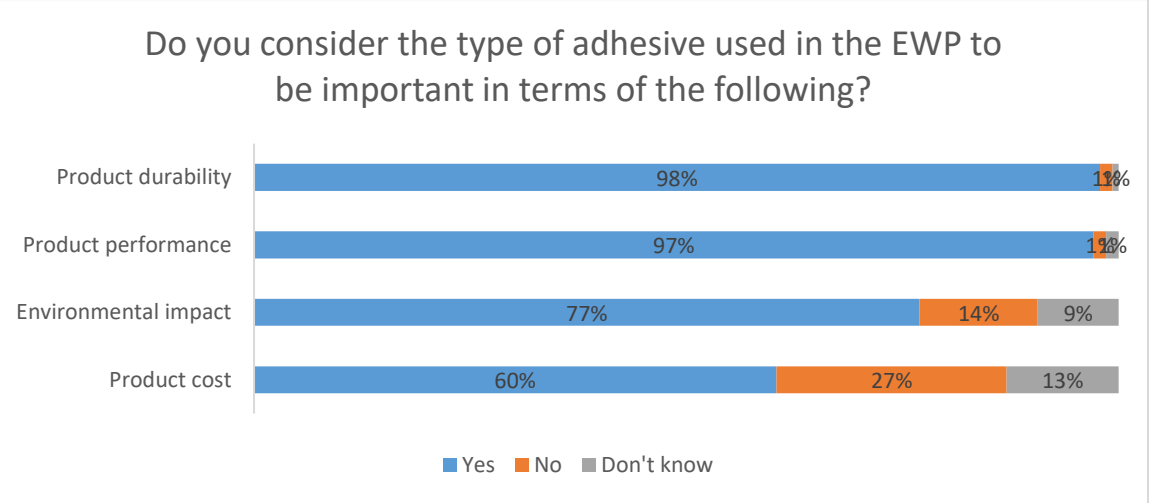

Figure 6. Perceptions of the importance of different features of EWP adhesives.

Almost all respondents considered the adhesive's durability (98%, 136) and product performance (97%, 135) to be important.

More than three-quarters (77%, 107) considered environmental impact to be important, but 14% (19) did not think environmental impact was important.

Cost was considered important by 60% (84) and not important by 27% (37).

Some respondents provided additional comments about their perceptions and expectations of EWP adhesives:

- "The products need to be as **cost effective** and **environmentally friendly** as possible to be used more readily."
- "[The adhesive] has to be **compliant**."
- "Glues should be **specified** in consent documents."
- "**Performance is critical** – if [the adhesive] fails, so does the EWP. Cost shouldn't really come into it."
- "We are mainly **directed by architects and engineers** of the product and type of glue to be used."
- "Unsure environmental impact can be considered when purchasing laminated timber. **Performance** is what we expect. If there were glues that gave good performance as well as **eco-friendly** then that would be my preference."

One respondent had been in the building trade for around 50 years. They said that they did not have a lot of experience with EWPs but thought they were a great innovation. They commented that the glue was often the weak point in glued wood products and gave examples of failures in finger joints in trims and weatherboards. The respondent asked what guarantees there were for glues and said there was a lack of information in general about their performance. They said that, if information was not available and people used the product and it failed, they would shy away from using it again. They also commented that LVL framing was a brilliant innovation as long as glue joints do not fail in 20 years' time.

Another respondent had experienced delamination of LVL rafters on several occasions. They had been using LVL rafters on a concrete tilt-panel house with a pitched roof. The roof had 17 skylights in it, and they had all been installed when the delamination occurred. All the affected rafters had to be replaced, which cost around $10,000 overall. However, the respondent noted that the manufacturer was prompt in reaching agreement on replacement and cost. The same respondent also experienced delamination on the next job but was not prepared to replace the rafters so instead bolted them together to solve the issue. The respondent had also noticed some delamination on one rafter on their current project. They said they were happy to keep using the product as long as the manufacturer took responsibility if things went wrong. They said that, as builders, they were expected to use the products specified by engineers and designers but often took the blame themselves when there were faults with the product.

Another respondent expressed concerns with the structural adhesives used in EWPs and said they had experienced products delaminating. They were wary that, with EWPs, there was heavy reliance on the adhesive to perform, and that the products could only be as good as the adhesive was. They said that the impact on the adhesive when timber expanded and contracted with moisture absorption needed to be considered. Most of the laminated products the respondent used were internal and would stay dry, but they were concerned about exposed EWPs such as laminated fence posts. They said that, even though there was a lack of information about how the adhesives performed, the industry would still use them and just wait to see what happens. The respondent had experienced delamination of dry beams before they were even installed, which made them wonder what quality control was done on EWPs during manufacturing. The respondent had read a bit about different types of adhesives, but not too much. Instead, they trusted that the experts who developed the product would ensure its quality.

The respondent also felt that the environmental concerns surrounding adhesives should be a major consideration for the industry. They said that formaldehyde had been given a bad name, rightly or wrongly, and that consumers were becoming increasingly environmentally conscious.

Phenol formaldehyde is the only adhesive used in structural LVL manufactured to AS/NZS 4357. Either phenol formaldehyde or polyurethane adhesives are used in glulam, depending on the particular product. Polyurethane adhesives are used exclusively in CLT. Structural adhesives are designed to produce bonds which are stronger than the timber itself. A failure in the adhesive indicates a manufacturing fault. In New Zealand, phenol formaldehyde has a very long history of use and proven durability.

The Engineered Wood Products Association of Australasia (EWPAA) has tested bond durability of more than 8,000 samples of LVL produced by New Zealand manufacturers over the past 8 years. 99.5% of these have met the long-term bond durability requirement of AS/NZS 4357. EWPAA reports that manufacturers' experience of customer complaints reinforces this, with negligible instances of delamination occurring in New Zealand-produced LVL for the New Zealand market. As with all products, occasional delamination does occur. The experiences of delamination detailed by survey respondents should not be taken as indicative that this is a widespread issue with the product. (EWP industry feedback)

5. Benefits and drawbacks of EWPs

Respondents were given a selection of nine features of EWPs and asked whether they felt they were a benefit or a drawback. Results are shown in Figure 7.

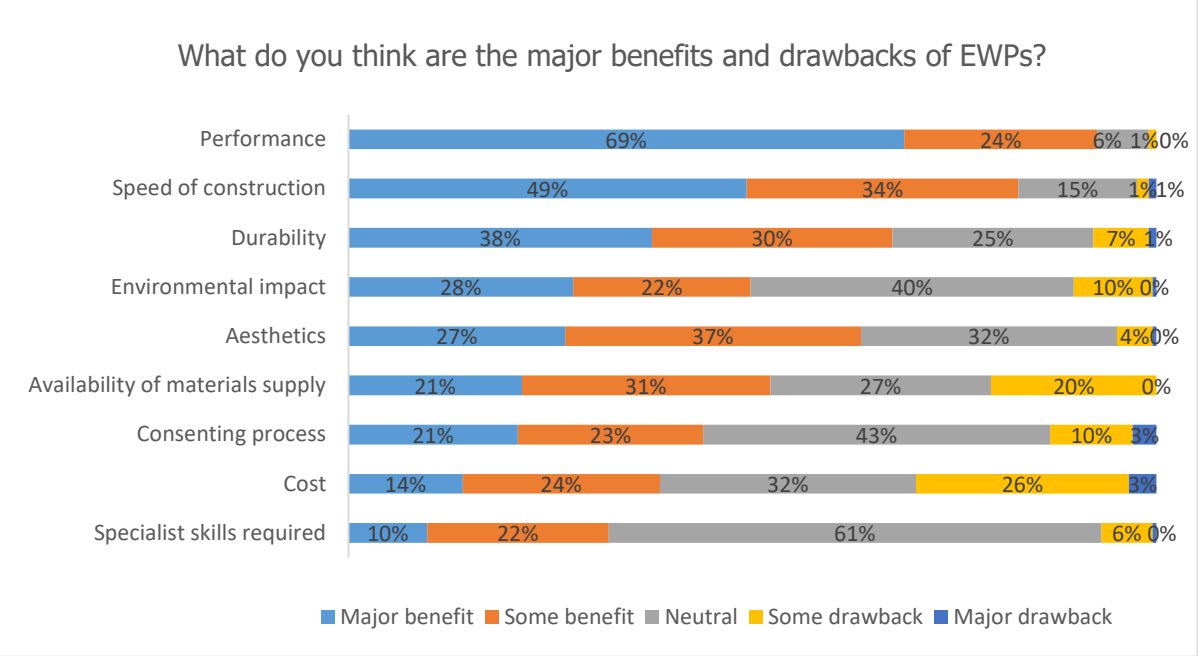

Figure 7. Perceived benefits and drawbacks of EWPs.

5.1 Benefits

Almost all respondents (93%, 190) thought the performance of EWPs was either a major benefit or offered some benefit.

83% (169) thought speed of construction was either of major or some benefit, and seven people commented that they found EWPs easy to work with.

Additional themes relating to perceived benefits of EWPs are listed below, with the number of comments received relating to that theme given in brackets:

- More strength and stability than solid timber (9).
- Sustainability (2).
- More flexibility to build with bigger spans (2).
- More lightweight than solid timber (1).
- EWPs have the potential to add more value to exported timber (1).

One respondent had owned a building company that made its own prefabricated building system almost entirely from EWPs. The system was designed to be transportable and to withstand earthquake and cyclone events. Many of the buildings were exported to the Pacific region where they had proven their durability by surviving several extreme weather events.

Another respondent said they had had a fair amount of experience with EWPs over the years. They liked EWPs because they were dimensionally accurate timber and had good spans. Using EWPs typically meant faster construction and fewer health and safety procedures because they didn't need to work at height to plane or adapt joists.

Overall, they found the build process with EWPs was faster and more efficient. Instead of using a red dot laser or straight edge, they could just put up the straight LVL and therefore save a lot of time. The respondent expressed concerns about New Zealand EWP manufacturing plants moving offshore. They thought that the use of EWP would continue to grow and that there should be investment to keep manufacturing in New Zealand.

The same respondent was asked whether they felt the need for specialist skills was a drawback with SIPs. They answered that it wasn't but that it depended on whether the practitioner was prepared to learn a new method or instead wanted to keep doing things the way they had always done. The respondent had a background in precast concrete and felt that SIPs were just a smaller version of that. They said there was a risk that builders who were inexperienced with SIPs would raise the cost of the job to account for the risk involved in using a new method. There was a need for proficient practitioners to make sure the cost of building with SIPs was reasonable.

Reduced construction waste was an additional advantage of EWPs mentioned by several respondents. Taking the example of LVL, one respondent said that, because LVL has no knots, the building could be designed to make use of the whole length of LVL. The respondent had recently built tiny houses and ended up with a small trailer load of waste material – much less than with standard designs that resulted in large amounts of waste. It was also an advantage that EWPs made use of lower-quality raw timber that would otherwise be wasted. Even though the upfront cost of EWPs could be more expensive, the savings from waste materials must be considered. The respondent said it was important that savings were considered at a project level.

5.2 Drawbacks

Few respondents viewed any of the nine options as major drawbacks. Cost was voted the biggest drawback, with almost a third of respondents (29%, 61) selecting that it was either a major or some drawback. Four respondents commented that EWPs were more expensive than traditional timber products.

43% (88) thought the consenting process is neither a benefit or a drawback, but 13% (27) saw it as a major or some drawback.

Over two-thirds (61%, 125) thought the need for specialist skills was neither a benefit or a drawback. Additional comments about the drawbacks of EWPs included the following themes:

- Concerns about swelling with moisture (1).
- Concerns about toxicity in a fire (1).

One respondent gave the example of people being less likely to use SIPs than conventional products because it was more expensive, even though SIPs may be better in some applications. They went on to compare buying a car to buying a house and said that consumers typically considered fuel economy before buying a car but did not necessarily consider the running costs of a building when choosing construction materials. The same respondent thought that the price of products had a big impact on the industry and that people in New Zealand paid more than they should for materials. Freight of materials around the country was a significant factor. They mentioned that people from overseas coming to build in New Zealand were amazed at how little their money would buy them because of high construction and materials costs.

The response to consenting was interesting. Anecdotally, EWPs and other less commonly used materials seem to cause more issues and delays with consenting compared to more traditional construction materials, but this wasn't strongly reflected in the views of these survey participants. One respondent said that NZS 3604:2011 *Timber-framed buildings* did not cover EWPs well, which meant that, when using EWPs, councils required additional evidence of the building's performance. They said that EWPs were being used so widely so there should be an urgent addition to NZS 3604:2011 that would speed up the consenting process.

Another respondent had worked mainly on high-end residential building projects and had used a lot of EWPs, mainly LVL rafters. They had used LVL more and more to achieve greater spans than they could with solid timber. Overall, they thought EWPs were good products because of their dimensional consistency and large spans. They said one drawback was that there was a lack of guidance from manufacturers about how to protect exposed LVL. They had received inconsistent advice about whether they needed to paint LVL and would like to see more information about the product's warranty.

6. Future use of EWPs

To conclude the survey, participants were asked whether they thought EWPs would become more commonly used building products in New Zealand in the near future (Figure 8).

Almost all respondents (93%, 190) thought that they would be used more often. Nobody thought they would not be more commonly used, but 7% (15) said they didn't know either way.

Nine respondents commented that they hoped EWPs would be used more, and four respondents said they were already seeing that that was the case.

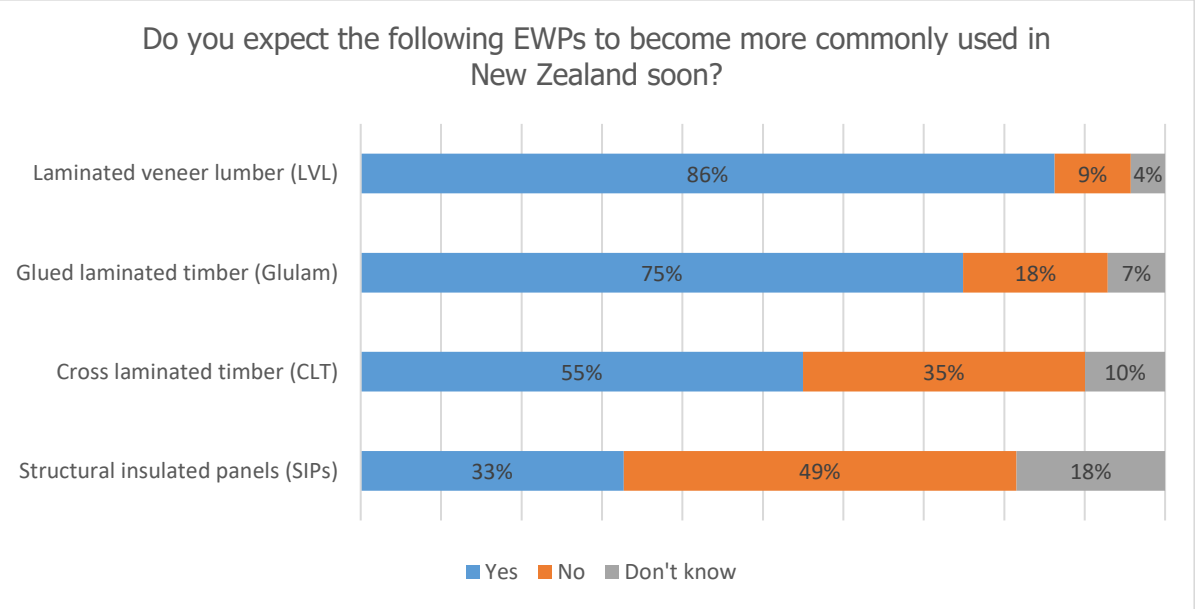

Figure 8. Expected future use by EWP type.

Other comments related to the future use of EWPs included the following:

- Will be used more if costs are reduced (2).
- Concerns about using EWPs for 'quick housing wins' when durability is not proven (1).
- Will be used only if architects specify and engineers support their use (1).
- Will be used more, especially in residential and low-rise buildings (1).
- EWPs will become more commonplace if Building Code requirements increase (1).
- Will continue to specify and work with EWPs (1).

To supplement the survey results, statistical databases were searched to determine whether any emerging trends in the use of EWPs and structural adhesives in New Zealand could be identified across residential, alterations and non-residential consented building work. The only EWP with sufficient data was LVL.

Figure 9 shows estimated market growth for LVL, with data provided by EWPAA.

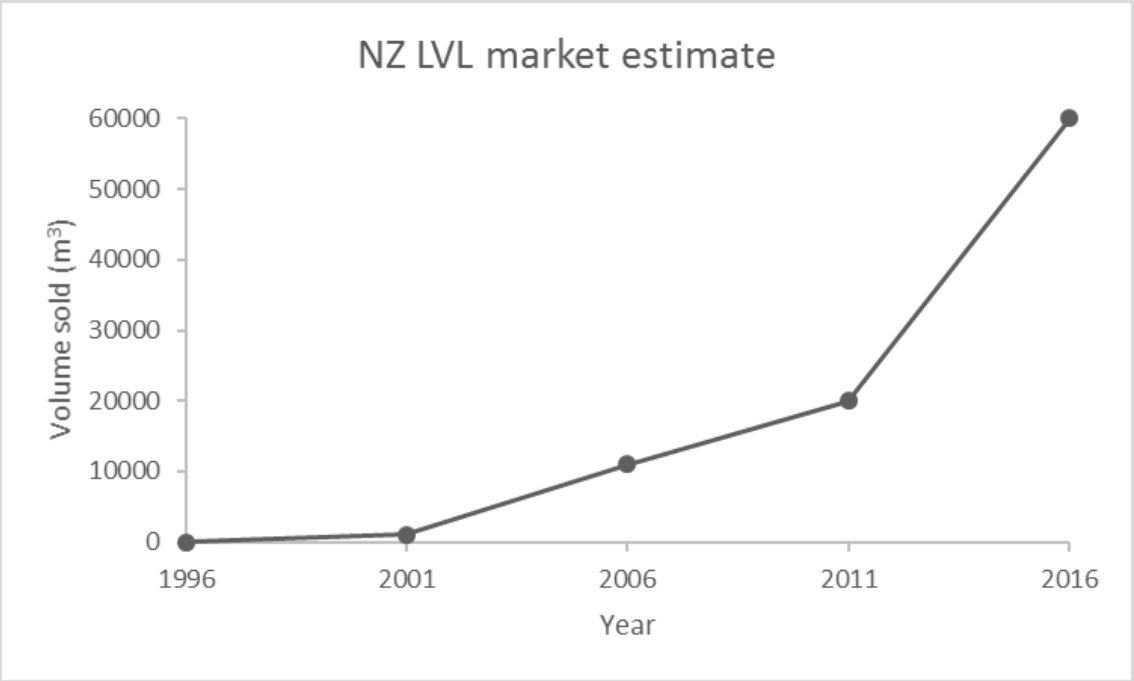

Figure 9. Estimated annual LVL sales data for New Zealand provided by EWPAA. The data includes framing products.

7. Conclusions

While recognising that this survey was limited in terms of respondent numbers, the following key points can be made:

- 85% of survey participants had been involved in construction projects using EWPs, reflecting the increased EWP usage in New Zealand in recent years. This trend is anticipated to continue.
- In cases where individual practitioners had not used EWPs before, there was an overwhelmingly strong interest in being able to use them in the future.
- There was a generally positive reaction to EWPs by those people who worked with them.
- The perceived major benefits of EWPs are performance, speed of construction and durability.
- There were few perceived major drawbacks of EWPs identified in this survey. However, cost and availability of materials were the two factors most often cited as having some drawbacks.
- More technical information from manufacturers around the long-term performance of EWPs and adhesives would assist with increasing confidence in these products.
- Instances of product failures, while representing a small percentage of product, present an opportunity for manufacturers to collect data in order to better understand why failure may occur. This data would also assist in ensuring that products are used within the stated scope and that they are fit for their intended purpose.
- There is currently insufficient data to track usage and trends of EWPs other than LVL. Given the increasing importance of EWPs as construction materials, this is an area that would benefit from improved data collection.

Appendix A: Survey questions

* 1. Have you been involved in any construction project(s) using EWPs?

- ◯ Yes
- ◯ No

Comments

* 2. If you have not used EWPs, why not?

- ☐ Don't know about them
- ☐ Not interested
- ☐ Haven't had an opportunity to use them
- ☐ Don't have the necessary knowledge/skills
- ☐ Other (please specify)

* 3. Do you plan to use EWPs in the future?

- ◯ Yes
- ◯ No

Comments

* 4. What type of work (including alterations) have you undertaken using EWPs?

- ☐ Residential: standalone
- ☐ Residential: multi-unit
- ☐ Commercial
- ☐ Other (please specify)

* 5. How often have you used the following products in construction projects?

	Frequently	Sometimes	Rarely	Never
Cross-laminated timber (CLT)	○	○	○	○
Laminated veneer lumber (LVL)	○	○	○	○
Glued laminated timber (Glulam)	○	○	○	○
Structural insulated panels (SIPs)	○	○	○	○

Comments

* 6. Do you expect to be involved in future construction projects which will use any of the following?

	Yes	No	Don't know
Cross-laminated timber (CLT)	○	○	○
Laminated veneer lumber (LVL)	○	○	○
Glued laminated timber (Glulam)	○	○	○
Structural insulated panels (SIPs)	○	○	○

Comments

* 7. Are you aware that there are different types of adhesives used in EWPs?

○ Yes

○ No

Comments

* 8. Do you consider the type of adhesive used in the EWP to be important in terms of the following?

	Yes	No	Don't know
Product performance	◯	◯	◯
Product durability	◯	◯	◯
Product cost	◯	◯	◯
Environmental impact	◯	◯	◯

Comments

* 9. What do you think are the major benefits and drawbacks of EWPs?

	Major benefit	Some benefit	Neutral	Some drawback	Major drawback
Performance	◯	◯	◯	◯	◯
Durability	◯	◯	◯	◯	◯
Cost	◯	◯	◯	◯	◯
Speed of construction	◯	◯	◯	◯	◯
Availability of materials supply	◯	◯	◯	◯	◯
Specialist skills required	◯	◯	◯	◯	◯
Aesthetics	◯	◯	◯	◯	◯
Environmental impact	◯	◯	◯	◯	◯
Consenting process	◯	◯	◯	◯	◯

Comments

* 10. Do you think EWPs will become more commonly used building materials in NZ in the near future?

◯ Yes

◯ No

◯ Don't know

Comments

11. Do you have any further comments you would like to add about your experience with EWPs?

* 12. Would you be happy to be contacted directly to follow up on any of your responses?

- ◯ No
- ◯ Yes

Please provide your preferred contact details

* 13. Would you like to enter the draw to win one of five $100 Prezzy cards?

- ◯ No
- ◯ Yes

Please provide your preferred contact details

End of survey