WORLD CONFERENCE ON TIMBER ENGINEERING 2025
BRISBANE, AUSTRALIA
Advancing Timber for the Future Built Environment

SURVEY RESULTS OF POTENTIAL USERS' PREFERENCES AND PERCEPTIONS ON THE RECONSTRUCTION OF COLONEL BY HALL (CBY) USING MASS TIMBER ELEMENTS

Fernanda Scussiato Lago[1], Ghasan Doudak[2], Mohammad Mohammad[3].

ABSTRACT: This study is a component of a larger investigation into the potential reconstruction of the Colonel By Hall (CBY) building, the home of the Faculty of Engineering at the University of Ottawa. The primary aim was to assess various structural archetypes (including concrete, steel, timber as well as timber-hybrid structures) that could potentially replace the current building. In order to evaluate the feasibility of integrating Mass Timber Products (MTP) into educational facilities and engage potential users in the decision-making process, a survey was conducted among 332 participants to gauge their awareness and perceptions of the surrounding built environment. The survey results revealed that there is a significant aesthetic preference for buildings with exposed elements or finishes using wood. Respondents tended to choose such environment to help reduce stress, and they reported that it made them feel relaxed, energetic and calm. Most respondents indicated that environments featuring exposed timber offer a comfortable space for social interaction and help against mental exhaustion. However, numerous misconceptions about wood's performance capabilities were also identified.

KEYWORDS: built environment, wood applications, user perception.

1 – INTRODUCTION

People spend the majority of their lives indoor, and the built environment plays a crucial role in shaping their health and well-being. Recent studies suggested that social sustainability should be considered in construction projects from the early stages, and the social impacts should be taken into account [1, 2]. In educational spaces, studies have highlighted the positive impact of wood interiors on students' mental states. Reported benefits include both physical well-being and psychological welfare, which was mainly attributed to the biophilic benefits of using wood [3]. As such, there is a growing interest in enhancing the quality of the connection between individuals and their built environments, particularly in educational institutions.

A feasibility study was conducted to explore the potential replacement of an existing building at the University of Ottawa – the CBY Engineering Building – with a new structure, that would contain laboratories, offices, lecture halls and study spaces for faculty, staff and students. The project primarily explored the option of using exposed timber elements and their impact on the students' comfort and ability to spend time in a safe and learning-conducive environment. Central to this investigation is an assessment of various construction materials – specifically concrete, timber, and steel – to determine their aesthetic and functional impacts. The study aimed to understand how these materials can enhance the building's design and functionality, while yet promoting student well-being and engagement. To gather valuable insights, a survey was developed and distributed to potential users of the proposed space, capturing their feedback and preferences regarding the different construction options.

2 – GENERAL OVERVIEW OF PRESENT AND FUTURE DEMANDS FOR THE BUILDING

Today the Faculty of Engineering occupies four buildings (ARC, STE, STM and CBY). The CBY Hall was constructed in 1970 and is home to the faculty of engineering, on the main campus of Ottawa University. The entire facility contains eight storeys including a full basement level, with a total area of 24,386 m² (262,488 ft²). The facility provides laboratories, lecture halls, classrooms, and faculty offices. The building was constructed in five blocks as shown in Fig. 1.

2.1 USE AND SPACE REQUIREMENTS

The current space is already at over-capacity, and therefore a solution to accommodate the anticipated continued

[1] Fernanda Scussiato Lago, Dept. of Civil Engineering, University of Ottawa, Ottawa, Canada, fscus082@uottawa.ca.

[2] Ghasan Doudak, Dept. of Civil Engineering, University of Ottawa, Ottawa, Canada, gdoudak@uottawa.ca.

[3] Mohammad Mohammad, National Resources Canada, Ottawa, Canada, mohammad.mohammad@nrcan-rncan.gc.ca.

https://doi.org/10.52202/080513-0653

growth over the next decade would be necessary. The current use of the building is:

- 9 Seminar & Classrooms.
- 150 labs including 44 wet, 48 dry, 5 computer, and 53 specialty labs spaces.
- 184 Offices.

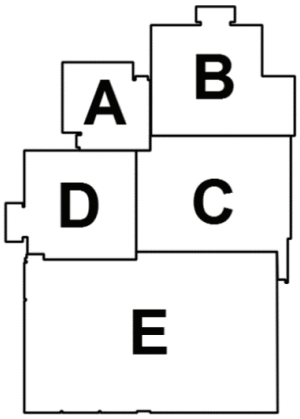

Figure 1. Current block divisions of Colonel By Hall.

Today around 75% of the gross floor area is assigned to offices, classrooms, public spaces, and dry labs, and 25% to wet labs. Besides that, there are urgent space requirements that need to be fulfilled as presented in Table 1.

Table 1: Immediate space required in the faculty of engineering [4].

Type of Space	Requirements
Teaching & Research Lab	Movement within Engineering buildings – 1,230 m^2
	New space required – 615 m^2
Academic Office	Movement within Engineering buildings – 75 m^2
	New space required – 40 m^2
Various	Meet increase in the number of students in various sections including computer science – total estimated area to be confirmed

2.2 PROJECTIONS

In 2019, student enrollment in the faculty of engineering was 4,429 undergraduate and 1,572 graduate positions, 139 full-time professors, and around 70 administrative staff. The projections for 2040 are that there will be a significant increase in the numbers of students, faculty members and staff based on a growth rate of about 5%.

Today, there is a current shortage of space to meet minimum teaching and research lab space requirements and there is no designated future development space to accommodate anticipated growth. The Building is expected to lack the necessary adaptability, accessibility, safety, well-being and security for modern engineering education.

Contemporary engineering schools across Canada boast innovation spaces where individuals with similar interests, particularly in computing or technology, can collaborate on projects while exchanging ideas, tools, and knowledge. Engineering education demands an environment that fosters project-based, interdisciplinary learning, allowing for flexibility in layout and technological integration.

Modernizing classrooms to offer layout versatility and advanced technology is crucial for effective group work and contemporary engineering pedagogies. Faculty and students alike would benefit from these enhancements, creating a more dynamic and engaging learning environment. A state-of-the-art engineering building is vital for the academic success and it serves as a valuable instrument for establishing strong ties with the community, enhancing the university's reputation and fostering collaboration with industry partners.

A cutting-edge facility goes beyond just being a building; it becomes a hub of innovation and a beacon of excellence, showcasing the university's commitment to providing the best educational experience. Investing in such infrastructure signifies a forward-thinking approach, ensuring that the institution remains competitive and relevant in an ever-evolving educational landscape. It's about creating a space where future engineers can thrive, innovate, and lead in their respective fields, ultimately contributing to the advancement of technology and society as a whole.

3 – SURVEY OF POTENTIAL USERS ON THE PERCEPTION OF THE BUILT ENVIRONMENT

A survey to gather information on how building's potential users perceive wood and wood applications in a learning-oriented environment was conducted. In the questionnaire, a variety of photos were provided for assessing personal preferences, satisfaction, perceived performance, and perceptions of various archetype buildings. Integrating the occupants' perceptions aids in developing some knowledge on the rates of satisfaction with space and conditions of built environments, revealing the connections between interior environmental attributes, user satisfaction and productivity. The data collected also serve to demonstrate the visual and sensorial user preferences and elucidate assumptions made by individuals with or without technical knowledge in the field of structural engineering.

The survey was conducted on the principles of voluntary participation, confidential personal information and anonymous data. Quantitative data was collected in the form of a questionnaire, titled 'Future Cities', containing 23 questions. The survey contains multiple choice questions (1-4), Likert scale questions (6, 16-21), picture choice questions (7-10 and 12), checkbox questions (5, 11, 13-15) and an open-ended question (23). The scales of judgements for Likert scale questions are presented in Table 2.

https://doi.org/10.52202/080513-0653

Table 2: Scales of judgement for Likert scale questions.

Indexes	Scores
To what extent do you think the buildings and facilities at your school or university have an impact on the following leaning outcomes: • Inclination to stay at university • Facilitating to entice new students to join • Spend time in university • Organize group discussions	Not at all ▿ Very little ▿ Some ▿ A lot ▿ N/A
In terms of the following emotions, this space makes you feel: • Anxious • Fatigued • Depressed • Stressed • Relaxed • Energetic • Cheerful • Calm.	Strongly Disagree ▿ Disagree ▿ Neutral ▿ Agree ▿ Strongly Agree
Aesthetically pleasing for applications • Floors • Walls • Ceilings • Furniture • Countertops	
This environment inspires me to work or study.	
Spending time in this environment would help me to recover from mental exhaustion.	
Spending time in this area would provide a welcome break from my daily routine.	
In this space, I would feel comfortable interacting socially with other students.	
Preferences for material combinations in interior applications • Concrete and wood • Steel and wood • Concrete and steel • Ceramic and wood • Glass and wood • Stone and wood • Marble and wood	Strongly Dislike ▿ Dislike ▿ Neutral ▿ Like ▿ Strongly Like

4 – RESULTS

The survey was taken by 332 potential users including students, full-time and part-time professors, and staff. Males accounted for 61% of respondents, females 37%, and the remaining 2% are gender variant/non-conforming or preferred not to answer. Regarding age, 65% of respondents were between 18 and 24 years old, 18% were between 25 and 34 years old and 9% were between 35 and 44 years old. The majority (87%) of respondents were students followed by professors (6%).

When asked about the time they spend at the university, nearly 47% of respondents declared that they spent more than 20 hours a week in those spaces, while 17% spent 16 to 20 hours, 16% spent 11 to 15 hours and others 16% spent 1 to 10 at the university. These indices show that the study was successfully assessing respondents that will be affected by the new built environment.

Regarding the methods of learning/receiving information, individuals could choose one or more preferred methods between the ones shown in Fig. 2. Results show that 74% of the respondents preferred visual method of learning, while 71% preferred logical methods to receive information. Visual learners prefer to receive information through images, graphs, reading and colours to communicate ideas and thoughts. Logical learners seek order, steps, and logic. They can easily create connections and identify patterns, and they perform well with numbers. They study in a highly methodical manner and are quite organized. These choices are not surprising since the majority of respondents are engineering students.

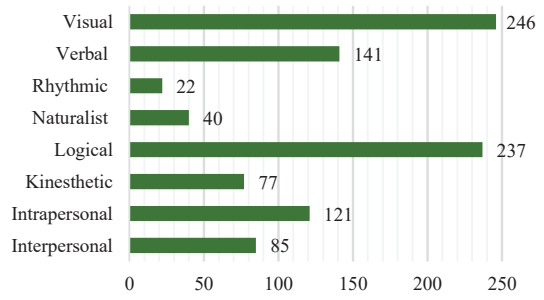

Figure 2. Methods of learning/receiving information.

The survey sought to understand, according to the users' opinions, the influence of buildings and facilities on the aspects presented in Fig. 3. It is worth noting that around 84% of respondents felt that the built environment influences their learning outcomes to a certain extent and, among them, 52% reported that the impact can be very significant. About 66% of respondents believed that buildings and facilities contribute a lot to making them more inclined to spend more time studying at the university than at home. Also, 80% believed that, to some extent, the conditions of the built environment may attract new students to join and 82% that it makes them more inclined to organize face-to-face group discussions.

In the subsequent section, participants were invited to view images depicting spaces with similar layouts but different construction methods or material applications. The questions showed libraries, lounges, classrooms, and facades. No explanations or criteria were offered for the choice of spaces, as it was thought that the decision should be based on their visual preferences. Fig. 4 and Fig. 5 show a sample of photos presented in this section.

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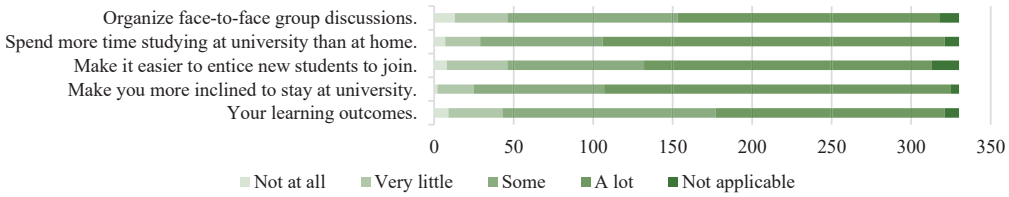


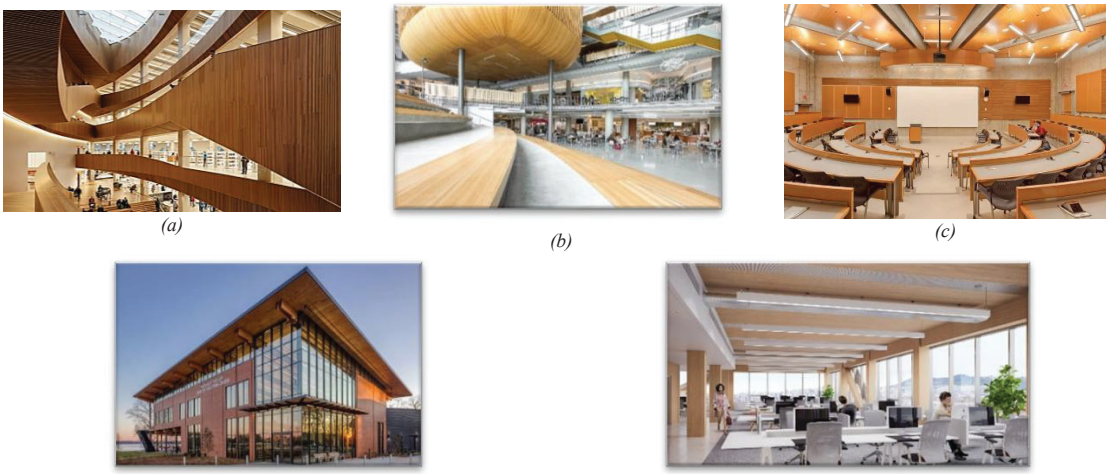
Figure 3. Influence of buildings and facilities on the routine of respondents.

(a) *(b)* *(c)*

Figure 4. Sample of photos used in the survey to represent lounges: (a) Alexandre Vachon Pavillon - Laval University [5]; (b) Alma Master Society Nest - University of British Columbia [6]; (c) Energy Environment Experiential Learning Building (EEEL) - University of Calgary [7].

(a) *(b)* *(c)*

Figure 5. Sample of photos used in the survey to represent facades: (a) FBO Jet Hangar [8]; (b) Andy Quattlebaum Outdoor Recreation Center - Clemson University [9]; (c) Quest University [10].



(a) *(b)* *(c)*

(d) *(e)*

Figure 6. Spaces chosen based on the result of the visual preferences: (a) Library: Calgary Central Library [11]; (b) Open lounge: Alma Master Society Nest - University of British Columbia [6]; (c) Classroom: Ed Lumley Centre for Engineering Innovation – University of Windsor [12]; (d) Facaade: Andy Quattlebaum Outdoor - Recreation Center - Clemson University [9]; (e) Study lounge: 2150 Keith Drive [13].

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As presented in Fig. 6, results show a preference for buildings with exposed elements, and external and internal applications with wood or wooden materials. The finding is substantiated by the fact that for libraries, 66% of participants preferred the 'Calgary Central Library'; for open lounges (Fig. 6.a), 78% preferred the 'University of British Columbia'(Fig. 6.b); for classrooms, 43% chose the 'University of Windsor'(Fig. 6.c); for facades, 86 % chose the 'Clemson University'(Fig. 6.d); and for study lounges: 42 % chose the '2150 Keith Drive'(Fig. 6.e).

When asked to point out factors related to the space design and layout that support their decision, lighting (85%), furniture and furniture arrangements (72%), the open-concept floor plan (59%) and the modern design layout (58%) were indicated as aspects that support their decision.

Wood as a building material for structure and surface finishes was appreciated by most of the potential users, frequently described as enjoyable and natural sense. Individuals were attracted by timber elements and associated them with high-quality design. A person explained the emotional impact of wooden materials:

> *"I love all the spaces of the pics provided. I think the most important thing is to have a beautiful but warm and inviting space. Wood does all of that".*

Respondents were then required to select elements that they believe helped to create a comfortable and stress-free environment for spending time studying. According to the results shown in Fig. 7, natural or artificial lighting is considered the most important element, selected by nearly 95% of people. It was followed by the use of natural materials such as living walls and exposed wood, which was selected by 67% of participants.

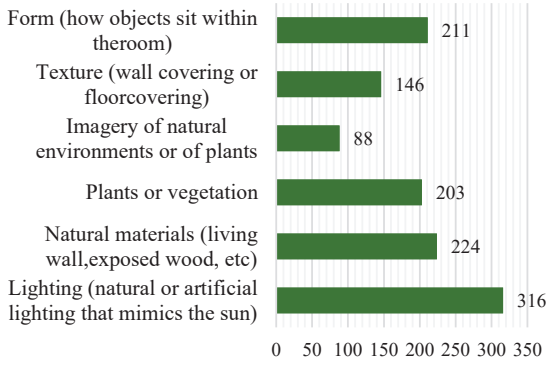

Figure 7. Elements that help to create a comfortable and stress-free environment for spending time studying.

Lighting is widely recognized as one of the most important aspects of architectural design. Natural or artificial sunlight-like lighting may create a warm and inviting environment, establishing the character of a space and an individual's impression of it. Also, enhancing the amount of natural light allowed inside the building is one of the most successful strategies to minimize a building's energy use. Another key approach used in modern architecture is the use of natural materials provided with their physical, environmental, and aesthetic features. As people become increasingly aware of the harm caused by many synthetic materials, there is a growing desire to choose materials that are easier to replace, recycle, and reuse. They also have the benefit of requiring less energy to manufacture and transport (i.e., less GHG emissions). From an emotional standpoint, they may provide a connection between nature and the work inside closed spaces, assisting people in creating a relaxing atmosphere, which aids in the improvement of their well-being. One of the participants mentioned:

> *"The use of natural materials and plants I find, in addition to large windows that do not make the room too bright (coatings, placement) make the most comfortable environments."*

To access the understanding and perception of potential users on the performance of different construction methods, individuals were asked to choose one or more options of materials, between concrete, wood, and steel, that they would consider suitable for the construction of a building considering the following criteria separately: aesthetics, ability to carry heavy loads, fire hazard, vibration, durability, insulation against cold and heat, environmentally friendly. The results are presented in Fig. 8.

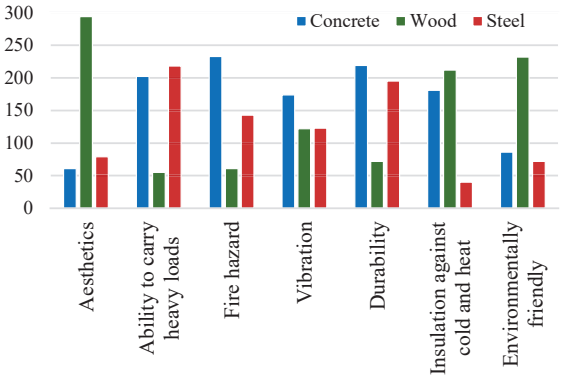

Figure 8. Perception of users on the performance of different construction methods.

The results clearly show that wood's aesthetic, ability to insulate and environmental attributes are strongly preferred over other materials. On the other hand, wood's perceived ability to carry heavy loads, perform in the case of fire or ability to last was questioned. This result is expected since it is well-known that there are a lot of misconceptions about wood's structural, durability and fire performance. This also provides the opportunity for more education of the public in those areas.

The survey also intended to access how potential users feel in spaces where wood elements are prominently present in the architecture and design. For that, participants were

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invited to imagine themselves in the space depicted in Fig. 9 and identify how they feel about it.

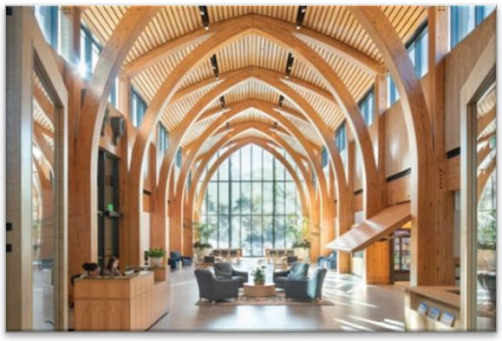

Figure 9. Reference image to answer questions 16-20: Karsh Alumni and Visitors Center - Duke University: [14].

The results revealed that 73% felt relaxed being in this space, 72% felt calm and 56% felt cheerful. In terms of negative emotions, participants did not report feeling depressed (82%), stressed (80%), anxious (77%) or fatigued (69%) about this space (i.e., respondents checked 'disagree' or 'strongly disagree').

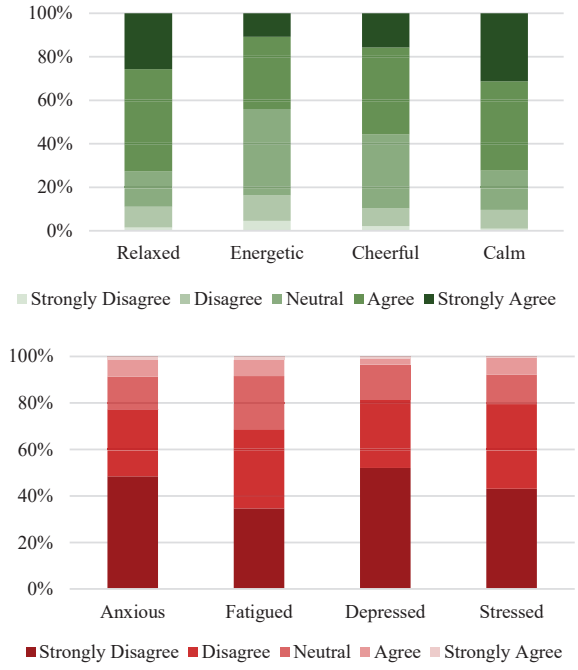

Figure 10. Effects of the space on the emotions.

This result emphasizes previous findings on the psychological reaction to wood in interior applications and its benefits for human health and well-being. In a tactile study, wood materials were described as pleasurable, calming, relaxing and desirable and perceived more positively in emotional touch than coated surfaces, especially in surfaces where the wooden texture was left natural [5]. The degree of wooden elements in the interior application was also associated with increased individuals' evaluation of the room as 'natural' and 'warm' [6]. Some studies have also shown how wood promotes positive feelings and reduces anxiety and anger [7, 8]. Participants were then invited to rate the effect of working in the building shown in Fig. 9 on their activities. As presented in Fig. 11, participants believed that this environment could provide a welcoming space to interact with other people (72%), which would provide a welcome break from daily routine (75%), that would help to recover from mental exhaustion (67%) and that it inspires to work (58%).

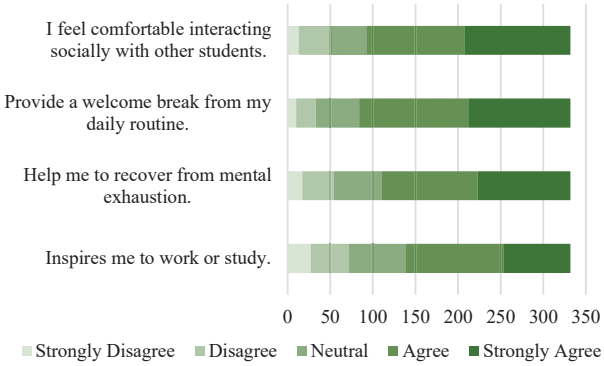

Figure 11. Effect of the space on activities.

Participants were also asked about their preferences for using wood for different internal applications. According to Fig. 12, the majority of participants embraced the concept of using wood or wooden finishes in the suggested applications (floors, walls, ceilings, furniture and countertops), especially for floors (76%), and furniture (75%).

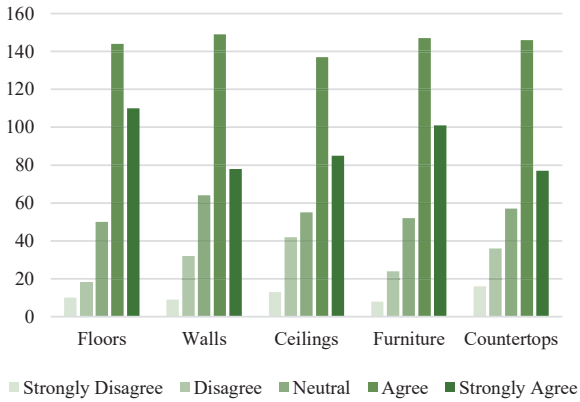

Figure 11. Application of wood in different elements

Finally, participants were asked about their visual preferences for combining materials in interior applications. Fig. 13 shows that wood in combination with other materials is highly received by the respondents. The research also showed that the 'glass & wood' and 'stone &

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wood' combinations are the most popular among the listed options.

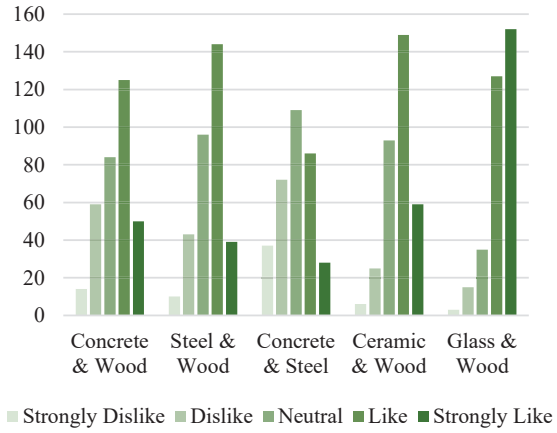

Figure 13. Visual preferences for different combinations of materials in interior applications.

4 – CONCLUSIONS

The survey reveals significant insights into the preferences and perceptions of potential users regarding the built environment in educational settings. The impact of the built environment on learning outcomes is notably highlighted, with 84% of participants acknowledging its significance.

The survey also highlights the crucial role of wood in the design of educational environments, revealing its strong preference among potential users. This finding aligns with the principles of biophilic design, which emphasizes the connection between natural elements and human well-being. Respondents associate wood with warmth, comfort, and tranquility, reporting relaxation and calmness in wood-rich environments. This suggests that natural materials like wood can enhance mental health, reduce stress, and foster a supportive atmosphere for learning, reinforcing the benefits of biophilic design.

In addition to its aesthetic appeal, wood contributes to the overall functionality of educational spaces. The survey indicated that effective lighting and thoughtful furniture arrangements are essential for creating productive environments. When combined with the natural qualities of wood, these design elements can enhance the overall experience for users, promoting focus and engagement. Furthermore, the preference for natural materials reflects a broader trend towards sustainability in architectural design.

Alongside these positive attributes, the survey also highlighted misconceptions regarding the safety and performance of wood in construction. Many participants expressed concerns about wood's ability to carry heavy loads, its fire resistance, and its durability. These apprehensions reflect a common misunderstanding about the structural capabilities of wood, which is often perceived as less safe than materials like steel or concrete. In reality, modern engineered wood products can meet or even exceed rigorous safety standards and perform exceptionally well in various structural applications. Education on these advancements is essential to dispel fears and promote a more nuanced understanding of wood as a viable, durable and safe building material.

This finding suggests that educational institutions can enhance their environments by integrating natural elements into their designs. Emotional well-being is another critical factor highlighted by the survey. Participants reported feeling relaxed and calm in spaces that feature wood and natural materials, reinforcing the idea that such elements can enhance mental health and reduce stress.

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