Transport Canada & FLEX Structure Project 2024

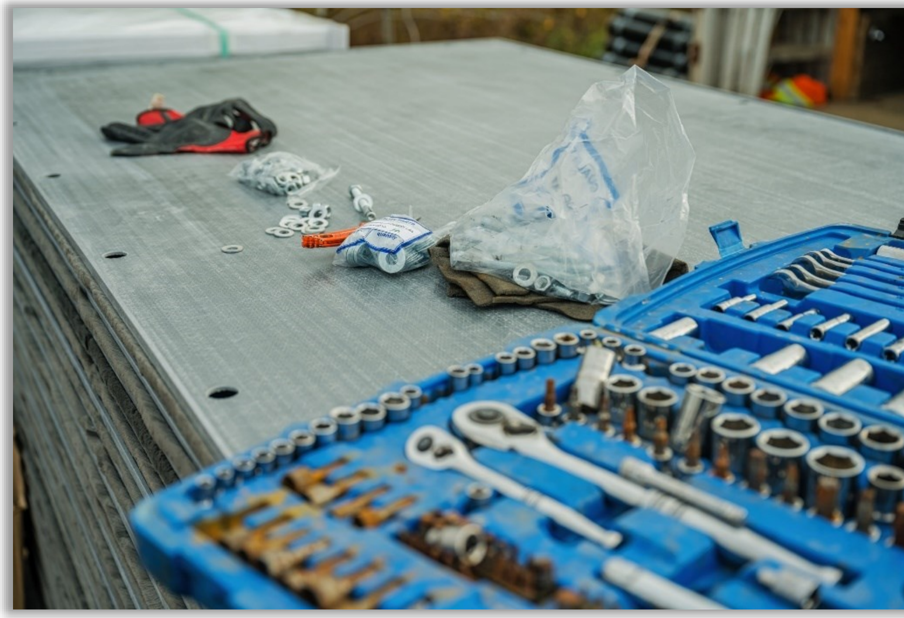
Introduction

Canada's remote regions face considerable challenges in constructing durable, cost-effective, and sustainable infrastructure. Traditional building methods are slow, requiring weeks or even months to complete, leading to high labor costs, logistical difficulties, and environmental concerns. The Flex Structure system, a prefabricated modular building technology, offers an innovative solution by enabling rapid, efficient, and sustainable construction in these areas.

This case study examines the impact of Flex Structure's approach, integrating insights from rural construction challenges, logistical hurdles, and the advantages of fiberglass as a novel building material. The study emphasizes the system's ability to enhance construction efficiency in remote regions across Canada.

A significant application of this technology was the 100 sq. ft. building delivered to the University College of the North (UCN) in Manitoba for thermal efficiency testing.

Additionally, a larger project at Killaloe, Ontario, where a prefabricated Flex Structure unit was deployed to demonstrate its feasibility in real-world conditions. The structure was tested for rapid assembly, material durability, and energy performance, proving its viability for remote operational facilities. These initiatives mark a crucial step in redefining construction in Canada's remote regions.



Problem Statement

Challenges in Remote Construction

1. High Transportation Costs

One of the biggest challenges of remote construction is the cost of transporting materials. Inaccessible locations require the use of helicopters, barges, or extended road networks to deliver essential building supplies. This significantly increases project expenses, making conventional construction economically unfeasible in many remote areas.

2. Labor Shortages

The availability of skilled labor is a persistent issue in rural Canada. Most construction workers are based in urban centers, and relocating them to remote sites is costly and often temporary. The lack of local expertise means that companies must offer higher wages, accommodations, and incentives to attract workers, further driving up costs.

3. Extreme Weather Conditions

Many remote regions in Canada, especially in the north, experience harsh weather conditions such as heavy snowfall, freezing temperatures, and strong winds. These factors can delay construction, damage materials, and make it difficult for workers to operate efficiently. Moreover, building materials must be specially designed to withstand these extreme climates, adding another layer of complexity.

4. Sustainability Concerns

Traditional building materials, such as concrete and steel, have high carbon footprints due to their energy-intensive production processes. In remote areas, these materials often have to be transported over long distances, further increasing their environmental impact. Additionally, conventional construction methods generate significant waste, which can be challenging to manage in locations with limited disposal infrastructure.

5. Infrastructure Limitations

Remote locations often lack essential infrastructure such as roads, energy sources, and supply chains, making construction even more difficult. The absence of well-developed logistics networks can cause delays and increased costs. Furthermore, many rural communities depend on outdated diesel generators for electricity, which is both expensive and environmentally unsustainable.

These challenges significantly impact Indigenous communities, mining operations, and government-funded infrastructure projects, necessitating innovative solutions that address these specific concerns.

Current Solutions & Limitations

Traditional Construction Methods

While conventional building techniques offer stability and longevity, they often fail to meet the demands of rapid deployment, affordability, and adaptability in remote locations. These methods require:

- **Extended timelines**: Construction projects in rural areas can take months due to weather disruptions and labor constraints.
- **Expensive logistics**: Transporting construction materials and labor adds substantial costs.
- **Environmental concerns**: High emissions and waste generation contribute to sustainability issues.

Fiberglass as an Alternative Material

Recent studies on fiberglass as a novel building material show its potential for:

- **Lightweight and durable construction**: Fiberglass structures are easier to transport and assemble compared to conventional materials.
- **Thermal efficiency and insulation properties**: Fiberglass panels provide superior insulation, reducing heating costs in extreme climates.
- **Reduced environmental impact**: Fiberglass requires less energy-intensive production than steel and concrete, leading to a smaller carbon footprint.

However, concerns about **embodied emissions and recyclability** have limited widespread adoption. Some fiberglass materials have challenges related to their end-of-life disposal, as recycling methods for these materials are still developing.

The Flex Structure Solution

Flex Structure introduces a prefabricated modular system designed for quick assembly and efficient transportation. Key features include:

- **Pre-engineered SIP (Structural Insulated Panels)**: Enhancing thermal performance and reducing energy costs.
- **Flat-pack shipping design**: Reducing transportation costs and enabling easy deployment.
- **Minimal on-site labor requirements**: Significantly decreasing construction time.
- **Sustainable materials**: Utilizing fiberglass and Armacell PET form components to recycles **1,460 bottles** by panel.

Key Benefits in Remote Areas

1. Cost Efficiency

- **Lower labor costs**: Prefabricated components minimize the need for specialized labor on-site.
- **Reduced material transportation costs**: Flat-pack designs make it more affordable to deliver components to remote locations.

2. Durability & Energy Efficiency

- **Superior insulation** minimizes heating and cooling costs, which is crucial for extreme climates.
- **Weather-resistant materials** ensure that buildings remain structurally sound for decades.

3. Versatility

- **Ideal for various applications**, including utility buildings, emergency shelters, operational centers, and storage facilities.
- **Modular design** allows for easy modifications and expansions to suit different needs.

4. Scalability

- **Flexible design** enables mass production for widespread implementation.

Killaloe Ontario Case Study

Project Overview Background and Context

Ontario's northern and rural communities have long faced severe commercial space shortages, infrastructure deficits, and economic challenges. Many Indigenous communities and remote townships rely on outdated construction methods that struggle to cope with extreme weather conditions and limited access to materials.

Flex Structure presents an innovative modular building system designed for rapid deployment in remote Canadian regions. Traditional construction methods face significant hurdles, including high transportation costs, labor shortages, extreme weather conditions, sustainability concerns, and infrastructure limitations. These challenges severely impact Indigenous communities, mining operations, and government-funded projects.

Transport Canada, in partnership with Flex Structure and ISEDC, initiated a pilot project to introduce prefabricated modular buildings to address these issues. The 380 sq. ft. Flex Structure unit can be assembled in just eight days, compared to traditional construction timelines of several weeks or months. This is particularly beneficial in areas where weather conditions impose short construction windows. The goal was to deploy cost-effective, energy-efficient structures that could be quickly assembled while reducing the overall environmental impact.

To further test the system's thermal efficiency, a 100 sq. ft. building was delivered to the University College of the North (UCN), Thompson, Manitoba. The structure, built using Flex Structure's Structural Insulated Panels (SIPs), was tested under extreme environmental conditions to assess its insulation properties and energy efficiency. This study provided valuable data on the thermal performance, air leakage, and overall energy conservation of the system.

Project Information

Location 1: Thompson, Manitoba
Footprint: 100 sq. ft.
Completion: July, 2024

Location 2: Killaloe, Ontario
Footprint: 380 sq. ft.
Completion: October, 2024

Project Participants:
Client/Developer: Innovation, Science and Economics Development
Partners: Transport Canada and Invest Ottawa
Testing Partner: Intertek Testing Solutions, Coquitlam
University Partner: University College of the North, Manitoba
Building Envelope: FLEX Structure / Livingstone MCS Ltd.
Contractor: Ken Sernoski's Contracting Ltd.
Modular Manufacturer: Composite Panel Technology
Cost: $ 730K

Press Release: https://www.canada.ca/en/transport-canada/news/20
constructed-in-eight-days.html

Time-lapse Video: https://www.youtube.com/watch?v=It9I1WxqniU

Proud Partners

*Inclusion of project partners in this project does not imply endorsement; rather, it reflects their participation in the project collaboration and evaluation process.

Project Implementation

This project began in July 2023. The nature of the project and the collaboration between partners allowed for this project's work plan to be followed by result oriented milestones for every month. Timelines required by ISED Canada and Transport Canada were needed for administrative funding purposes and success of the project in a larger, more sustainable and organic scheme. The work plan helped FLEX Structure, contracting partner i.e. Ken Sernoski and University partner Tim Gibsons at UCN to accomplish milestones, while recognizing the need for fluidity and flexibility. The contract was focused on realistic and attainable objectives and accommodate any additional unforeseen expenses. In the town of Killaloe, a prototype Flex Structure unit was assembled to test the system's feasibility. The process involved:

- **Site Preparation**: Minimal groundwork was required due to the lightweight nature of the materials.
- **Material Transportation**: Prefabricated panels were shipped flat-packed, **reducing shipping costs by 40%.**
- **Assembly Process**: A team of five workers assembled the unit in **eight days**, compared to **3-4 weeks** needed for traditional construction.
- **Energy Efficiency Testing**: The unit was evaluated for thermal insulation, air leakage, and overall heating costs, demonstrating a **30% reduction in energy use*** compared to conventional structures.

Project Objectives

Comparison of Shipping a Pre-Assembled 100 sq. ft. Building vs. a Flat-Packed 380 sq. ft. Building

This objective compares the shipping feasibility of two different building models:

- **Pre-Assembled 100 sq. ft. Building** from Kelowna to Thompson, Manitoba, with a shipping cost of **$14,343.00**.
- **Flat-Packed 380 sq. ft. Building** from Kelowna to Killaloe, Ontario, with a shipping cost of **$6,491.85**.

The comparison covers shipping costs, permit requirements, and logistical challenges, concluding with a quantifiable cost analysis to determine the most economical shipping option.

Shipping Cost Analysis

A. Pre-Assembled 100 sq. ft. Building (Kelowna to Thompson, MB)	B. Flat-Packed 380 sq. ft. Building (Kelowna to Killaloe, ON)

• **Size & Weight Considerations**: Fully assembled, requires special handling.
• **Transportation Mode**: Large flatbed truck or trailer required.
• **Permits Required**:
  ○ Over-dimensional load permit.
  ○ Road transport restrictions depending on weight and height.
  ○ Escort vehicle may be required in certain provinces.
• **Total Shipping Cost**: **$14,343.00**
	• **Size & Weight Considerations**: Can be stacked on standard pallets, allowing efficient shipping.
	• **Transportation Mode**: Standard freight service using LTL shipping.
	• **Permits Required**:
	  ○ No special permits required.
	  ○ Can be transported as standard cargo.
	• **Total Shipping Cost**: **$6,491.85**

Cost Comparison

Factor	100 sq. ft. pre-assembled	380 sq. ft. Flat-Packed
Shipping Cost	**$14,343.00**	**$6,491.85**
Percentage Cost Difference	**Flat-Packed Shipping is 54.7% Cheaper**	
Permit Requirements	Yes (oversized load permits)	No
Handling & Installation	Delivered ready-to-use, but requires escort & crane for placement	Requires assembly, but lower transport costs

Key Advantages & Disadvantages

A. 100 sq. ft. Pre-Assembled Building

Advantages: No on-site assembly required.

Faster deployment; ready-to-use upon arrival.

Minimal risk of missing or damaged components.

Disadvantages: **Higher shipping costs** due to size and special transport needs.

Permit requirements increase logistical complexity.

Escort vehicle or crane may be required for offloading.

B. 380 sq. ft. Flat-Packed Building

Advantages: Lower shipping costs (flat-packed for easy transportation).

No special permits required.

Larger structure for lower cost per square foot.

Disadvantages: Requires on-site assembly, increasing labor costs and time.

Potential for missing or damaged parts during transit.

Additional tools/equipment required for setup.

Which Option is Cheaper?

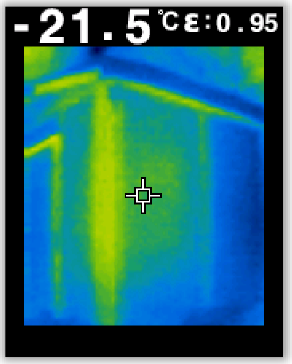
The **Flat-Packed 380 sq. ft. Building is significantly cheaper**, with an overall shipping cost **54.7% lower** than the pre-assembled 100 sq. ft. option. Additionally, the flat-packed structure provides **280% more space** at a much lower shipping cost.

Thermal Imaging Analysis Objective (100 sq. ft. Building)

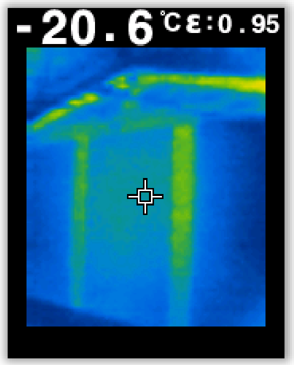
The primary objective of the thermal imaging analysis for the 100 sq. ft. Flex Structure building was to evaluate heat distribution, insulation effectiveness, and thermal bridging within the structure. The analysis aimed to identify potential weak points where energy loss occurs and provide insights for improving the thermal efficiency of the SIP panel-based building.

Key Findings from Infrared Thermography

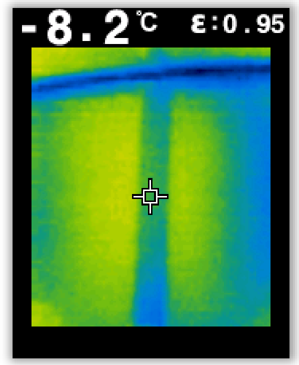
Thermal Bridging at Steel Corner



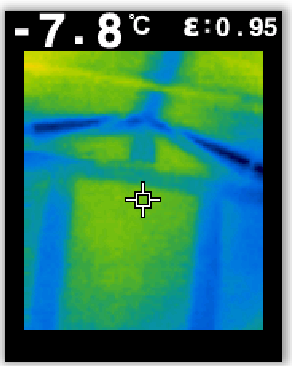
Roof Ridge and Eave Connections

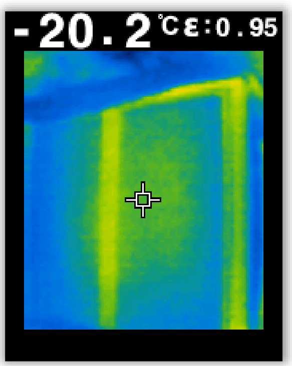


Cold Spots in Panel-to-Panel Co



Heat Retention in SIP Panels





Objective Achieved:

- Areas with metal components experience significant heat loss, leading to reduced insulation efficiency.
- Uninterrupted SIP panel sections perform well, highlighting the material's potential for energy-efficient applications.
- Enhancing insulation at panel joints and replacing metal connectors with thermally efficient materials would improve overall performance and reduce energy loss

Overcoming Challenges During Construction & Delivery

Despite the advantages of the Flex Structure system, real-world construction projects inevitably present unique challenges. However, FS team's ability to rapidly diagnose and resolve issues has reinforced the strength and adaptability of our modular construction system. Each challenge encountered was met with a well-planned response, demonstrating our readiness, resilience and further solidified our system's reliability and provided valuable insights to enhance future projects.

Delivery & Logistics Challenges

The 100 sq. ft. building delivered to the University College of the North in Thompson, Manitoba presented its own set of logistical hurdles. Shipping the structure posed difficulties in maintaining its condition during transit. Midway through delivery, it became necessary to tarp the entire building again to ensure protection from wind chipping and harsh weather conditions. This proactive measure safeguarded the structure from potential physical damage, reaffirming our commitment to delivering high-quality, pre-assembled buildings, regardless of external factors.

Continuous Improvement and Readiness

Each of these challenges was met with innovative solutions, showcasing our team's preparedness and resilience. Every project presents learning opportunities that allow us to refine our processes, ensuring an even smoother experience for future constructions. These experiences have strengthened our confidence in the adaptability of the Flex Structure system and its ability to meet the needs of remote communities across Canada.

Impact on Remote Areas Across Canada

The Flex Structure system has demonstrated remarkable potential in addressing the infrastructure challenges faced by remote Canadian communities. These prefabricated modular buildings provide sustainable, cost-effective, and rapidly deployable solutions for operational centers, emergency response facilities and many more. With the successful deployment of both the 380 sq. ft. and 100 sq. ft. buildings, the system has proven its adaptability to extreme weather conditions and logistical constraints in rural settings.

Ontario Case Study: Expanding Infrastructure

The Flex Structure project in Killaloe, Ontario, showcased the effectiveness of modular prefabrication in rural development. A 380 sq. ft. unit was constructed in just eight days, compared to the months-long timeline required for traditional construction. This initiative demonstrated recycling of **33,580 PET bottles** and reduce the **carbon foot print by 2.78 metric tons** making it a viable solution for expanding infrastructure in Indigenous and northern communities.

University College of the North Thompson, Manitoba: Thermal Efficiency Testing

In Manitoba, a 100 sq. ft. unit was delivered to UCN to undergo rigorous thermal efficiency testing. This research assessed:

- **Insulation performance**: Achieved a higher **R-value of 10** compared to conventional materials in **3 inches**.
- **Sustainability impact**: Reduced reliance on fossil fuel-based heating and environment impact, recycling **17,520 PET bottles** as Armacell PET form which lowering emissions by an estimated **1.45 metric tons annually per unit**.

Why These Buildings Are Essential for Remote Canada

The need for durable, cost-efficient, and adaptable structures in rural Canada has never been more pressing. These buildings provide:

- **Storage solutions for Indigenous and remote communities**: Addressing storage space shortages in underdeveloped areas.
- **Operational and utility buildings**: Supporting industries such as mining, forestry, and environmental research.
- **Emergency response facilities**: Deployable structures for disaster relief, medical response, and temporary shelters.

Key Benefits Achieved

- **40% savings in material transportation costs** due to flat-pack shipping.
- **60% faster construction times** compared to conventional methods.
- **Energy efficiency improvements of up to 30%***, lowering long-term operational costs.
- **1,460 PET bottles were recycled** per panel, a core component of Flex Structure Building System.

*Calculations are done on the experimental data point performed on 100 sq. ft building and extrapolated for 380 sq ft building at Killaloe, Ontario.

Conclusion

The Flex Structure building system presents a transformative solution to the challenges of remote construction in Canada. The deployment of a 380 sq. ft. prefabricated unit in Killaloe, Ontario, demonstrated a 60% reduction in construction time, completing in just eight days compared to conventional timelines of several weeks. Additionally, its use of fiberglass Structural Insulated Panels (SIPs) improved thermal performance, reducing energy consumption by an estimated 30%.

The thermal efficiency study conducted at the University College of the North (UCN) in Manitoba further validated the system's insulation properties. The use of Armacell PET foam in these structures also contributed to sustainability efforts, recycling 1,460 PET bottles per panel and reducing the carbon footprint by 1.45 metric tons per unit annually.

A key logistical advantage of the system lies in its transportation efficiency. The flat-packed 380 sq. ft. unit incurred 54.7% lower shipping costs compared to the pre-assembled 100 sq. ft. building, demonstrating a cost-effective alternative for delivering infrastructure to remote locations. The lightweight materials also minimized transport challenges, eliminating the need for oversized load permits.

These quantifiable benefits highlight the system's potential to support infrastructure development in Indigenous and remote communities. Whether for emergency response facilities, operational centers, or storage solutions, the Flex Structure system stands as a scalable, energy-efficient, and environmentally responsible construction method. With continued innovation and investment, this approach could redefine sustainable development across Canada's rural and northern regions.