Jackson Triggs Winery, KPMB
Forum Wood Building Nordic 2019

Reciprocal Framing Systems

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Reciprocal Frame - “A structure made up of mutually supporting beams in a closed circuit”

Reciprocal Frame Architecture
Olga Popovic Larsen, 2008
• Span
• Geometric Complexity
• 2-Way Action
• Folly
How do you use a 5m joist to span 6m?
When a problem is redefined to suit a preferred solution.
Lamella -
“A thin scale, plate, or layer of bone or tissue...”

- The American Heritage® Dictionary of the English Language
1270 - Present
Villard de Honnecourt

Reciprocal frame Sketches

1270

“ensi poes ovrer a one tor u a one maison de bas si sunt trop cor”

“how to work with a tower or with a house using timbers that are too short”
Sebastiano Serlio 1475-1554

Italian Architect wrote the “7 books on Architecture” and helped define the “5 orders of architecture”
John Wallis  1616-1703
English Mathematician
Author Opera Mathematica
Gave us $\infty$
Thomas Tredgold 1788-1829
English Engineer and Author of
Elementary Principles of Carpentry
Tower of the Schools of the Quadrangle, Bodleian Library, Oxford
Friederich Zollinger
1880-1945
German Architect and Engineer
Lamella “Zollinger Roof”, Merseberg Germany 1920s
Hugo Häring 1882-1958
German Architect
Lamella - Gut Garkau, Germany 1923-1926

Fort York Armoury - Toronto
Built in 1935
Case Study 1

Simple Grid – Toronto
Architect - Top Secret
Blackwell Engineers

Objective

Shallow depth
Long spans
Stringent vibration criteria
Option 1 – Conventional Framing
Designed for Strength and Deflection

Piece Count – 5
Deepest Member – 494
Total Volume – 7.07 m³

265x494
Option 2 – Reciprocal Framing
Designed for Strength and Deflection

Piece Count – 10
Deepest Member – 456
Total Volume – 12.2 m³

265x456
Deflection
Do we take L/360 for granted?
Deflection

So what do we do instead?

\[ \frac{L}{360} \]
Option 3 – Conventional Framing
Designed for Strength and Updated Deflection Criteria

Piece Count – 5
Deepest Member – 570
Total Volume – 8.16 m³

265x570
Summary

<table>
<thead>
<tr>
<th></th>
<th>Standard Framing</th>
<th>Reciprocal Framing</th>
<th>Standard Framing (Δ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Piece Count</td>
<td>5</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Depth (mm)</td>
<td>494</td>
<td>454</td>
<td>570</td>
</tr>
<tr>
<td>Total Volume (m³)</td>
<td>7.07</td>
<td>12.2</td>
<td>8.16</td>
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Other Considerations

Vibration

1 kN

0.6 mm

1 kN

0.3 mm
Case Study 2

Indian River Pavilion – PEI
David Sisam
Blackwell Engineers
Construction Documents
Option 1
Valley Framing

Piece Count – 15
Total Volume – 5.8 m³
Largest Piece – 731 kg
Option 2
Reciprocal Beam

Piece Count – 37
Total Volume – 4.8 m³
Largest Piece – 268 kg
Option 3
Reciprocal Joist
Piece Count – 47
Total Volume – 5.6 m³
Largest Piece – 60 kg
### Summary

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![Diagram of Valley Beam, Reciprocal Beam, and Reciprocal Joist](image.png)
Discovery Center, Ventura California
Restored 1940s Lamella
Canadian Pavilion at Venice Biennale (BBPR, Milan Architect 1958)
Drawing by 41° to 66° Team led by John McMinn 2008
Bunraku Theatre – Kazuhiro Ishi
Hale County Animal Shelter
Rural Studio 2006

Ross Creek Picnic Pavillion
Ted Cavanagh / Coastal Studio and Studio North 2010
UBC Transit Shelter – Fast + Epp
Apple Store,
Fifth Avenue,
New York City

Bohlin Cywinski Jackson Architects
Jack Layton Ferry Terminal, Toronto
KPMB Architects
“It is amazing how much you can accomplish when it doesn’t matter who gets the credit” – Unknown