Optimizing Steel and CLT for Seismic Performance

Solomon Tesfamariam
Professor, University of British Columbia
Optimizing Steel and CLT for Seismic Performance

Dr. Solomon Tesfamariam, P.Eng.
Professor
Principal’s Research Chair in the Resilient and Sustainable Built Environment (Tier 1)
Motivation
FPInnovations’ CLT Handbook

- State-of-the-art peer-reviewed technical source for designers that facilitates use of CLT as alternative solution (2013)

Origine, Quebec City (13 Stories, completed 2017)

Brock Commons, UBC Vancouver  (18 Stories, completed 2017)

https://www.thinkwood.com/our-projects/brock-commons-tallwood-house
Steel MRF – CLT Infills
FORCE BASED DESIGN GUIDELINE FOR
TIMBER-STEEL HYBRID STRUCTURES:
STEEL MOMENT RESISTING FRAMES WITH CLT INFILL WALLS

PRINCIPAL INVESTIGATORS
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STUDENTS
Matyas Bezaheb
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(Senior Lecturer, Bristol University)

December 2015

https://dx.doi.org/10.14288/1.0223405
Validation for $R_d = 4$

$$V = \frac{S(T_0) M_v I_e W}{R_d R_o}$$

<table>
<thead>
<tr>
<th>performance group</th>
<th>Hybrid Building Configuration</th>
<th>Calculated $R_o$ and $ACMR$</th>
<th>Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-rise</td>
<td>No. of storey</td>
<td>Infilled bays</td>
<td>$R_o$</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>3.54</td>
<td>3.05</td>
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<tr>
<td>Average</td>
<td></td>
<td><strong>3.54</strong></td>
<td><strong>7.8</strong></td>
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<tr>
<td>Mid-rise</td>
<td>6</td>
<td>2.82</td>
<td>3.49</td>
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<tr>
<td>Average</td>
<td></td>
<td><strong>2.82</strong></td>
<td><strong>17.1</strong></td>
</tr>
<tr>
<td>High-rise</td>
<td>9</td>
<td>2.46</td>
<td>2.96</td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td><strong>2.46</strong></td>
<td><strong>21.14</strong></td>
</tr>
</tbody>
</table>

Force Based Design
(Carla’s MASc thesis)
Displacement Based Design
(Matiyas’s MASc thesis)
\[ E_k + E_d + E_s + E_h = E_i \]

Energy Based Design
(Caleb’s MASc thesis)

Coupled CLT Shear Walls – Replaceable Steel Link
Design of Tall-Coupled-Wall Timber Building: Energy Dissipating Coupling Beams

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December 2021

THE UNIVERSITY OF BRITISH COLUMBIA
FACULTY OF APPLIED SCIENCE, SCHOOL OF ENGINEERING

https://dx.doi.org/10.14288/1.0403817
Structural Engineering

Tall Timber Buildings: Innovative Building Design and Damping Considerations

“The most important sources of intrinsic damping for tall buildings are soil structure interaction (SSI) and structural behavior.”
Coupled CLT Shear Walls – Outrigger Beams
Resilient Tall Timber Building Design: Damped-Outrigger System

PRINCIPAL INVESTIGATOR
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Sourav Das
(PHD Student, UBC Okanagan Campus)
Coupled CLT Shear Walls – Steel Diagrid Skeleton
Topology optimization

2-story

4-story

6-story
“There’s a way to do it better—find it.”

Thomas Edison

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