Executive Summary

This summary is a condensed version of the comparative study for the Rothesay Recreational Facility completed by Hanscomb. All of the information is transcribed directly from the Hanscomb report and has been summarized into a condensed, more generalized form.

Enclosed is a narrative of each material application outlining the productive and logistical factors of choosing the material, with a comparative emphasis on the wood alternative. The appendix includes indirect numeric cost comparisons of the least and most expensive options for each material application. Numeric rates are expressed in two categories when applicable.

1. **Total costs** which include labor, material, equipment, subcontractor's overheads and profits.
2. **Labor & Equipment** which include a labor rate of $75.00/hr and all equipment related costs for installation inc. cranes and pumps.

The delta in eventual cost to all categories would ultimately depend on the complexity of the designer's choice.

Material Comparisons

Walls

Concrete wall Installation requires coordination of 4 separate crews and 4-6 hours to pour the concrete and 2 hours the next day to strip forms. This pertains to the best install option of using Fly Form Walls (roughly 9m each). Suggested use is using a stronger mix of concrete than steel *(see Table 2 - Concrete forms with rebar weight constant)*

Precast concrete would likely be a close competitor to CLT installs rates, but would be in the same range of cost as the site cast concrete wall plus additional of freight.

Tilt-up Concrete (un-insulated) panels are more expensive per square foot (SF) in the 3 and 5 layer CLT panels and competitive in cost for the 7 and 9 layer panels *(see Table 4 - Tilt-Up Concrete (un-insulated))*.

Concrete Masonry Block Install time ranges from 8 hours to 14 hours or about (1.75 days), due to the curing and load bearing characteristics of the mortar. Installation needs to be sequenced due to the weight of concrete block and the plasticity of the mortar; there is a limiting height to consider due to the curing and subsequent load bearing capabilities of the mortar during assembly. Comparison advantage for CLT is based on productivity rather than cost.

Cross Laminated Timber (CLT) walls are quicker (2.1 to 3.7 hours) than concrete to install walls of the same surface area - regardless of the thickness of the concrete wall *(see Table 1 - Cross Laminated Timber (CLT))*. The largest contributing factor is that all of the work for the concrete is done on site while the fabrication of the CLT panels is completed off site; therefore installation is the only process to consider once delivery is made. CLT method can have a higher daily productivity on a regular 8 hour

shift basis and require less coordination than the listed wall types. CLT wall surface installation versus block installation in one day could be doubled on the first day and added to for the following day(s) while the masonry work is completed. On a cost basis, CLT is more effective (depending on the design) than the listed types with the exclusion of concrete masonry blocks *(Table 5 - Concrete masonry block)*.

Floors

Concrete floors apply the same logistics and productivity factors as concrete walls. See cost distribution in *(Table 7 - Concrete Floor with varying ratios of rebar to concrete)*.

Precast concrete would likely be a close competitor to the CLT install and supply rates in many regards. One extra step exists as the top finish requires a concrete topping and there is usually a camber to the span panels.

Open Web Steel Joists (OWSJ) assembly requires coordination of 2 trades (concrete and steel) - Steel erectors, welding, decking and concrete laborers. It takes 4-6 hours + 1 hour to place the concrete + 2 hours to finish it. No curing to consider because no need to strip forms. OWSJ works well in areas of poor soil bearing capacity as its lighter. It is also easier to conform to design parameters as there is a vast array of joists with different factored loads and spacing.

Cross Laminated Timber (CLT) floors apply the same logistics and productivity factors as CLT walls. The same - potentially doubled - productivity factor exist when comparing CLT floors to concrete and OWSJ floors (all of the same surface area). The cost advantage is only present when compared to concrete. CLT is not a clear advantage in cost per SF when compared to OWSJ. In shorter spans (6-7m) CLT is cheaper but as the span increases, CLT panels have to be thicker and the costs are higher, making OWSJ more competitive.

Beams and columns

Concrete Column installation requires the coordination of 3 separate crews plus concrete supply and can take 1-2 hours if done continuously when using fly form columns, a rebar crew and a tower crane or pump to pour the concrete. Preparation for concrete pour is usually a whole day event which must include time for the hydration process (curing) of concrete to complete before stripping the forms. A Rebar crew can pre-fabricate the rebar grid for the column and fly it into place. This identifies some of the same characteristics associated with engineered wood.

Structural Steel costs are obvious, the heavier the steel member the more expensive per lineal meter. *This is the first DIRECT COST COMPARISON* *(Table 11 - Structural Steel Beams – W – Shaped)* for more information.

- Steel - W150x13, weighing about 13kg/m costs $57/m ($17.43/ft)
- Glulam – SPF 130mm x 120mm (5 1/8” x 4” dp) is $53/m ($16.07/ft)

Hollow Structural Steel (HSS) is used in a wide variety of lighter structural steel framing projects at a relatively lower cost compared to structural steel beams. Without direct substitution requirement for HSS vs. Glulam it is difficult to determine true cost comparison. HSS has more potential to be considered as a direct competitor to glulam beam. The cost range is low and not out of line with glulam costs. A more competitive comparison would be HSS vs. Engineered wood framing.

Glulam installation takes roughly 0.8 hours per column including crane time. The material cost varies depending on the species used. Spruce being the cheapest and Western Fir the most expensive. Compared to concrete, a glulam column has a higher productivity potential on a daily basis and at a potentially lower productivity cost depending on the design of comparator.

Roof Decking

Same productivity and logistics apply to installing both **Metal** and **Wood** roof decking and there for it is a *DIRECT COST COMPARISON.*

- 1x6 wood decking is more economical to install than the 38mm (1 ½") roof or floor deck, under certain productivity scenarios.
- 2"x 6" wood decking compares to 38mm (1 ½")
- 3x6 wood deck is competitive to the 3" metal roof decking but not competitive to the interior 3" metal floor deck.
- (4" x 6") wood decking is competitive to the (3") metal roof deck's heavier gauge, but less competitive to the interior (3") metal floor deck.

Conclusion

Important Observations

Concrete is heavier than steel and steel is heavier than wood. Wood construction applies less load to cross sectional bearing points of the foundation and the design of the foundations could be reduced accordingly. This will also decreasing excavation costs.

A review of the engineered wood stick framing method finds that costs and productivity appear to be comparable to a heavier gauge metal stud load bearing framing system which includes structural steel elements for headers and other span bracing.

Figure 1 - Historical cost comparisons on completed projects

	Historical costs on building structures				
	Glulam		Steel		Steel with concrete topping
	Roof - Glulam, trusses, purlins & decking		Roof - Framing & Decking (no purlins)		Small structure &
	Glulam (120 ft span)	Glulam (167ft span)	Steel (26ft high) HD	Steel (150ft span)	compartmentalized
m2	$215.00	$490.00	$360.00	$345.00	$140.00
SF	$20.00	$45.00	$33.00	$32.00	$13.00

Material options in the future that needs to be compared:

- Wood wave 269 – 322/m2 ($25-$30 /SF) Structure craft also has a product called NLT for about 10% less.
- NLT fabrication (10% less than woodwave) is mobile and can be brought to construction site for use of local wood types.
- There are also engineered wood products and standard dimensioned lumber products which are produced in panelized systems for both wall and floor construction. Panelized systems are more productive to install than traditional wood stick framing, although the cost to produce the panels is slightly more than stick framing.
- Wood "I" Joists that allow for larger spans and greater design requirements for long floor and roof spans are also a viable alternative to concrete and steel construction
- Long span wood roof truss systems

Appendix

Table 1 - Cross Laminated Timber (CLT)

3 Layer Vertical Application of CLT (18m L x 0.10m W x 3.05m H)			
Total Cost		Labor & Equipment (2.1 hrs)	
$ 141.00	$/m^2	$ 43.00	$/m2
$ 13.12	$/SF	$ 4.00	$/SF

9 Layer Vertical Application of CLT (18m L x 0.31m W x 3.05m H)			
Total Cost		Labor & Equipment (3.7 hrs)	
$ 345.00	$/m^2	$ 75.00	$/m^2
$ 32.03	$/SF	$ 7.00	$/SF

Table 2 - Concrete forms with rebar weight constant

150mm concrete thickness (25Mpa) (18m L x 0.15m W x 3.05m H)		
Total cost		Labor & Equipment
$ 305.00	$/m^2	N/A
$ 28.36	$/SF	N/A

600mm concrete thickness (45Mpa) (18m L x 0.6m W x 3.05m H)		
Total cost		Labor & Equipment
$ 417.00	$/m^2	N/A
$ 38.75	$/SF	N/A

Table 3 - Concrete forms with rebar proportionate to concrete

150mm concrete thickness (25Mpa) (18m L x 0.15m W x 3.05m H)		
Total cost		Labor & Equipment
$ 305.00	m^2	N/A
$ 28.36	SF	N/A

600mm concrete thickness (45Mpa) (18m L x 0.6m W x 3.05m H)		
Total cost		Labor & Equipment
$ 578.00	m^2	N/A
$ 53.73	SF	N/A

Table 4 - Tilt-Up Concrete (un-insulated)

Tilt up Concrete (un-insulated) **thickness not specified*	
Total Cost	Labor & Equipment
N/A m^2	N/A
24-35 SF	N/A

Table 5 - Concrete masonry block

100mm Concrete Masonry Block (18m L x 0.10m W x 3.05m H)		
Total cost		Labor & Equipment (7.8hrs)
$ 135.00	m^2	TBD
$ 12.54	SF	TBD

300mm Concrete Masonry Block (18m L x 0.3m W x 3.05m H)		
Total cost		Labor & Equipment (13.7)
$ 212.00	m2	TBD
$ 19.72	SF	TBD

Table 6 - Horizontal CLT Application (Suspended Floor)

3 Layer Horizontal Application of CLT (Floor) (12.9m L x 6m W x 0.10m H)			
Total Cost		Labor (2 hrs)	
$ 112.00	m^2	$ 27.00	m2
$ 10.37	SF		

9 Layer Horizontal Application of CLT (Floor) (12.9m L x 6m W x 0.31m H)			
Total Cost		Labor (3.2 hrs)	
$ 291.00	m^2	$ 43.00	m2
$ 27.06	SF		

Table 7 - Concrete Floor with varying ratios of rebar to concrete

150mm (6") Concrete Slabs (30Mpa) > Rebar (12.2m L x 6m W x 0.15m H)		
Total Cost		Labor
$ 230.00	m2	N/A
$ 21.00	SF	N/A

300mm (12") Concrete Slabs (45Mpa) < Rebar (12.2m L x 6m W x 0.3m H)		
Total Cost		Labor
$ 375.00	m2	N/A
$ 34.81	SF	N/A

Table 8 - OWSJ 38mm Metal Deck – 75mm Concrete Topping (Factored Load 9-18 KN/m)

3m Span

9.0 KN/m Joist Depth 200mm (8") OWSJ No. 25, 0.50 Spacing		
Total Cost		Labor
$ 140.00	m2	N/A
$ 13.04	SF	N/A

10m Span

9.0 KN/m Joist Depth 800mm (32") OWSJ No. 16, 0.80 Spacing		
Total Cost		Labor
$ 151.00	m2	N/A
$ 14.00	SF	N/A

3m Span

13.5 KN/m Joist Depth 200mm (8") OWSJ No. 25, 0.50 Spacing		
Total Cost		Labor
$ 140.00	m2	N/A
$ 13.04	SF	N/A

10m Span

13.5 KN/m Joist Depth 800mm (32") OWSJ No. 16, 0.80 Spacing		
Total Cost		Labor
$ 180.00	m2	N/A
$ 16.73	SF	N/A

3m Span

18 KN/m Joist Depth 200mm (8") OWSJ No. 25, 0.50 Spacing		
Total Cost		Labor
$ 156.00	m2	N/A
$ 14.46	SF	N/A

10m Span

18 KN/m Joist Depth 800mm (32") OWSJ No. 16, 0.80 Spacing		
Total Cost		Labor
$ 202.00	m2	N/A
$ 18.78	SF	N/A

Table 9 - Glulam SPF & Western Fir

SPF 130mm (5 1/8" Wide Glulam) min depth (0.12 D x 0.13m W x 6.10m H)		
Total Cost		Labor (.6hrs)
$ 53.00	m	TBD
$ 16.07	FT	TBD

SPF 217mm (8 1/2" Wide Glulam) max depth (0.65 D x 0.21m W x 6.10m H)		
Total Cost		Labor (.8hrs)
$ 213.00	m	TBD
$ 65.00	FT	TBD

Western Fir 130mm (5 1/8" Wide Glulam) min depth (0.12 D x 0.13m W x 6.10m H)		
Total Cost		Labor (.6hrs)
$ 59.00	m	TBD
$ 17.94	FT	TBD

Western Fir 217mm (8 1/2" Wide Glulam) max depth (0.65 D x 0.21m W x 6.10m H)		
Total Cost		Labor (.8hrs)
$ 265.00	m	TBD
$ 80.69	FT	TBD

Table 10 - Concrete Columns

Rebar Weight based on 20M V ea 150mm-10M stirrup ea 300mm – allow splice

150mm Wide 25Mpa (0.15 L x 0.15m W x 3.05m H)		
Total Cost		Labor
$ 106.00	m	N/A
$ 32.41	FT	N/A

300mm Wide 45Mpa (0.15 L x 0.15m W x 3.05m H)		
Total Cost		Labor
$ 442.00	m	N/A
$ 134.83	FT	N/A

Rebar Weight based on 25M V ea 150mm-10M stirrup ea 300mm – allow splice

150mm Wide 25Mpa (0.15 L x 0.15m W x 3.05m H)		
Total Cost		Labor
$ 133.00	m	N/A
$ 40.41	FT	N/A

450mm Wide 45Mpa (1.0 L x 0.45m W x 3.05m H)		
Total Cost		Labor
$ 521.00	m	N/A
$ 158.82	FT	N/A

Rebar Weight based on 35M V ea 150mm-15M stirrup ea 300mm – allow splice

300mm Wide 25Mpa (0.30 L x 0.30m W x 3.05m H)		
Total Cost		Labor
$ 370.00	m	N/A
$ 112.83	FT	N/A

450mm Wide 45Mpa (1.0 L x 0.45m W x 3.05m H)		
Total Cost		Labor
$ 906.00	m	N/A
$ 276.19	FT	N/A

Rebar Weight based on 45M V ea 150mm-15M stirrup ea 300mm – allow splice

450mm Wide 25Mpa (0.45 L x 0.45m W x 3.05m H)		
Total Cost		Labor
$ 702.00	m	N/A
$ 213.87	FT	N/A

450mm Wide 45Mpa (1.0 L x 0.45m W x 3.05m H)		
Total Cost		Labor
$ 1,140.00	m	N/A
$ 347.34	FT	N/A

Table 11 - Structural Steel Beams – W – Shaped

W150x13 Beam Depth 150mm, 13kg/m		
Total Cost		Labor
$ 57.00	m	N/A
$ 17.43	FT	N/A

W920x1191 Beam Depth 920mm, 1191kg/m		
Total Cost		Labor
$ 5,240.00	m	N/A
$ 1,597.29	FT	N/A

Table 12 - Hollow Structural Steel – CSA G40.20

HS38x38x3.2, Depth 38mm, Mass 3.28kg/m			HS305x305x16, Depth 305mm, Mass 139kg/m		
Total Cost		Labor	Total Cost		Labor
$ 14.00	m	N/A	$ 612.00	m	N/A
$ 4.40	FT	N/A	$ 186.42	FT	N/A

Table 13 - Wood Decking

25mm dp x 150mm Wide (1" x 6") wood decking (12.19 L x 6.0 W x 0.10 H)			100mm dp x 150mm Wide (4" x 6") wood decking (12.19 L x 6.0 W x 0.31 H)		
Total Cost		Labor (7 crew 1.9hrs)	Total Cost		Labor (6 crew 3.8hrs)
$ 28.00	m2	$ 13.45	$ 82.00	m2	$ 13.45
$ 284.00	m3	-	$ 266.00	m3	-
$ 2.63	SF	$ 1.25	$ 7.66	SF	$ 1.25

Table 14 - Metal Decking

Roof Deck Depth 38mm dp, 22 Gauge			Roof Deck Depth 76mm dp, 18 Gauge		
Total Cost		Labor	Total Cost		Labor
$ 32.31	m2	$ 15.60	$ 56.39	m2	$ 27.30
-	m3	-	-	m3	-
$ 3.00	SF	-	$ 5.24	SF	-

Questions for Hanscomb

1. No precast concrete costs available for walls.
2. What are the labor costs for concrete masonry blocks.
3. No comparison in logistics or Productivity for structural steel vs glulam beams & columns.
4. Crew of 6 people installing 4”x6” wood decking boards when smaller boards have crews of 7.