

CROSSLAM[®]CLT

BY STRUCTURLAM

Engineered Matting Specifications

Access Mats | Rig Mats | Crane Mats



ANSI/APA PRG 320: Standard for
Manufacturing Cross Laminated Timber



CSA-0177-M89: Standard for
Manufacturing Engineered Wood



US Provisional
Patent No. 61943523

www.structurlam.com

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CrossLam® CLT Matting (US Provisional Patent No. 61943523)

Our revolutionary access, crane, and rig mats are durable, greatly reduce shipping costs and save you money. Our mats are built with CrossLam® CLT Technology; an innovative cross layered wood system that uses structural adhesive rather than bolts. This advanced blend of laminated timber distributes the heaviest weights evenly over more area than traditional mats.

CrossLam® CLT mats offer a number of benefits over traditional mats:

- Lightweight and easy to ship.
- Cost effective.
- No bolts on the main face.
- Performs well in extreme conditions.
- Twice as many access and crane mats per truck.
- Replaceable tongues on access mats.
- Mats do not diamond or deform if mishandled.
- No trip hazards.
- Reduction in tire damage.

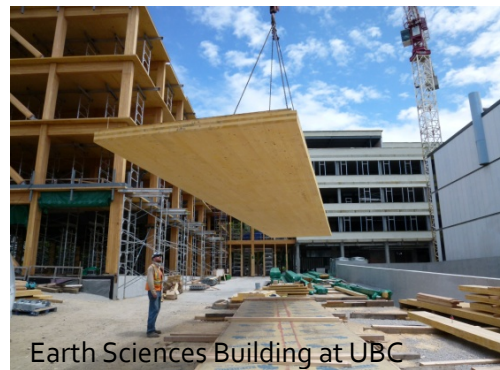
Structurlam Products LP

Structurlam Products LP has over 50 years' experience manufacturing quality engineered wood products for the construction industry. We are passionate about wood and operate out of three state-of-the-art production facilities. Using CrossLam® CLT technology, Structurlam has designed and built the strongest rig, access and crane mats. CrossLam® CLT is so strong it's replacing concrete in the construction industry. This same ingenuity and innovation continues to revolutionize matting for the oil and gas, pipeline, transmission line and construction industries.

Only 4 words are needed to describe our revolutionary CrossLam® CLT mats; strong, stiff, lightweight and consistent.



Fort McMurray Airport



Earth Sciences Building at UBC

We are an authority on engineered wood and wood technology.

CrossLam® CLT Engineering + Design

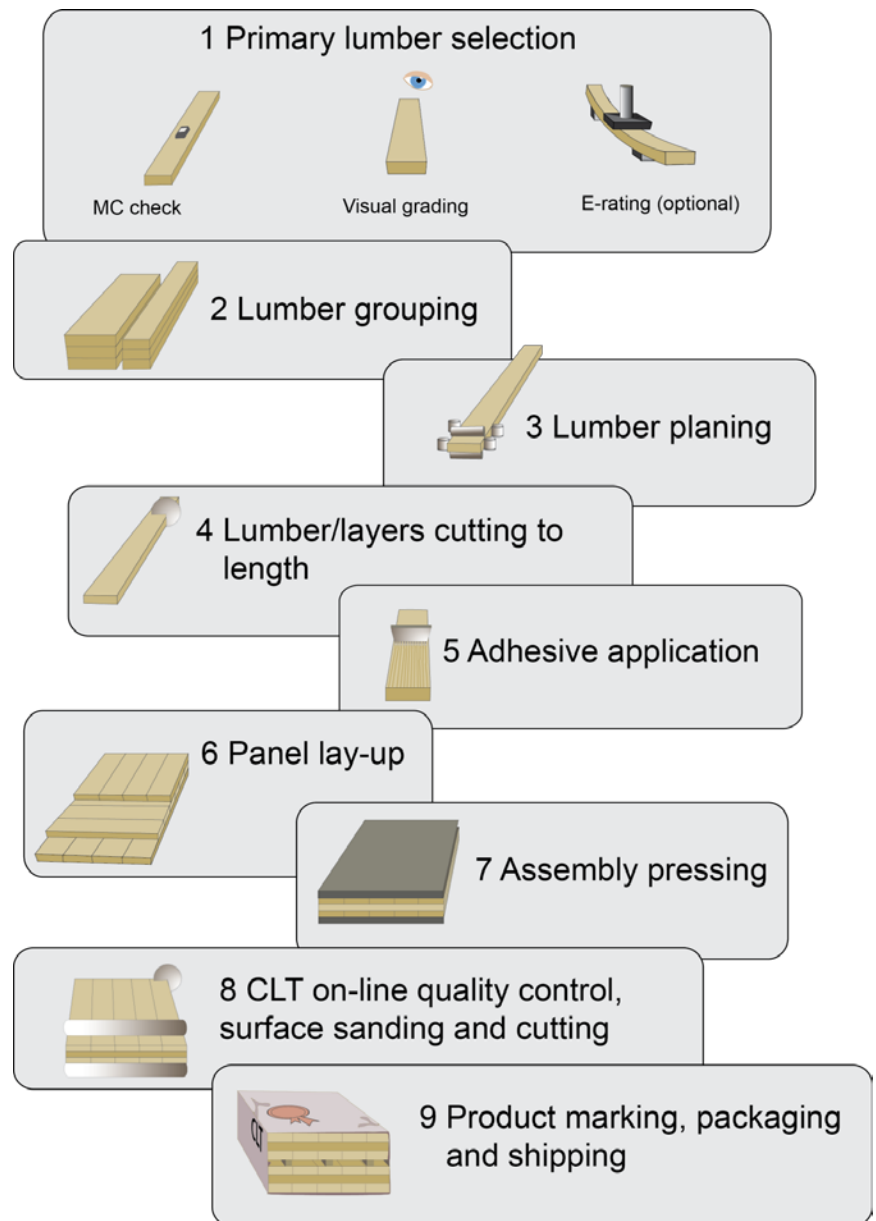
CrossLam® manufacturing is an innovative engineered process that sets CrossLam® matting solutions apart from 'old school' matting fabrication. The solvent free and formaldehyde-free structural adhesive used in our proprietary press design, allows CrossLam® to be the most consistent engineered matting on the market today.

CrossLam® is manufactured with ZERO toxic emissions at any stage of the life cycle. The manufacturing process and the laminating of layers in crosswise directions reduce wood expansion and shrinkage to insignificant levels; and allows for a consistent stability throughout the lifecycle of the mat (see Figure 1 – CrossLam® Manufacturing Process).

Mats are tested in accordance with current APA testing and far exceed anything that the industry currently provides:

- full destruction testing is done weekly;
- tested to extremes of climactic conditions;
- oven baking;
- pressurized boil in water tests that simulate life spans of up to 20 years; and
- cyclical shear and bending testing for strength and structural properties.

Figure 1 – CrossLam® Manufacturing Process (source FP Innovations)





Health, Safety + Environment

Structurlam follows strict internal safety standards and has achieved Worksafe BC and BC Construction Safety Alliance certification for our health and safety management program. We maintain a continuous commitment to raising the standard of worker health and safety.

	Worksafe BC	BCCSA Certificate of Recognition	Safety Statistics
Account Number	902681		
Industry Code	714009	714009	
Certificate		9026811120130308HL	
Expiry		Dec 1, 2015	
TRIF			.033
VIR			1.48
LTIR			0

We are committed to promoting a clean environment and minimizing our environmental footprint.

Structurlam promotes the use of wood as a renewable and sustainable material and uses only raw material from timber harvested from certified sustainably managed timberlands.

Structurlam is proud to purchase lumber for CrossLam® from the following Canadian suppliers; Interfor, Tolko, Canfor, Millar Western, and West Fraser. All of these suppliers are either SFI or FSC certified. For more information on SFI programs visit their website

<http://www.sfiprogram.org>. We aim to mitigate the environmental impacts of our manufacturing process and exceed all regulations regarding waste material. We currently utilize waste fibre as biofuel and are always looking to incorporate environmental aspects into our product development.

All of our matting products are produced with Lumber Purchased from SFI or FSC Certified Mills. CrossLam® Mats are made from fibre sourced in British Columbia and Alberta; thus supporting the Canadian economy. In addition, all of our products are engineered with low VOC, exterior grade adhesives which contain no added urea-formaldehyde and deemed to be inert, creating no impact to the environment. Please download the CrossLam® Environmental Product Declaration Report available at www.structurlam.com/product/cross-laminated-timber.php.



Our BioMass unit turns CrossLam® waste into heat for our plant.

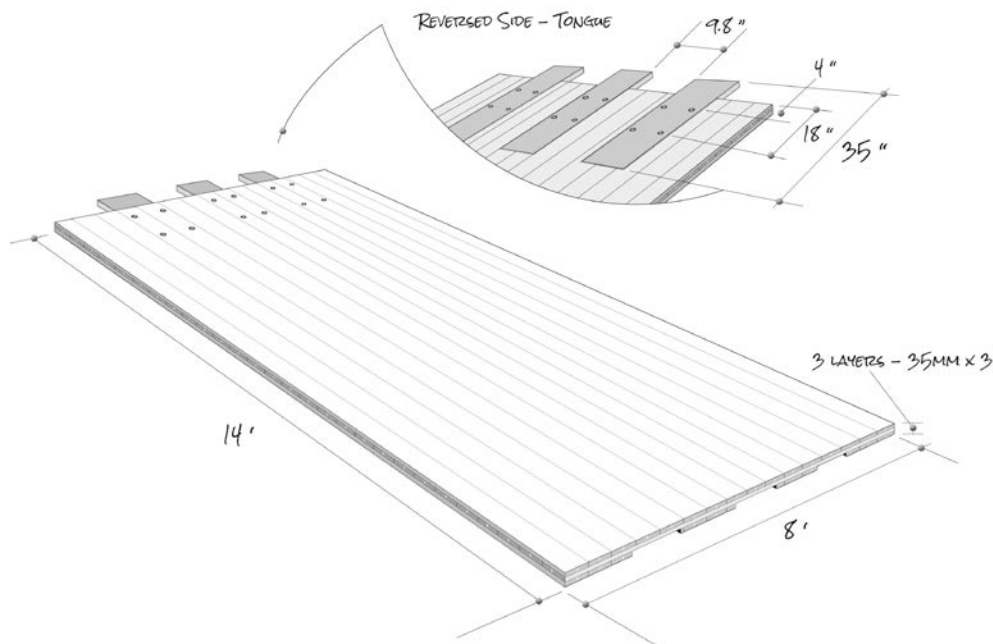
CrossLam® Access Matting

Our standard Douglas-fir access mat:

- has twice the strength of a traditional bolted access mat;
- is 5 times stiffer than a traditional bolted access mat;
- has 96% less bolts than a traditional mat;
- is two-thirds the weight of traditional bolted mats;
- has a solid top;
- has glue lamination that helps to repel moisture; and
- has identification tags that provide traceability and assist with inventory management.



The revolutionary design has a solid top making them the easiest mats in the industry to clean, and prevent the migration of site to site contamination.



CrossLam® Access Mat Properties

Maximum Mat Size:	7'10" 1/2 x 14'
Maximum Thickness:	4 1/4"
Weight:	1150 lbs
Maximum Loading:	Span 12' - 1.6" of deflection at maximum loading of 25000 lbs With 98% soil compaction – 55000 lbs/ft ²
Mat Edges:	3/4" chamfer on long edges
Moisture Content:	14% (+ or – 2% at time of production)
Glue Specifications:	Polyurethane adhesive
Wood Species:	Douglas-fir & SPF
Squareness:	Panel face diagonals shall not differ by more than 1/8"

Differentiate your company through huge freight savings.



Shipping costs are significantly lower with CrossLam® mats. Let's say you wanted to ship 1,000 access mats from Edmonton to Fort McMurray. If you used oak mats which weigh 3,000 lbs a mat your total shipping cost would be approximately \$64,000. If you used Fir mats which weigh 1,975 lbs a mat your total cost would be approximately \$42,000. However if you used CrossLam® mats which only weigh 1,150 lbs a mat then your costs would be \$24,000.

You can cut your shipping costs by 60%! These are savings that only compound themselves over the life-cycle of the CrossLam® access mat.

Type of Mat	Weight	Shipping Cost
Bolted Oak Mat	3,000 lbs	\$64,000
Bolted Fir Mat	1,975 lbs	\$42,000
CrossLam® Mat	1,150 lbs	\$24,000

Engineering + Independent Testing of Access Mats

Independent testing shows CrossLam® Access Mats are more than twice the strength of bolted mats. During testing the CrossLam® mat collapsed with a weight of 58,411 lbs, while the Fir bolted mat crumbled at just 25,550 lbs. At the point of collapse, the Fir bolted mat flexed 8.88" while the CrossLam® access mat only flexed a mere 1.60". The tests clearly showed the stiffness and strength of the CrossLam® mat far exceeded that of a bolted mat.

Tested by the world's largest independent forest research centre:

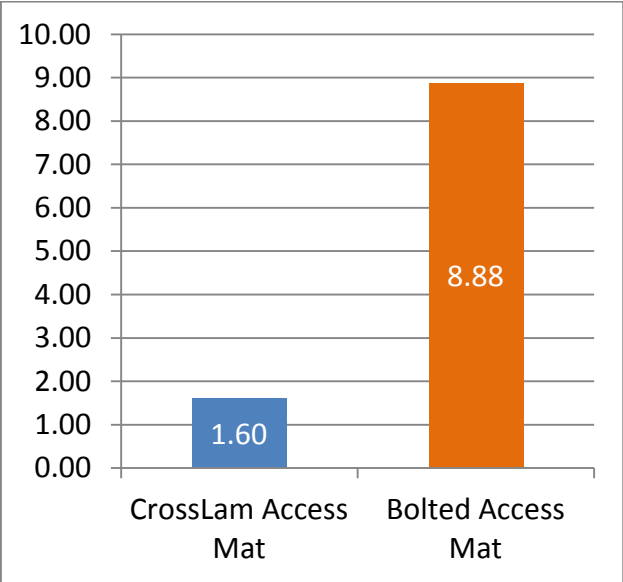
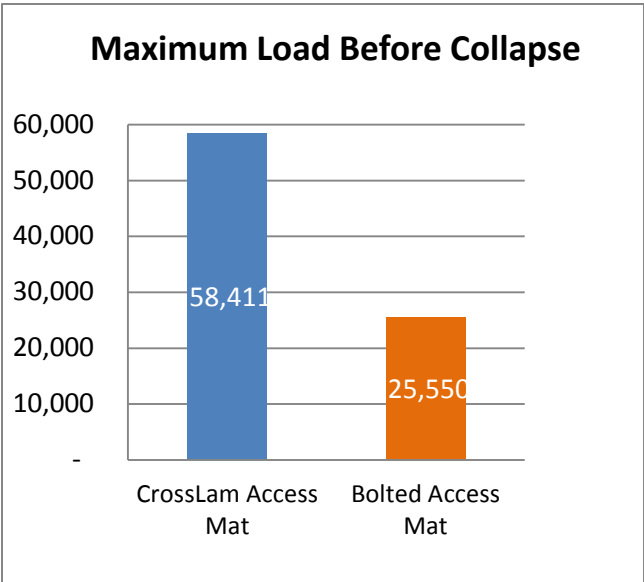


1. Mats were tested in third point bending with a span of 144".
2. An initial stiffness test was done.
3. Mats were cycled 100 times up to 10,000 lbs.
4. Another stiffness test was performed.
5. The mats were loaded to failure. The maximum load and deflection at maximum load were recorded.

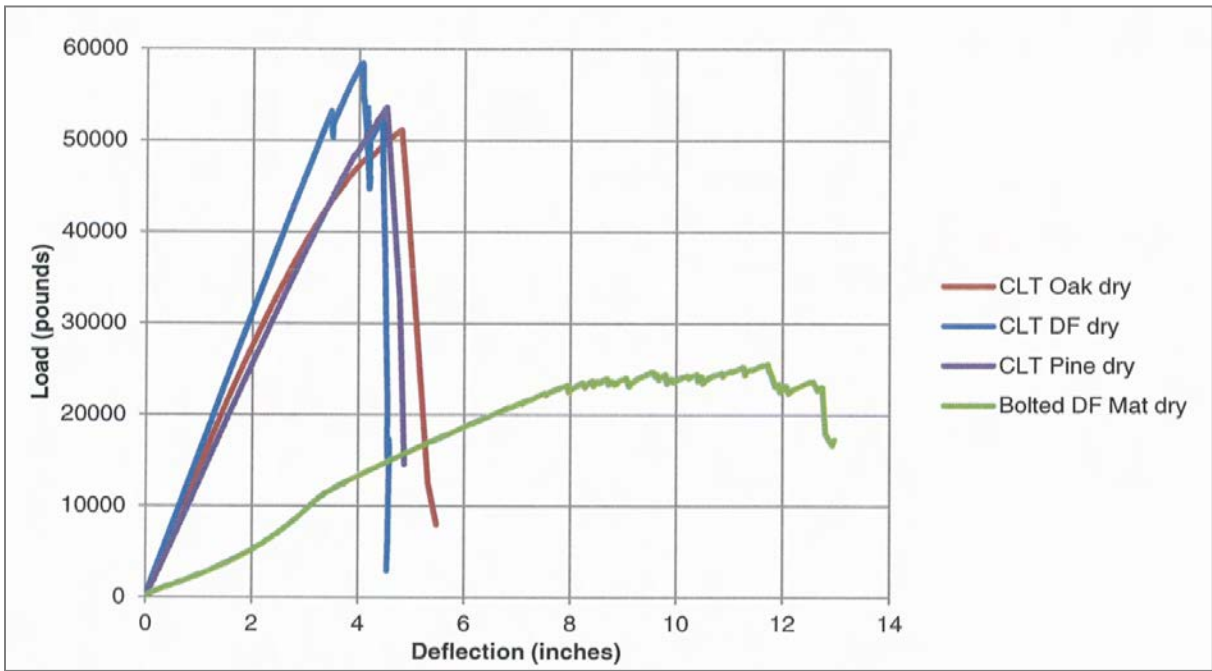
CrossLam® access mats are twice the strength and 5 times stiffer than bolted mats.



Engineering + Independent Testing of Access Mats



Maximum Load Before Collapse of CLT Mats vs. Bolted Douglas-fir Mat



CrossLam® Rig Mat Core

CrossLam® rig mat core is the next generation of Rig Mats. In CLT technology, the panel either replaces or reduces all internal steel from a traditional 3-beam and 4-beam rig mat. The steel becomes necessary only to protect the outside of the rig mat from external damage. The Rig mat core wrapped in traditional I-Beam steel is stronger and stiffer than a 4 beam rig mat. It will always return to shape if bent, twisted, or dropped (see Figure 1 – Independent Testing of CrossLam® Core).



Rig mat core panels are strong, durable and lighter than traditional rig mats. A 4" CLT rig mat replaces a 6" conventional rig mat and provides you with 50% less weight and 25% more product per truckload. Structurlam can supply you with CrossLam® core for your own rig mat designs or put you in contact with our partners already producing 3 beam / 4 beam equivalent rig mats.

CrossLam® core offers substantial increases in strength and reduces the life-cycle cost of rig mats due to its strength to weight ratio advantages over traditional block style mats. CrossLam® solves the challenges faced when moving walking rigs and ensuring safe working pads. CrossLam® rig mat core is the only mat that can offer load ratings that are equal to the requirements of today's drilling operations.

CrossLam® Rig Mat Core Properties

Standard Size:	7' 10 1/2" x 40'
Maximum Size:	10' x 40'
Standard Thickness:	5.5"
Thickness Range:	4.5" - 12"
Ultra Core:	4500 lbs (wood only no steel frame, 8' x 40' - 4 ply)
Mat Frame:	As per steel frame specifications supplied by other
Moisture Content:	14% (+ or – 2% at time of production)
Glue Specifications:	Polyurethane adhesive
Wood Species:	SPF & Douglas-fir
Dimensional Tolerances:	<i>Thickness:</i> +/- 3/64" or 1mm at time of production <i>Width:</i> +/- 1/4" or 6mm <i>Length:</i> +/- 1/4" or 6mm

Freight Savings

The CrossLam® core provides a weight savings that allows for two more mats per truck load.



Weight Comparisons of Traditional Rig Mats vs. CrossLam® Rig Mat Core

Traditional Rig Mat Wideflange	Weight	CrossLam® Rig Mat	Weight	Freight Savings
8' x 40' - 3 Beam	7000 lbs	8'x 40' - Channel	5440	29%
8' x 40' - 4 Beam	7600 lbs	8' x 40' - Wideflange	6080	25%
8' x 20' - 3 Beam	3550 lbs	8'x 20' - Channel	2720	31%

Strength Comparisons of Traditional Rig Mats vs. CrossLam® Rig Mat

Traditional Rig Mat Wideflange	Load Capacity	CrossLam® Rig Mat	Load Capacity	Increase in Load Capacity
8' x 40' - 3 Beam	35000 lbsft ²	8'x 40' - Channel	70000 lbsft ²	100%
8' x 40' - 4 Beam	45000 lbsft ²	8' x 40' - Wideflange	80000 lbsft ²	78%
8' x 20' - 3 Beam	35000 lbsft ²	8'x 20' - Channel	70000 lbsft ²	100%

Engineering + Independent Testing of CrossLam® Core

On site testing was done on traditional rig mats and CrossLam® rig mats. Figure 1 – Testing the Deflection of CrossLam® Rig Mats vs. Traditional 3 Beam Rig Mat, shows significantly more deflection when 16,000 lbs of weight is added to the traditional rig mat versus the CrossLam® rig mat. After the testing the CrossLam® mat was still able to retain its shape while the traditional mat has a denoting bend (see Figure 2 – Stiffness of CrossLam® Rig Mat vs. Traditional 3 Beam Rig Mat After Weight Applied).

Figure 1 – Testing the Deflection of CrossLam® Rig Mat vs. Traditional 3 Beam Rig Mat



Three beam mat with a lot of deflection.



CrossLam® mat with little deflection.

Figure 2 – Stiffness of CrossLam® Rig Mat vs. Traditional 3 Beam Rig Mat After Weight Applied



Three beam mat remains bent.



CrossLam® mat keeps its shape.

Engineering + Independent Testing of CrossLam® Core

Testing by Bourcet Engineering found that the bending capacity of rig mats was the governing factor. Table 3 shows the results from the analysis. The bending utilization factor (U.F.) is taken as the factored bending moment divided by the factored bending resistance. A utilization factor less than one meets passes, while a value greater than one exceeds the capacity.

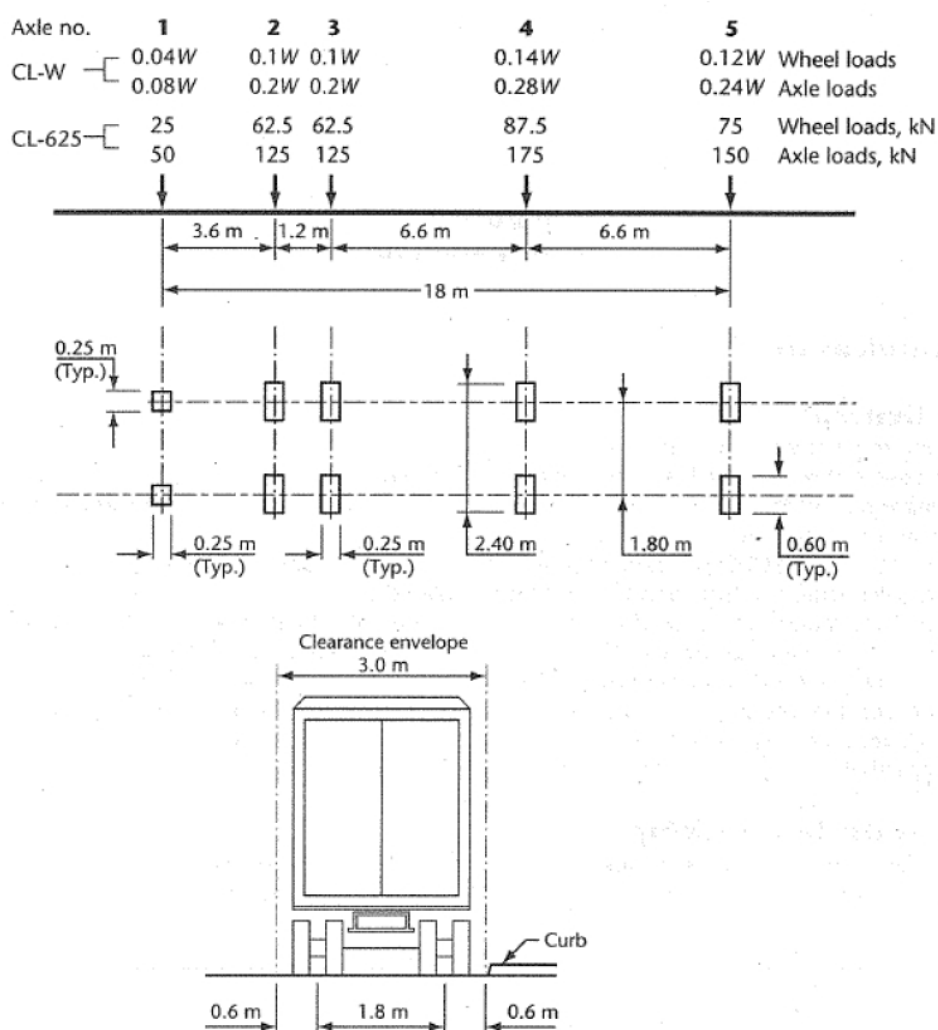
Table 3. Analysis results.

Soil Type	Maximum axle load		Single Point Load		Maximum Bending		Bending	Deflection
	kN	(kip)	kN	(kip)	kN*m/m	(kip*ft/ft)	U.F.	(mm)
Loose sand & soft clay	61	(13.6)	36	(8)	33.6	(7.6)	0.96	9.3
Firm clay	157	(35.2)	36	(8)	32.7	(7.4)	0.94	6
Compact sand	196	(44)	45	(10)	33.6	(7.6)	0.96	4.4

Although the mat was modelled as an isotropic material, the rig mat has different bending capacities in both the longitudinal and lateral directions.

The bending resistance was calculated using the mechanically jointed beams theory, also known as the gamma method.

The bending resistance of the mat in the longitudinal direction is $34.9 \text{ Kn}\cdot\text{m/m}$, while the bending resistance of the mat in the lateral direction is $9.9 \text{ kN}\cdot\text{m/m}$.



CrossLam® Crane Mats

Structurlam crane mats allow you to save money on every truck load. At sixty-four 20ft mats per Tridem, our crane mats have **double** the square footage and **lower** handling costs than a truck load of traditional crane mats.

Our crane mats:

- Are 8' wide and have double the square footage than traditional mats.
- Require less handling and moving of mats because you cover more square footage with wider mats.
- Have no trip hazards; helping to increase safety and decrease injuries.
- Have no bolts; reducing tire damage.
- Include notched ends or cable loops to allow for easy lifting.
- Perform well in extreme conditions.



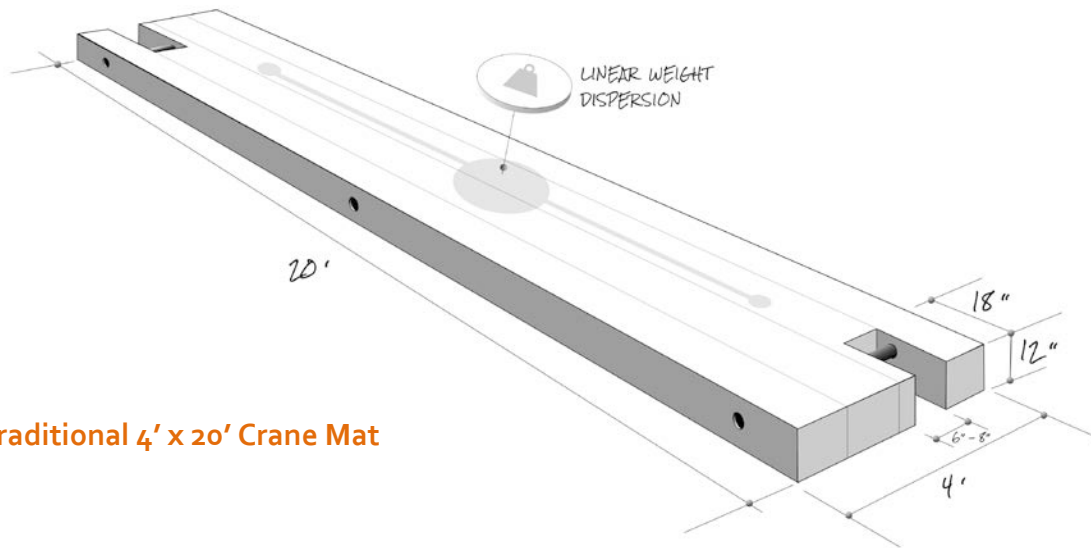
CrossLam® technology allows for weight bearing up to 425psi over ideal soil conditions. CrossLam® crane mats allow cranes to be driven right into position and moved around the construction site. Structurlam will custom build crane mats to any specified size to meet the requirements of a specific site.

CrossLam® Crane Mat Properties

Maximum Size:	10' x 40'
Standard Size:	7' 10 1/2" x 20'
Standard Thickness:	7"
Thickness Range:	4.5" - 12"
Moisture Content:	14% (+ or - 2% at time of production)
Glue Specifications:	Polyurethane adhesive
Wood Species:	SPF & Douglas-fir
Lifting:	Bar or loop

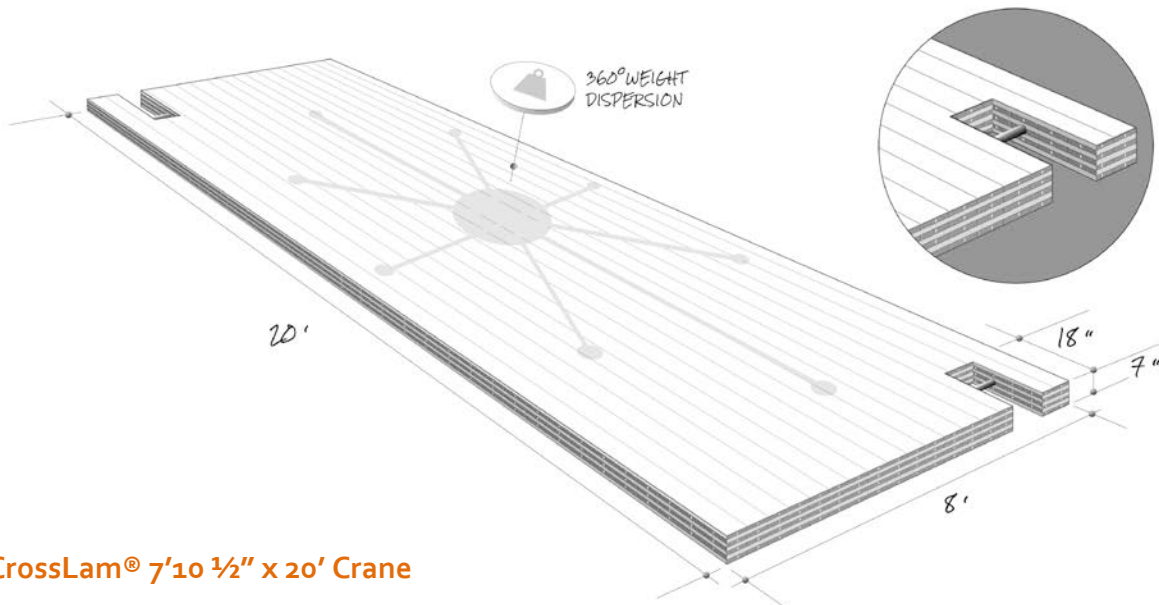


Crane Mat Weight Distribution - Traditional vs. CrossLam®



Traditional 4' x 20' Crane Mat

Traditional crane mats have linear weight dispersion.



CrossLam® 7'10 1/2" x 20' Crane

CrossLam® crane mats allow for 360° weight dispersion.

Crane Mat Shipping – Traditional Bolted vs. CrossLam®

Because of the CrossLam® technology, crane mats are lighter, easier to ship and easier to handle than traditional bolted crane mats.

	Size	Thickness	Weight	Mats Per Tridem Truck	Total Coverage Per Tridem Truck	Mats Per Super B Truck	Total Coverage Per Super B Truck
CrossLam® Crane Mat	7' 10 ½" x 20'	7"	2756 lbs	23	3680 sq.ft	34	5440 sq.ft
Traditional Bolted Crane Mat	4' x 20'	12"	3072 lbs	20	1600 sq.ft	30	2400 sq.ft

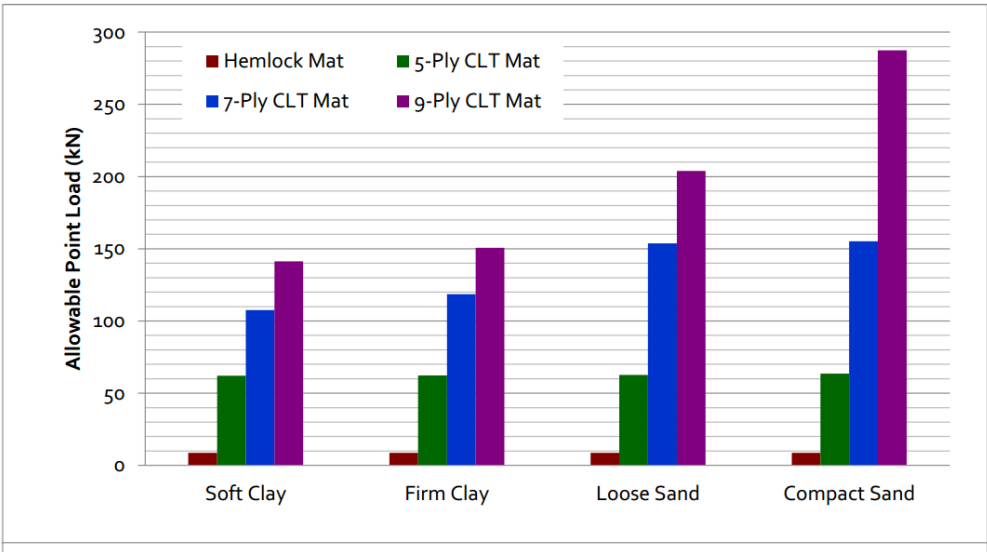
Crane Mat Sizes Available

Sizes	Layers	Weight	Mats per Tridem truck	Mats per Super B truck	Thickness (net)	Sq. Ft.
8' x 20'	5ply	2756	23	34	6 7/8"	160
	7ply	3858	16	25	9 5/8"	160
	9ply	4866	13	19	12"	160
4' x 20'	5ply	1380	46	69	6 7/8"	80
	7ply	1930	33	49	9 5/8"	80
	9ply	2435	26	35	12"	80
5' x 30'	5ply	2585	24	36	6 7/8"	150
	7ply	3620	17	26	9 5/8"	150
	9ply	4560	14	21	12"	150

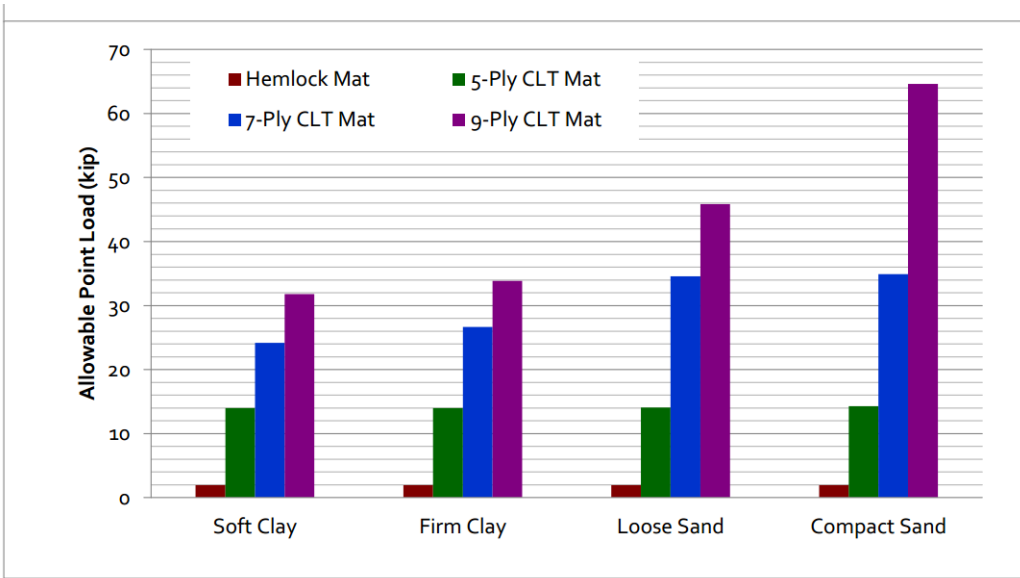
Engineering Analysis of CrossLam® Crane Mats

The maximum allowable loads for each crane mat and soil type are presented graphically below. It is important to note that as the bearing area of the crane mats increases, the subgrade modulus decreases, which will decrease the allowable load and increase deflections.

Allowable Point Loads for a 4ft x 20 ft Crane Mat



Allowable Point Loads for a 8ft x 20ft Crane Mat



Numerical Results

1,219 x 6,096 (4 ft. x 20 ft.) Hemlock Crane Mat

SOIL TYPE	Pmax kN (kip)	Dmax mm (in)		Failure Mode
		Centred	Off-Centre	
Soft Clay	8.6 (1.9)	5.1 (0.20)	7.2 (0.28)	Trans. Bending
Firm Clay	8.7 (1.9)	3.6(0.14)	4.8 (0.19)	Trans. Bending
Loose Sand	8.7 (1.9)	1.3 (0.05)	1.4 (0.05)	Trans. Bending
Compact Sand	8.7 (2.0)	0.5 (0.02)	0.5 (0.02)	Trans. Bending

1,219 x 6,096 (4 ft. x 20 ft.) 5-Ply CLT Crane Mat

Soft Clay	62.2 (14.0)	26.0 (1.02)	46.4 (1.83)	Trans. Bending
Firm Clay	62.2 (14.0)	19.0 (0.75)	31.5 (1.24)	Trans. Bending
Loose Sand	62.6 (14.1)	7.1 (0.28)	1.1 (0.04)	Trans. Bending
Compact Sand	63.5 (14.3)	2.9 (0.12)	3.1 (0.12)	Trans. Bending

1,219 x 6,096 (4 ft. x 20 ft.) 7-Ply CLT Crane Mat

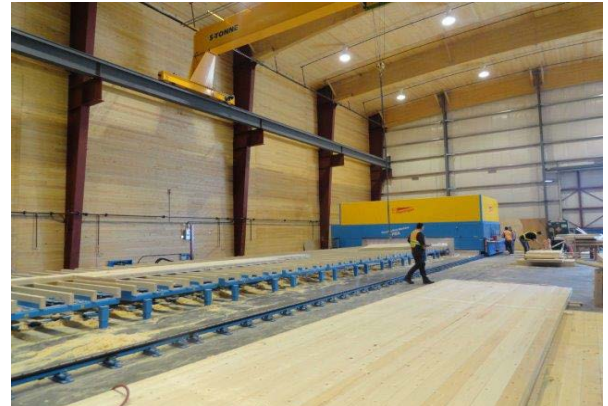
Soft Clay	107.5 (24.2)	33.7 (1.33)	71.3 (2.81)	Long. Bending
Firm Clay	118.6 (26.7)	27.2 (1.07)	54.8 (2.16)	Long. Bending
Loose Sand	153.7 (34.6)	13.4 (0.53)	2.3 (0.09)	Trans. Bending
Compact Sand	155.3 (34.9)	5.5 (0.22)	6.5 (0.26)	Trans. Bending

1,219 x 6,096 (4 ft. x 20 ft.) 9-Ply CLT Crane Mat

Soft Clay	141.3 (31.8)	37.5 (1.48)	85.6 (3.37)	Long. Bending
Firm Clay	150.7 (33.9)	28.9 (1.14)	63.4 (2.49)	Long. Bending
Loose Sand	203.9 (45.8)	14.9 (0.58)	27.4 (1.08)	Long. Bending
Compact Sand	287.5 (64.6)	8.7 (0.34)	12.4 (0.49)	Long. Bending

Quality Assurance

Structurlam is a member of various professional associations and all of our products are certified to meet or exceed industry standards. We adhere to these strict standards to make the development, manufacturing and supply of our products more efficient, safer, cleaner and safeguard our customers. Being a member of the following organizations allows us to share technological advances and good management practice.



American Plywood Association – The Engineered Wood Association -

APA completes the inspection of our plants and the testing of our glue laminated products. Through this process, APA provides Structurlam with its certifications for CSA, ANSI/AITC and JAS.



ANSI - American National Standards Institute - Structurlam is certified under ANSI/APA PRG 320: Standard for Manufacturing Cross Laminated Timber. Structurlam is also certified under ANSI A190.1 for Manufacturing of Structural Glue Laminated Timber.

CSA – Canadian Standards Association - Structurlam is certified under CSA 0177-M89 and CSA 0122-M89 through APA and monitored and inspected by APA to ensure standards are being met.

FSC - Forest Stewardship Council - Under FSC certification, fibre from certified forests is tracked all the way to the consumer through the chain of custody certification system. FSC certification is voluntary and Structurlam is proud to have achieved FSC status.



Cleaning & Phytosanitary Aspects of CrossLam®

When it comes to phytosanitary certification and cleaning, CrossLam® mats are in a league of their own:

1. All lumber sourced from BC and Alberta. No cross border contaminants.
2. All inbound lumber is kiln dried and heat treated meaning no bugs of any kind.
3. Solid surface makes it easy to clean on site (hydraulic broom or pressure wash).

Structurlam's CrossLam® mats offer a Phytosanitary Certificate. This certification is an official document issued by the plant protection organization of the exporting country to the plant protection organization of the importing country. The issuance of Phytosanitary Certificates achieves three major objectives:

- it confirms that the plants, plant products or other regulated articles in the shipment covered by the certificate do not pose an undue risk of introducing quarantine pests from the exporting country into the importing country;
- it informs the plant protection organization of the importing country that the shipment meets its phytosanitary import requirements at the time that the shipment leaves Canada; and
- it facilitates the trade of plants, plant products and other regulated articles between countries.



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