Straker Engineering Services

ENGINEERING REPORT

RE15012 rev 1

Subject	Analysis of Proposed Load Restraint Configurations for Round Cotton Modules
Client	Cotton Australia Pty Ltd
Client Address	115 Campbell St, Toowoomba, QLD 4350
Revision	1
Date	04/06/2024
Report By	Noel Straker

1 Scope and Introduction

Cotton Australia requested that Straker Engineering Services assess the suitability of a proposed load restraint system for the transport of round cotton modules, and its ability to comply with the requirements of the Load Restraint Guide 2018.

The examined configuration is detailed below, along with a summary of the analysis performed.

2 Exclusions

This analysis is an assessment of the load restraint capacity, and does not include any assessment of trailer or load dimensions for the purposes of highway regulation compliance.

3 Reference Material

- Load Restraint Guide 2018, *National Transport Commission*
- Engineering Report RE11049 - Analysis of Proposed Load Restraint Configurations for Round Cotton Modules, *Straker Engineering Service Pty Ltd*

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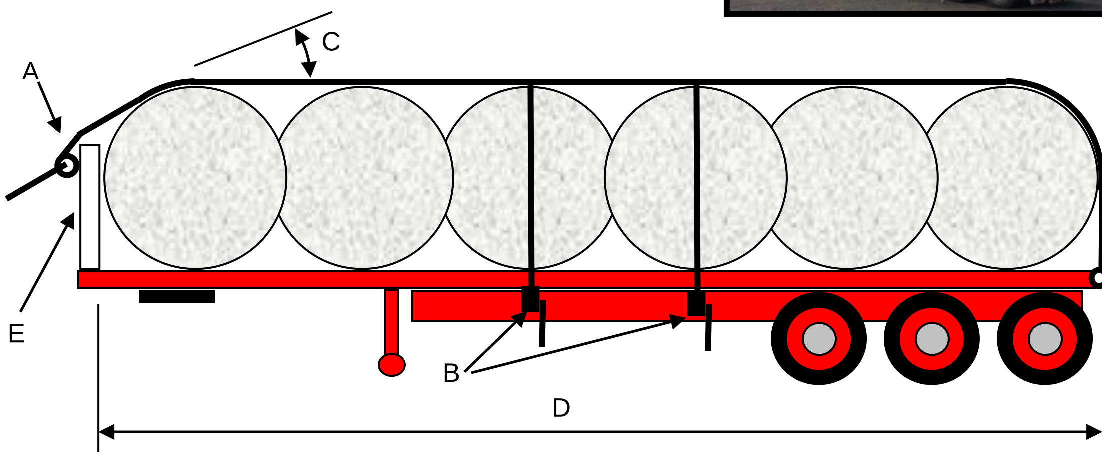
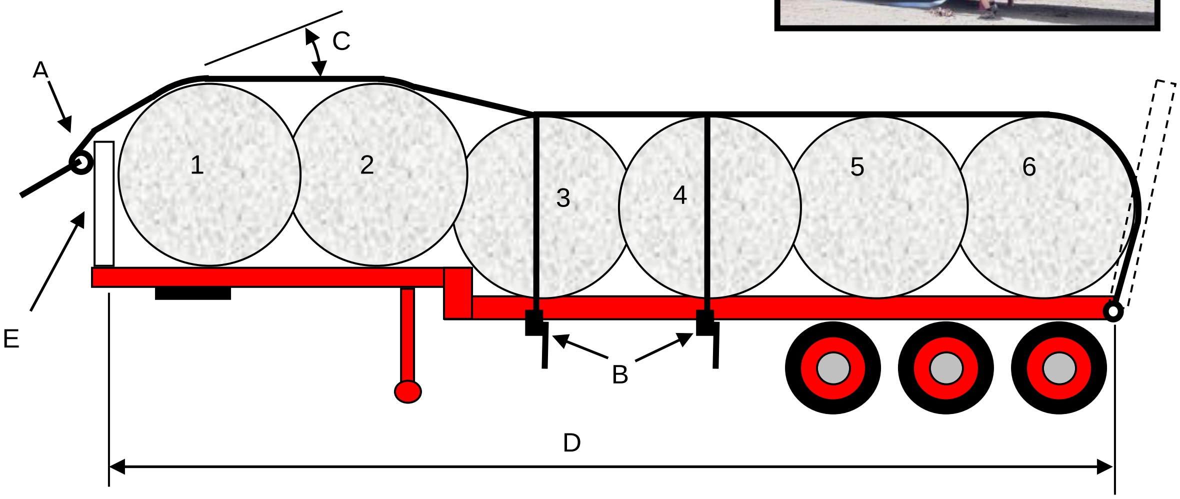
4 Proposed Restraint Configurations

4.1 Flat Bed Trailer



A	75mm or 100mm webbing strap winch (may be located at front or rear) minimum lashing capacity: 4000kg minimum pretension capacity: 1150kgf
B	50mm webbing strap winch, run across top of 100mm strap to opposite tie rail. minimum lashing capacity: 2000kg minimum pretension capacity: 600kgf
C	45° minimum
D	13700mm maximum (maximum 12300mm from kingpin to rear of trailer)
E	Reinforced headboard with minimum forward restraining capacity of 6000kgf
Load	6 off Plastic wrapped cotton modules
Maximum module weight	2500kg
Module nominal dimensions	2438 mm wide x 2286 mm diameter
Trailer Surface	Smooth Steel or Floor plate
Tensioning Sequence	1. Tension longitudinal strap using winch “A” to 1150 kgf (minimum) 2. Tension lateral straps using winches “B” to 600 kgf (minimum).
Maintenance	All components are to be visually examined for evidence of deformation, corrosion, cracking or distortion. If any such damage is noted, the system is to be withdrawn from service until the damage is repaired, or affected components are replaced.

4.2 Drop Deck Trailer



A	75mm or 100mm webbing strap winch (may be located at front or rear) minimum lashing capacity: 4000kg minimum pretension capacity: 1150kgf
B	50mm webbing strap winch, run across top of 100mm strap to opposite tie rail. minimum lashing capacity: 2000kg minimum pretension capacity: 600kgf
C	45° minimum
D	13700mm maximum (maximum 12300mm from kingpin to rear of trailer)
E	Reinforced headboard with minimum forward restraining capacity of 6000kgf
Load	6 off Plastic wrapped cotton modules
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Trailer Surface	Smooth Steel or Floor plate
Tensioning Sequence	1. Tension longitudinal strap using winch "A" to 1150 kgf (minimum) 2. Tension lateral straps using winches "B" to 600 kgf (minimum).
Maintenance	All components are to be visually examined for evidence of deformation, corrosion, cracking or distortion. If any such damage is noted, the system is to be withdrawn from service until the damage is repaired, or affected components are replaced.

5 Design Data

5.1 Design Data

	Data	Value	Source
A	Friction Co-efficient – Module on Smooth Steel	0.4	Engineering Report RE11049 – Straker Engineering Services
B	Inter-module Friction	290 kgf	Engineering Report RE11049 – Straker Engineering Services

6 Calculations

6.1 Forward Direction Restraint

Forward direction restraint is provided by frictional contact with the trailer floor and load blocking contact with the headboard. A summary of the calculation is provided below:

A	maximum module mass	2500kg	
B	number of modules	6	
C	total mass	15000kg	= A x B
D	forward restraint required	12000kgf	= 0.8 x C (Load Restraint Guide 2018)
E	friction due to self weight	6000kgf	= friction co-efficient x C
F	headboard capacity	6612kgf	calculated for 2 off 75x75x3.0 SHS Gr350 reinforcing uprights
G	**total forward restraint**	**12612kgf**	**= E + F (exceeds D therefore acceptable)**

The proposed restraint system has been calculated to provide a forward direction restraint force exceeding the performance standard set out in the Load Restraint Guide 2018.

NOTE: The following sources of additional restraint were conservatively omitted from the calculation above:

- *Friction due to lashing downforce*
- *Blocking and friction due to step in drop deck configuration*

6.2 Rearward direction restraint

Rearward restraint is provided by the longitudinal 100mm webbing strap. A summary of the calculation is provided below:

A	maximum module mass	2500kg	
B	number of modules	6	
C	total mass	15000kg	= A x B
D	friction due to self weight	6000kgf	= friction co-efficient x C
E	100mm webbing strap capacity	4000kgf	Lashing capacity for 100mm webbing
F	**total rearward restraint**	**10000kgf**	**= D + E (exceeds G therefore acceptable)**
G	rearward restraint required	7500kgf	= 0.5 x C (Load Restraint Guide 2018)

The proposed restraint system has been calculated to provide a rearward direction restraint force exceeding the performance standard set out in the Load Restraint Guide 2018.

NOTE: The following sources of additional restraint were conservatively omitted from the calculation above:

- *Friction due to lashing downforce*
- *Blocking and friction due to loading ramps in drop deck configuration*

6.3 Lateral direction restraint

The proposed restraint system acts in two fashions to restrain the load of cotton modules. Firstly, it provides a lashing force to prevent relative movement between the modules. Secondly, it provides lashing downforce to clamping the load to the deck of the trailer.

To determine the efficacy of this restraint system, the ability of the longitudinal strap to prevent relative movement between the modules was first examined. Taking the worst case (modules 2 and 5) a calculation was performed, a summary of which is provided below:

A	Module Mass	2500kg	Specified maximum module mass
B	Friction Coefficient	0.4	Straker Engineering Services – December 2011
C	Friction Due to weight	1000kgf	= A x B
D	Inter-module friction	290kg	Straker Engineering Services – December 2011
E	Total relative restraint between modules	1580kgf	= C + (D x 2)
F	Required restraint (per module)	1250kgf	= 0.5 x A (Load Restraint Guide 2018)

From this it was seen that the inter-module friction would prevent relative movement between the modules until loads exceeding the 0.5g performance requirement.

The load was then considered as a whole unit, and the total lateral restraint requirements were assessed as follows:

A	maximum module mass	2500kg	
B	number of modules	6	
C	total mass	15000kg	= A x B
D	lateral restraint required	7500kgf	= 0.5 x C (Load Restraint Guide 2018)
E	friction due to self weight	6000kgf	= friction co-efficient x C
F	Friction at headboard	660kgf	= friction co-efficient x clamping force (Straker Engineering Services – December 2011)
G	lashing restraint required	840kgf	= D – (E + F)
100mm strap at Module 1			
H	pretension	1150 kgf	Straker Engineering Services – December 2011
I	angle effect	0.7	
J	effective downforce	805 kgf	= H x I
50mm Strap at Module 3			
K	pretension	600kgf	
L	angle effect	2	
M	effective downforce	1200kgf	= K x L
50mm Strap at Module 4			
N	pretension	600kgf	
O	angle effect	2	
P	effective downforce	1200kgf	= N x O
100mm Strap at Module 6			
Q	pretension	1150kgf	
R	angle effect	1	
S	effective downforce	1150kgf	= Q x R
T	total lashing downforce	4355kgf	= J + M + P + S
U	Lashing lateral restraint	1742kgf	= T x friction co-efficient
V	**total lateral restraint**	**8402kgf**	**= E + F + U (exceeds D therefore acceptable)**

The proposed restraint system has been calculated to provide a lateral restraint force exceeding the performance standard set out in the Load Restraint Guide 2018.

NOTE:
The following factors were conservatively omitted for the purposes of this calculation:

- *increases in the tension of the longitudinal strap caused by the tensioning of the mid-strap, and*
- *mechanical interaction present between the strap and end modules where the strap buries into the module.*
- *The additional frictional contribution provided by the step in the drop deck configuration*

While not necessary to achieve the required lateral restraint, the presence of coaming rails provides additional resistance to lateral movement of the cotton modules. From the tests conducted by Straker Engineering Services it has been determined that this will provide a minimum of an additional 150kgf per module for a 25mm coaming rail. It is therefore considered advisable that, where practical, vehicles be fitted with coaming rails to a minimum height of 25mm.

6.4 Vertical direction restraint

Vertical restraint is provided by the combination of the clamping actions of the longitudinal 100mm webbing strap, the lateral 50mm webbing strap and inter-module friction.

It has previously demonstrated for lateral restraint that the inter-module friction generated by the longitudinal clamping effect of the 100mm webbing strap should prevent relative motion of the cotton modules to loads exceeding the 0.5g. In turn, this indicates that the 0.2g vertical direction performance standard should not cause relative movement between modules.

Considering the load as a whole unit, the following calculation was made:

A	maximum module mass	2500kg	
B	number of modules	6	
C	total mass	15000kg	= A x B
D	vertical restraint required	3000kgf	= 0.2 x C (Load Restrain Guide 2018)
	100mm strap –Module 1		
E	pretension	1150 kgf	John Lambert and Associates – March 2011
F	angle effect	0.7	
G	effective downforce	805 kgf	= E x F
	100mm Strap –Module 3		
H	pretension	1150kgf	
I	angle effect	0.5	
J	effective downforce	575kgf	= H x I
	100mm Strap –Module 4		
K	pretension	1150kgf	
L	angle effect	0.5	
M	effective downforce	575kgf	= K x L
	100mm Strap –Module 6		
N	pretension	1150kgf	
O	angle effect	1	
P	effective downforce	1150kgf	= N x O
Q	**total vertical restraint**	**3105kgf**	**= G + J + M + P (Exceeds D therefore acceptable)**

The proposed restraint system has been calculated to provide a vertical restraint force exceeding the performance standard set out in the Load Restraint Guide 2018.

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7 Conclusion

The load restraint configurations detailed in section 4 have been calculated to comply with the performance standards set out in the Load Restraint Guide 2018.

Approved by

Name	Position	Signature	Date
Noel Straker ***MIEAust CPEng NPER RPEQ10652*, *IWE***	Principal Engineer	[signature]	04/06/2024

For and on behalf of Straker Engineering Services Pty Ltd.

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